Preschool-Aged Children's Learning From Video:

Influence of Unrealistic Content, Video Format, and Individual Factors

By

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Abstract

Children's educational TV programs are, in most cases, animated and contain unrealistic (fantastical) content. However, it is yet unclear how these factors influence children's learning. Thus, the purpose of this dissertation was to fill in this gap by examining the influence of unrealistic content, video format, and individual factors on preschool-aged children's learning from video content. Chapter 2 is a review of the literature exploring the possible factors that could explain the inconsistences in results among the studies that have examined the influence of unrealistic contents on children's learning from educational media (e.g., storybooks, videos). This chapter sheds light onto the importance of the degree of fantasticalness of an unrealistic content and the relation between the overall story narrative and unrealistic content on children's learning. For chapter 3, the influence of video format was empirically examined to provide an understanding of whether an animated video format affects children's transfer performance. Preschool-aged children ($N = 67$) were randomly assigned to either an animation or live-action video condition to watch an actor solve a problem. Then, children were provided with an analogical problem to examine children's transfer from video. The results of this study suggest that children's transfer performance was impacted by the video format. The final chapter presents a general discussion that identifies common themes and persistent gaps based on this work, including individual child and family factors.

keywords: animation, video format, fantasy, learning, transfer, television, preschool children, individual factors

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Chapter 1. Introduction

Well-designed educational TV programs help to improve cognitive, literacy, and social outcomes in preschool children (e.g., Crawley et al., 1999; Rasmussen et al., 2016), and such programs can be used as cost effective educational tools to promote learning (Mares & Pan, 2013). However, most of these TV programs are animated and incorporate some sort of unrealistic elements (e.g., anthropomorphic animals, a distant land with fantastical characters) to their program. When considering the preschool period as a time when children begin to understand the symbolic nature of TV (Barr, 2013) and actively construct reality-nonreality distinctions (Sharon & Woolley, 2004), animated format and unrealistic components of the programs could act as obstacles for children to learn and generalize the educational content presented in these programs. However, the literature lacks clear understanding of how unrealistic phenomena depicted in media (e.g., storybook, TV programs) and animated video format influence children's learning. Furthermore, individual child characteristics are often excluded from the discussion. Thus, this dissertation tried to fill in this gap by providing a better understanding of the impact of unrealistic phenomena, animated video format, and individual child characteristics on children's learning. This work is guided by information processing theories which emphasize the influence of limited working memory and cognitive processing, such as encoding, storage, and retrieval, on successful learning (e.g., Siegler & Alibali, 2005).

Preschool Children's Learning From Unrealistic Content

In the past, research has been designed to understand whether children can distinguish between reality and nonreality realms: imagination versus reality (e.g., Wellman & Estes, 1986); magic versus reality (e.g., Rosengren et al., 1994); and fantasy versus reality (e.g., Woolley & Cox, 2007). Only recently, studies have been designed to examine the effectiveness of including

an unrealistic (fantastical) narrative to educational media (e.g., storybooks, TV programs) in order to teach children new information (for review, see Hopkins & Weisberg, 2017). However, the results of such studies are mixed with some studies suggesting that unrealistic elements could help children's learning (e.g., Bonus & Mares, 2018) while others find them to be barriers (e.g., Walker et al., 2015).

This inconsistency across studies could be a product of a wide range of unrealistic contents that have been examined in relation to children's learning from educational media. For instance, some studies have portrayed an anthropomorphic animal by adding anthropomorphic language (e.g., describing the animal with a name and desires) to a story narrative while using a photograph of a real animal (e.g., Ganea et al., 2011) whereas some have used stories that portrayed a distant world with fantastical characters (e.g., fairy land) (e.g., Walker et al., 2015). Since children are sensitive to the degree of fantasticalness of events or entities that are portrayed in a narrative (Geerdts, 2016), one possibility for the mixed results among the studies could be due to the types of unrealistic contents used in the stories (e.g., anthropomorphic animal versus fairy land).

Another possibility of the inconsistency across prior studies could be the overall narrative content of the stories used: unrealistic versus realistic setting (e.g., giant robot at a distant planet versus a boy playing with human friends at an ordinary playground). It is possible that when an unrealistic event is inserted into a realistic narrative, children might consider the whole story as unrealistic. However, some researchers have argued that when children detect events that contradict their core knowledge about the world, such events motivate them to seek and learn new information about topics that contradicted their expectations (e.g., Stahl & Feigenson, 2019). Since unrealistic content in a realistic story narrative could be perceived as a violation of

their expectations, it might serve as a signal for children to pay attention to the content more carefully and subsequently promote learning. Thus, the influence of unrealistic content could be different by the overall story narrative setting.

In sum, there is a need to examine the influence of different types of unrealistic contents and the overall story narrative setting on children's learning to better understand the influence of unrealistic content on children's learning from educational media. The purpose of chapter 2 was to write a review paper that (1) identifies the different unrealistic and narrative contents used in research on learning from unrealistic media content and (2) considers how unrealistic contents in different narrative contents could influence children's learning from educational media.

Impact of Animated Video Format on Children's Learning

In addition to the unrealistic content, animated video format could impact children's learning through its perceptually salient and unrealistic context. Perceptual similarity plays an important role in children's ability to generalize learned information to a different context in their daily lives (e.g., Gentner & Toupin, 1986). This also has been demonstrated to be the case with screen media. Children younger than 3 years of age are less likely to transfer from screen to real life (e.g., Schmidt et al., 2007; Troseth & DeLoache, 1998) and also from real life to screen (Zack et al., 2009). Thus, prior research suggests that the contextual mismatch between the encoded and retrieval cues could lead to a negative impact on children's transfer.

Barr (2013) argued that this difficulty is due to poor representational flexibility in children. That is, children often fail to retrieve a memory in a different context when perceptual cues change (Barnett & Ceci, 2002). Such relation could hold true for preschool children when it comes to transferring from animated videos. Since there is a clear mismatch between perceptual cues in animations versus real-world settings, children might form a specific memory of the information

presented in an animation and not be able to retrieve that memory when they are faced with a similar situation in the real world.

In addition to these bottom-up, perceptually driven factors, there may be top-down, conceptual factors that interfere with learning from animated TV programs. Preschool children are more likely to perceive animated screen content (versus live-action videos) as unrealistic (Li et al., 2015) and as a source of entertainment (Wright et al., 1994). When considering that children's judgement of story content depends on how they perceive depicted images in a story (e.g., Hoffner & Cantor, 1985), children could perceive animated programs as programs that are intended for enjoyment and not for learning. Such perception of animations could further prevent children from retrieving the learned information in real-world contexts by specifically coding the learned information as 'entertainment'.

In sum, even though many educational TV programs are animated, there is a possibility that this format could hinder children's transfer due to perceptual dissimilarity and children's expectations. Furthermore, since unrealistic contents are often confounded with animated video format, it is important to disentangle these two factors to see how each influences children's learning. Such research would, by extension, better our understanding of the influence of educational programs on children's learning. Yet, there has not been a controlled experimental study that examined children's learning from comparable animated and live-action videos. Thus, the second goal of this dissertation was to examine the influence of animated format on children's learning from videos.

Influence of Individual Factors on Children's Learning From Video

Lastly, children's development does not happen in a vacuum but rather through interactions with their environment (Bronfenbrenner & Morris, 2006). This is also true when it

comes to learning from screen media. Theories on young children's learning from screen media posit that learning is moderated not only by media characteristics (e.g., content, format) but also by individual child characteristics (e.g., working memory) (Fisch, 2000; Valkenburg & Peter, 2013). Thus, it is important to acknowledge the influence of individual factors that could influence children's learning from animated and unrealistic video content. Since researchers have proposed that more working memory resources are required to process unfamiliar video content (Fisch, 2000; Lang, 2000) and reconcile perceptual difference between encoding and retrieval contexts (Barr, 2010, 2013), it is possible that children's learning could be moderated by children's working memory capacity. Thus, the role of individual difference was explored in this dissertation.

Conclusion

The purpose of this dissertation was to provide a better understanding of how animated and unrealistic video content influences children's learning. In order to achieve this goal, I first tried to explain the possible reasons for the inconsistency in results among the studies that have systematically compared children's learning from unrealistic and realistic media content. Then, I empirically examined the influence of animated video format on children's analogical transfer performance by comparing it to a live-action video. Furthermore, I explored the role of individual child characteristics in children's learning from educational media. Thus, I hoped to provide a clearer picture of how educational TV programs influence preschool-aged children's learning by providing a better understanding on the influence of unrealistic content and animated video format on children's learning through this dissertation.

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Chapter 2. Should Fantastical Content be a Part of Educational Children's Media?

Introduction

Imagine an educational children's program in which a house cat transforms into an adventurous anthropomorphized (human-like) explorer dressed as a Robin Hood and explores a volcano with its anthropomorphic animal friends. As they explore the mountain, factual information about volcano is presented for children to learn. For children to receive the intended lesson on volcano, they must recognize that the program represents the world that they live and be able to relate the information presented in the program with the real-world referents (e.g., volcano). However, two characteristics of the program could hinder these processes. First, the fantastical content (i.e., anthropomorphic animals) could prevent children from understanding that the program represents the real world and the information presented are relevant to the real world. Second, the low perceptual resemblance between the animated/illustrated volcano to a real-world volcano (low iconicity) could make it difficult for children to recognize the connection between the two volcanos. Even though both characteristics could potentially influence children's learning from educational media (e.g., storybooks, TV programs), the current chapter will focus on the influence of fantastical content on children's learning.

Only recently, studies have begun to examine the effectiveness of including fantastical content to educational media in order to teach new information to preschool-aged children, and a recent review paper suggested that it is hard to definitely conclude what kind of impact the fantastical content has on children's learning from media due to inconsistent findings among the studies (Hopkins & Weisberg, 2017). Thus, the current chapter builds on this prior work by teasing apart the studies that have empirically examined the influence of fantastical contents on preschool-aged children's learning to propose possible factors that could potentially explain the inconsistencies in results, and by providing directions for future research. To do this, I will first

discuss children's understanding of the fantastical realm and how such understanding could influence children's learning. Then, I will provide a summary of current literature and discuss how the influence of fantastical content in media may vary based on the characteristics of both the media content and learner. Finally, I will end with directions on how future research could shed more clarity on the influence of fantastical content on children's learning from educational media.

Children's Understanding of the Fantastical Realm

Young children start to distinguish between reality and nonreality, including the fantastical realm, during the preschool years. Starting from about 3-years of age, children can separate their imagination (e.g., pretend world) from reality and begin to understand that entities from their imagination have unique and different properties than real entities (e.g., Estes et al., 1989; Wellman & Estes, 1986). By 4- and 5-years of age, children can distinguish real from pretend behaviors (e.g., Morison & Gardener, 1978), possible from impossible events (e.g., Shtulman & Carey, 2007; Weisberg & Sobel, 2012; Woolley & Cox, 2007), real from fantastical characters (e.g., Skolnick & Bloom, 2006b), and even different fantastical worlds (Martarelli et al., 2015; Skolnick & Bloom, 2006b).

Such judgements become possible as children acquire foundational knowledge about core domains of the nature (psychological, physical, and biological domains) and integrate such knowledge into their naive theories to help them to explain how the world operates (e.g., Wellman & Gelman, 1992, 1998). With such developed theories, children can make judgements on superficially similar events involving psychological, physical, and biological mechanisms, by referring to causal mechanisms from each domain (Wellman, Hickling, & Schult, 1997). Studies have demonstrated that preschool children do use such theories to make decisions about the

reality status of events and entities (e.g., Rosengren & Hickling, 1994; Sharon & Woolley, 2004; Subbotsky, 1994). For instance, 3- to 5-year-old children were able to use physical, psychological, and biological properties to distinguish between real and fantastical entities by attributing more humanlike properties (e.g., sleeping, getting hurt) to real entities compared to fantastical entities (Sharon & Woolley, 2004).

Children also use their experiences and familiarity as their reference to make reality judgments (e.g., Goulding & Friedman, 2020; Lopez-Mobilia & Woolley, 2016). When an event or entity is outside of their knowledge, they become skeptical and consider them as unreal (e.g., Shtulman & Carey, 2007; Woolley & Ghossainy, 2013). Similarly, some researchers have proposed that children make reality judgement of a novel story by comparing and contrasting it to their own knowledge of the real world (Skolnick & Bloom, 2006a). From about 4-years of age children can distinguish between real and fantastical events depicted in storybooks (e.g., Woolley & Cox, 2007) and can take advantage of cues embedded in a narrative (e.g., scientific, historical) to determine whether unfamiliar objects or characters are real or fantastical (e.g., Corriveau et al., 2009; Woolley & Van Reet, 2006). Furthermore, even 3- to 4-year-old children can use narrative cues when they are prompted to examine whether an event in a narrative is possible or impossible (Corriveau et al., 2009).

In sum, even though children sometimes get confused when making a reality judgement, especially for entities or events that are endorsed by the society (e.g., tooth fairy) (e.g., Rosengren et al., 1994; Sharon & Woolley, 2004) or for which they are less knowledgeable of (e.g., knight) (Morison & Gardner, 1978), children start to distinguish between reality and fantasy by about 3-years of age. Such judgements are based on their naive theories on how the world operates and their own experiences and familiarity with the environment they are in.

Implications of Reality Judgments for Learning

Children's reality judgments can have substantial implications for learning. It could impact children's representation of an information that they encounter from educational media, such as storybooks and TV programs. Since preschool children understand that the real world is separate from a fantastical world (Skolnick & Bloom, 2006b) and what happens in a pretend world does not affect how things work in the real world (Leslie, 1987), it is possible for children to isolate an information that they encounter from a fantastical world as information that is only relevant to that context. Such overtly contextualized mental representation of the information could hinder children's generalization of the encoded information to the real world (e.g., Bransford & Schwartz, 1999).

Studies that have examined the relation between children's reality judgement of educational programs and their learning, have suggested that children are less likely to generalize knowledge from these programs to the real world when they judge the programs to be fantastical (Bonus & Mares, 2015; Mares & Sivakumar, 2014). For instance, when 3- to 5-year-old children were asked to help an experimenter to plan for a fiesta after watching a segment of *Sesame Street* that described what people do during a fiesta a week prior, there was a negative relation between children's memory of the fantastical content and their transfer performance. Children were less likely to transfer their knowledge about fiesta to help the experimenter to plan for the festival when they remembered more fantastical content regardless of age (Bonus & Mares, 2015). Thus, children's reality judgement of the educational content could influence their representation of the encoded information and subsequently impact their generalization of the knowledge.

In addition to the influence of reality judgement on children's representation, such judgements could have an implication on how the educational media, itself, could influence

children's learning as an instructional material. According to Cognitive Load Theory (CLT), a learner's acquisition of new information from an instructional material depends on how the learner's limited working memory resources are utilized by the educational content presented by the material and also by the design of the material itself (e.g., Paas & Sweller, 2014; Sweller, 2011).

CLT posits that the total cognitive resources that are required to process an instructional material is determined by the cognitive resources required to process the intrinsic nature of an educational information (intrinsic cognitive load) and the instructional material itself (extraneous cognitive load) (Sweller, 2010)[1]. An instructional material that requires less cognitive resources to process the material itself, provides an optimal environment for a learner to learn a new information. This becomes especially important when learning a new information that places heavy intrinsic cognitive load because using an instructional material that also places heavy extraneous cognitive load would eventually tax the cognitive capacity of a learner resulting in an impeded learning. However, if the educational content requires low intrinsic cognitive load, then one's learning would not be impacted by how the educational material is designed (e.g., Paas & Sweller, 2014).

Since it is difficult to alter the intrinsic cognitive load without changing the educational content or the prior knowledge of a learner, it is important to design an instructional material, in this case an educational media, in a way that would place less extraneous cognitive load. However, presenting an educational content in a fantastical context could require children to use

[1] According to CLT, three cognitive loads (intrinsic, extraneous, and germane) determine the total cognitive resources that are required to process an instructional material (Sweller, 1998). However, more recently, the germane cognitive load has been suggested to be a part of the intrinsic cognitive load and not provide an independent source of working memory load (Sweller, 2010).

more cognitive resources to process the instructional material and this has been suggested by studies that have examined the association between a fantastical content and children's executive function (Li et al., 2018; Lillard et al., 2015). Children who watched a TV program with a fantastical content showed decrease in effortful control compared to a control group who did not watch a fantastical program, suggesting that more cognitive resources were needed to process the fantastical TV content which led to a poor effortful control performance after watching the fantastical content (Lillard et al., 2015). Thus, when children are faced with an educational content that places heavy intrinsic cognitive load, the presence of a fantastical content could tax children's limited cognitive capacity to adequately process the educational content, leading to an impeded learning.

Alternatively, a fantastical content could turn from an extraneous to an intrinsic cognitive load when it overlaps with an educational content. For instance, if children are presented with a lesson on the day and night cycle and the sun and moon that were portrayed in the media suddenly turns into anthropomorphized sun and moon to reiterate the lesson before it ends, the fantastical content is now central to the educational content. In such case, it could have a different influence on children's learning by drawing children's attention to the lesson itself. Furthermore, prior research has demonstrated that children become motivated to learn when they experience an event that violates their expectations (Stahl & Feigenson, 2019). Since preschool children can judge fantastical contents as violations of their core knowledge, they might be similarly motivated to learn when encountering an 'unexpected' fantastical content in an educational media.

Therefore, children's reality judgement could have substantial implications on children's learning. The influence of fantastical content may not be all or nothing but rather it may vary

depending on how it is utilized in an educational media. When considering that 91.2% of children's popular media (100% in TV and 78.8% in storybooks) contain some sort of fantastical content (e.g., anthropomorphic animals, non-human fantastical creatures) in their narrative (Goldstein & Alperson, 2019), it becomes more important to understand the implications of fantastical content on children's learning. To weigh the evidence, I conducted a review of the literature on young children's learning from realistic versus fantastical media.

Review of Current Research on Children's Learning From Fantastical Educational Media

In this section, a summary of results from empirical studies that directly compared preschool-age children's learning from realistic versus fantastical media is presented. See Appendix A for a table of these studies and a description of how these studies were selected for this review.

Findings Suggest That Fantastical Contents Impedes Children's Learning

Some studies have demonstrated that fantastical contents do impede children's learning from media (Bonus, 2019; Ganea et al., 2014; Larsen et al., 2017; Richert et al., 2009; Richert & Smith, 2011; Walker et al., 2015). When studies manipulated the entire story narrative fantastically, children were less likely to learn the educational information conveyed in such context when compared to a realistic narrative. For instance, Richert and Smith (2011) read a storybook that had either a realistic or fantastical narrative to 3- to 5-year-old children and compared their transfer performance to an analogical problem-solving task. The fantastical narrative involved a young boy solving problems on a distant planet to escape from a giant robot, whereas the realistic narrative depicted a plot where a young boy was solving problems while playing hide-and-seek game with their babysitter. The stories were similar in their structure, and the characters solved similarly structured problems. Yet, when examining children's transfer

performance, children who were read the realistic story were significantly more likely to transfer the target solution from the story to their analogical problem than those who heard the fantastical story.

Negative effects of fantastical contents are found not only when the entire context is fantastical, but also when only the story's protagonist is fantastical, holding other content constant. For instance, when 3- to 5-year-old children were told two versions of the same story while manipulating the reality status of a protagonist (monster versus human child), children who heard the story with the realistic character were more likely to transfer the solution from the story than those who heard about the fantastical character when asked to perform an analogical problem-solving task after hearing the story (Richert et al., 2009). So, preschool children in this study were sensitive to the reality status of the protagonist in the story, and they were less likely to use the story with fantastical character as a source of analog.

Together, these studies suggest that preschool-aged children are less likely to transfer from a fantastical than a realistic content. One possible explanation for such results might be that preschool children perceive fantastical characters and narrative contents as an unreliable source of information for the real world which is consistent with children's understanding that the real world is separate from the fantastical world (Skolnick & Bloom, 2006b). In line with such explanation, Richert and Smith (2011) demonstrated that children's fantasy orientation (engagement in fantastical or imaginary plays) negatively predicts children's transfer from a fantastical content, suggesting that children who have a better understanding of the boundary between these two worlds (fantastical and real worlds) through their plays are more likely to isolate or 'quarantine' the information presented in a fantastical context in the fantastical world (Harris, 2000).

Findings Suggest That Unrealistic Contents do not Impede Children's Learning

In contrast to the studies mentioned above, other studies have found no negative influence of fantastical contents on children's learning from educational media (Bonus & Mares, 2018; Conrad et al., 2021; Ganea et al., 2011; Geerdts et al., 2016; Hopkins & Weisberg, 2020; Richert & Schlesinger, 2017). For instance, when 3- to 5-year-old children learned about camouflage through a storybook, children's learning did not vary based on how the animals in the story were depicted (realistically or anthropomorphically) (Geerdts et al., 2016). Children who were read the anthropomorphically depicted storybook were as likely to remember the facts about camouflage and generalize the concept to other animals as children who were read the realistically depicted storybook. Furthermore, there is some evidence to suggest that children learn better about a science concept when they learn the information from a story with a fantastical content that is relevant to the educational information (Bonus & Mares, 2018) as will be addressed later in the chapter.

So, the results from this group of studies suggest that fantastical contents do not invariably influence preschool children's learning of the factual content from media. Additionally, some researchers have speculated that including unrealistic contents could motivate children to learn by making them to be more attentive to a story content (Bonus & Mares, 2018; Hopkins & Weisberg, 2020; Parker & Lepper, 1992).

What Factors Moderate Whether Children Learn From a Fantastical Media Content?

There is an inconsistency among the results of the studies that have examined the influence of fantastical contents on children's learning. As was summarized above, some studies have found negative impact of fantastical contents on children's learning while others have found no or even positive effect. In order to provide a better understanding of the influence of

fantastical contents on children's learning from media, potential moderators that could explain the differences across studies will be explored in this section. First, factors that could moderate the relation between fantastical contents and learning will be addressed. Then, I will discuss how the degree of overlap between the fantastical and educational contents could influence children's learning.

Potential Moderators for a Fantastical Story Narrative

In order to better understand why there is an inconsistency among the studies, four factors that varied across the studies were examined as possible moderators: differences in unrealistic phenomena, learning domains, learning assessments, and the proximity of fantastical content to reality.

Differences in Unrealistic Phenomena

Studies have used different types of unrealistic phenomena to examine the influence of fantastical contents on children's learning. These phenomena range from anthropomorphic characters (e.g., animals depicted with human-like characteristics), events that violate the natural laws (e.g., a hamster walking through a wall), to a distant world with fantastical characters (e.g., a fairy land) (see Appendix Table A1 for a list of studies that examined each phenomenon). Even though they all represent phenomena that are impossible in the real world, children might perceive them differently. Since children are frequently exposed to anthropomorphic animals in books and TV programs (e.g., Goldstein & Alperson, 2019; Marriott, 2002), they might be more willing to learn from anthropomorphic animals compared to the other types of unrealistic phenomena. Thus, one possible reason for the mixed results might be due to the different types of unrealistic phenomena that researchers have used, specifically anthropomorphic content compared to the other fantastical contents.

Consistent with the view that children might learn better from anthropomorphic animals compared to the other unrealistic phenomena due to their familiarity with anthropomorphic characters, there is some evidence to suggest that anthropomorphic animals do not negatively influence children's learning (e.g., Bonus & Mares, 2018; Conrad et al., 2021; Ganea et al., 2011). For instance, when 3- to 5-year-old children were read a story about how animals protect themselves through the concept of camouflage, there was no difference in children's generalization of the concept to other animals whether the information was presented realistically or anthropomorphically (Geerdts et al., 2016). However, there are results that suggest the opposite: Anthropomorphic animals hinder children's learning from an educational media (e.g., Bonus, 2019; Ganea et al., 2014). For instance, 4- to 6-year-old children, who were read a storybook with a moral lesson about altruistic giving, were more likely to donate stickers that they received from an experimenter to other children after reading a realistic rather than an anthropomorphic version of the storybook (Larsen et al., 2017). Thus, there is an inconsistency even among the studies that have examined the influence of anthropomorphic animals on children's learning.

It is true that the results from the studies that used unrealistic phenomena other than anthropomorphism suggest a negative effect of unrealistic content on children's learning (except for Hopkins & Weisberg, 2020). However, it is hard to generalize from these results due to the limited number of studies (Richert et al., 2009; Richert & Smith, 2011; Walker et al., 2015). More studies would be needed in order to better understand how unrealistic phenomena other than anthropomorphism influence children's learning and to establish generalizability.

In sum, the mixed results across the studies cannot be adequately explained by the different types of unrealistic phenomena alone. There have been mixed results even among the

studies that have used anthropomorphic animals. Furthermore, it is hard to generalize the influence of other types of unrealistic phenomena on children's learning due to the limited number of studies.

Differences in Learning Domains

According to CLT, the level of intrinsic cognitive load needed to process an educational content is determined by the underlying level of element interactivity of the educational content (Sweller, 2010). An element refers to anything that needs to be learned or has been learned, and the level of cognitive load is determined by the level of interactivity among the elements. For instance, learning a name of an animal requires no interaction with other elements since it can be learned in isolation, whereas learning about an abstract biological concept like camouflage requires more interactions among different elements (e.g., prior knowledge about predator-prey relationship, new knowledge on the relation between color of an animal and the environment). Thus, a learning domain that requires heavy element interactivity would mean that it would require more cognitive resources for children to process the information (heavy intrinsic cognitive load). Therefore, the complexity of a learning domain could be a factor that could explain the differences among the studies.

There is some evidence to suggest that a fantastical content could hinder children's learning when an educational content is complex. For instance, studies that have examined children's learning of a procedural knowledge (i.e., problem-solving skill) have demonstrated that children are less likely to transfer of a solution from a story to their analogical problem when they learn the information from a fantastical story content (Richert et al., 2009; Richert & Smith, 2011). However, this does not always seem to be the case. In a different study, children were as likely to utilize a procedural knowledge that they learn from a fantastical story to solve an

analogical problem when the fantastical content was relevant to the problem-solving information conveyed in the story (Richert & Schlesinger, 2017). Thus, fantastical contents do not always negatively impact children's learning from a complex lesson. Also, it does not seem like children are less influenced by a fantastical content when an educational content is less complex (i.e., learning facts about a novel animal). For instance, when 3- and 5-year-old children were presented with some facts about novel animals (e.g., cavy) through either a storybook that depicted the animals anthropomorphically or realistically, children who were read the anthropomorphic version of the book were less likely to generalize the information that they heard from the storybook to real animals (Ganea et al., 2014). Thus, the mixed results do not seem to be a product of differences in the complexity of educational contents used across studies.

Learning domain not only differed by the complexity of educational contents but also by the subject of educational contents that were used among the studies: biology, problem-solving, moral lesson, and causal reasoning. Even though a majority of the inconsistencies resulted from studies that have used biology as their subject domain, it is also important to note that it was the most examined subject domain (7 out of 12 studies have used biology) (see Appendix Table A2). For the other subject domains, there were only one study per domain, except for the problem-solving domain. Such limited number of studies makes it hard to generalize what the influence of fantastical content is in each domain, and thus replication is much needed. Even for the problem-solving domain, all three studies were conducted from the same lab and replications from other labs would provide even a stronger support for generalizability. Thus, it is premature to conclude whether subject domain moderates the influence of fantastical contents on learning, and more research is needed especially in the domains other than biology to consider whether fantastical contents would influence children's learning differently by a subject domain.

Differences in Learning Assessments

Another possible explanation for the mixed result could be due to how children's learning was assessed. Two general types of learning assessments were used in the studies reviewed here: memory recall and transfer. As was explained in the earlier section, children could potentially form an overly contextualized mental representation of an information that was presented in a fantastical content. Having such an overtly contextualized representation of the encoded information could hinder children from generalizing the information to a different context, in this case the real world (Bransford & Schwartz, 1999). Thus, it is possible that the studies that have found a negative influence of fantastical content on learning have assessed transfer. Consistent with this view, there is some evidence to suggest that fantastical contents have a disproportionate effect on transfer beyond the content in which the information was learned. For instance, Richert and Smith (2011) found no difference in children's general memory or solution memory of a story whether it was read in a realistic or fantastical version of a storybook. However, children who were read the realistic story were more likely to transfer the target solution from the story to their analogical problem than those who heard the fantastical story. So, children who were read the fantastical story remembered the story content and the solution as well as the children in the realistic condition, but they were less likely to transfer the solution from the story to a similar problem in a different situation (the real world) than those in the realistic condition.

Even though this seems like a very plausible explanation and some studies that have examined transfer performance have found a negative influence of fantastical content (e.g., Bonus, 2019; Larsen et al., 2017; Walker et al., 2015), there are studies that have demonstrated that children perform similarly even when learning is assessed through transfer (Geerdts et al., 2016; Hopkins & Weisberg, 2020; Richert & Schlesinger, 2017). For instance, when 3- to 5-

year-old children were read a storybook on camouflage that varied by language (factual versus anthropomorphic language) and illustration (realistic versus anthropomorphic illustration), there was no different in children's recall of the camouflage facts regardless of the anthropomorphic content (Geerdts et al., 2016). Furthermore, the anthropomorphic content did not have any negative influence on children's transfer of the learned facts about camouflage to other animals. Thus, the differences in learning assessments do not by themselves explain the full set of mixed findings among the studies.

Differences in the Proximity of Fantastical Content to Reality

Then, why do children sometimes learn equally well or even better from a fantastical narrative compared to a realistic narrative and other times fail to learn? One plausible explanation might be that children are sensitive to the degree of fantasticalness that is portrayed in a narrative (Geerdts, 2016). Woolley (1997) suggested that ontological judgements are made on a continuum. This continuum of ontological commitment ranges from how we perceive the world is really like on one end to sheer fantasy, where nothing is impossible, on the other end. Depending on where a fantastical phenomenon is placed on this continuum, it can be perceived to be closer to or distant from the reality. So, if an unrealistic phenomenon portrayed in the media is closer to the reality, then it might not have a significant influence on children's learning. On the other hand, if a phenomenon is portrayed and perceived to be closer to the fantastical realm, then it could have a detrimental influence on children's learning. Thus, children's learning of an educational content from a fantastical narrative could depend on the extent to which the fantastical content represents a departure from reality.

There is some evidence to suggest that children's learning varies by how a fantastical content, specifically anthropomorphic animals, is depicted in a story. For instance, Ganea and

colleagues (2014) presented information about unfamiliar animals (i.e., oxpeckers, cavies, handfish) to 3- and 5-year-old children by using a storybook which used extremely humanized depictions of the animals. The animals were depicted to wear clothing, dine on a dining table with a fork and knife, and sleep on a bed wearing pajamas. In this study, children were less likely to extend the facts about the animals that were presented in the storybook to real animals when they were read the anthropomorphic version of the book. However, when the same age range of children were presented with a biological concept (i.e., camouflage) in a storybook that depicted the animals with some human-like characteristics (e.g., human-like posture, facial expressions) but in a more naturalistic environment, there was no difference in children's generalization of the concept to other animals when compared to children who were read a realistic version of the book (Geerdts et al., 2016).

Thus, the degree of anthropomorphic depiction could be driving the difference in the results of these two studies. When children are presented with a narrative that contains an extremely humanized depiction of non-human characters, children might consider such depictions as less realistic and more of a description of a distant, fantastic world. Furthermore, such depiction could make it harder for children to recognize the similarity between the story and a situation in the real world and to transfer what they have learned. However, subtle anthropomorphic depictions could have less of an impact on children's learning.

In a study that examined how children respond to a pretense that contradicted their general knowledge, 3- and 4-year-old children protested to and corrected a storyteller when they were told of an animal that made an atypical sound (e.g., a duck making 'oink' sound) (Van de Vondervoort & Friedman, 2017). However, this was not the case when they were told about a subtly depicted anthropomorphic animal (e.g., a duck saying 'Nice to meet you'). Similar to how

children responded to an animal that made an appropriate sound (e.g., a duck making ‘quack’ sound), children did not protest to or correct the storyteller when they heard about the anthropomorphic animal. Thus, it seems plausible that when subtle anthropomorphic animals are presented in a story, children might not consider such characters as entities that violate their general knowledge and subsequently do not negatively influence their learning.

Among the studies that are reviewed in this chapter, those that have used a subtle anthropomorphic depiction of animal characters have found either no difference or improved learning when compared with a realistic condition (see Appendix Table 2). This subtle depiction includes using a photograph of real animals with anthropomorphic language (Conrad et al., 2021; Ganea et al., 2011), illustrations of real animals with anthropomorphic language (Ganea et al., 2014; Geerdts et al., 2016), and subtle anthropomorphic illustrations with anthropomorphic language (Bonus, 2019; Bonus & Mares, 2018; Geerdts et al., 2016; Richert & Schlesinger, 2017). However, similar to studies that have used characters and narratives that portrayed a sheer fantastical world (Richert et al., 2009; Richert & Smith, 2011; Walker et al., 2015), studies that have used an extreme anthropomorphic depiction of animals showed a negative influence of the anthropomorphic content on children’s learning (Ganea et al., 2014; Larsen et al., 2017).

The explanation that children’s learning of educational content from a fantastical narrative could depend on the extent to which the fantastical content represents a departure from reality, also aligns well with an individual difference that Larsen and colleagues (2017) found in their study. There was a positive association between preschool children’s tendency to attribute human-like behaviors to anthropomorphic animals and their transfer after hearing an anthropomorphic story. Children who attributed human-like behaviors (e.g., sleeping on a bed) to anthropomorphic animals during a categorizing task, were in turn more likely to share some

stickers they received with other children after hearing the story with a moral lesson on altruistic giving than those who did not. So, for those who have the tendency to perceive anthropomorphic animals to behave like humans, hearing a story with extremely depicted anthropomorphic animals might not have triggered them to think of the story as a depiction of a fantastical world and subsequently resulted in a better learning.

Thus, it appears preschool children are sensitive to the underlying proximity of anthropomorphic content to reality when selectively learning novel information from stories. Children are likely to learn from a fantastical content when it does not fall far away from the reality. However, when the fantastical content drifts farther away from the reality, children may be reluctant to consider the information presented in those contexts as relevant information to the real world. In this case, children may quarantine the information in the fantastical world (Harris, 2000; Richert & Smith, 2011).

Conclusion

Four possible factors that varied across the studies have been examined to see if these factors could be used to explain the mixed results among the studies. Unlike what was expected, differences in the unrealistic phenomena, learning domains, and learning assessments did not by themselves explain the full set of mixed findings. However, the degree of anthropomorphic depictions seems to play a major role in children's learning from a fantastical content; Children were only negatively impacted by the extreme depictions. This explanation not only explains the inconsistencies found among the studies that have explored the phenomenon of anthropomorphism, but also the learning domain of biology. Since all but one study examined the influence of anthropomorphic animals on children's learning in the biological domain, the inconsistency can be explained by the differences in the degree of anthropomorphic depictions.

Furthermore, this is also true for the learning assessment. All but two studies that examined the subtle anthropomorphic animals showed no negative influence on learning regardless of whether the assessment was a near or far transfer. The two exceptions were different from the others in terms of the timing of transfer assessment (Bonus, 2019) and the relevance of the fantastical content to the educational content (Richert & Schlesinger, 2017), and these topics will be discussed later in the chapter. Thus, it appears that children are sensitive to how anthropomorphic contents are depicted in a narrative and are less likely to learn from an anthropomorphic content that are extremely depicted similar to how sheer fantastical contents (e.g., a distant world with fantastical characters) influence children's learning negatively. However, more research is needed since only two studies have used extreme depictions of anthropomorphic animals to examine children's learning. Also, since they are both from the same lab, replications from other labs would provide a stronger support for generalization.

Fantastical Contents and Their Relation to the Educational Content

Even though children's sensitivity to the degree of anthropomorphism does explain a majority of the mixed results, it does not explain all the inconsistencies. Some of the studies have shown that children's learning outcome differs even when the degree of anthropomorphism was similar (e.g., subtle depiction of anthropomorphic animals) (e.g., Richert & Schlesinger, 2017). One plausible explanation for such inconsistencies is the role of fantastical content in relation to the overall story narrative and to the educational content. Even though narrative and educational contents are intertwined with each other in a story, they refer to different information presented in a story (Fisch, 2000). Narrative content refers to the make-up of a story, such as the sequence of events, the goals set and achieved by the protagonists in the story, and so on, whereas the

educational content refers to the underlying educational information that the story is intended to convey.

Most of the studies that examined the influence of fantastical contents on children's learning have used stories that have well integrated the fantastical content into the narrative and educational content. Whether this was accomplished through illustrations (e.g., image of a fantastical monster) and/or the narrative language (i.e., anthropomorphic language), the fantastical theme was carried throughout the story. Also, the educational content was well integrated into the fantastical theme. Thus, the fantastical theme was an integral part of both the narrative and educational contents of the stories.

Instead of using a fantastically themed narrative, some studies have taken a different approach and presented the fantastical contents in a more realistic narrative. (Bonus, 2019; Bonus & Mares, 2018; Hopkins & Weisberg, 2020; Richert & Schlesinger, 2017). For instance, Bonus and Mares (2018) presented their participants with a 3.5-minute-long video clip of an educational TV program which was intended to teach life science to preschool-aged children. This clip started with a realistic narrative where a human protagonist learned facts about the day and night cycle, but during the last 60 seconds of the clip, the protagonist suddenly turned into an anthropomorphic rocket and went to outer space to sing an educational song with anthropomorphized sun, moon, and earth. Thus, different from a story with a fantastically themed narrative, a fantastical content in a story with a realistic narrative might provide different experience to its learners since it stands out as being different from the rest of the narrative. In such case, the degree of overlap between the fantastical and educational contents might predict the influence of fantastical contents on learning.

Fantastical Contents That are Relevant to the Educational Content

When a fantastical content is included in a realistic narrative, children might automatically consider the whole story as fantastical as they might do for a fantastically themed narrative. However, it is also possible that children could approach the fantastical content with a different attitude when included in a more realistic narrative. They might be surprised by an unexpected fantastical event, and this could enhance their motivation to learn the new information presented through such an unrealistic presentation in a realistic narrative.

Some researchers have suggested that children's core knowledge about the world might scaffold learning by enabling children to detect events that contract their knowledge and motivate them to seek and learn new information that contradicted their expectations (e.g., Stahl & Feigenson, 2019). In support of such assumption, studies have demonstrated that children across ages become more curious and exploratory, and learn better when they encounter violation of their expectations (e.g., Bonawitz et al., 2012; Stahl & Feigenson, 2015, 2017). For instance, infants were better at learning a hidden property of a novel object (i.e., making a sound) when the object itself violated their expectation (e.g., object floated in midair instead of dropping to a table) (Stahl & Feigenson, 2015). Similarly, preschool-aged children were better at learning a novel word (both nouns and verbs) when it was paired with a novel object that violated a physical law (e.g., object reappeared from a cup on the right when it was initially hidden under a cup on the left) than when the object did not show any violation (Stahl & Feigenson, 2017). Furthermore, children were better at recalling target nouns (names of animals, plants, and objects) after reading a story when the nouns were portrayed in a fantastical way (e.g., it never dies) than without such description (Banerjee et al., 2013). So, children show sensitivity to a violation of their expectations and this sometimes drives their learning.

Such curiosity to unexpected events might also apply to a fantastical phenomenon that happens in a realistic narrative. Children who watched a protagonist suddenly turn into an anthropomorphic rocket to sing with other anthropomorphic characters in Bonus and Mares' (2018) study, could have perceived the content as a violation of what has been happening in the narrative. This, in turn, could have motivated them to try to better understand what was happening in the video, resulting in a better learning outcome. In fact, children who watched the anthropomorphic version of the video showed increased knowledge about the day and night cycle after watching the video and were more likely to mention the facts learned from the video than children in the realistic condition. Thus, the fantastical content could have enhanced children's motivation to seek and learn more information that is relevant to the violation that they observed.

However, this explanation should be taken with a caution since the same study also found no condition effect when the educational topic was on characteristics of butterfly feet. Children in both the realistic and fantastic conditions were equally likely to mention the facts learned about butterfly feet after watching the videos. The null effect was also found in another study that examined 3- to 5-year-old children's learning of insect communication (e.g., bee dancing) from a short video clip (Bonus, 2019). Even though this study also included anthropomorphic animals dancing to an educational song at the end of video, it found no difference in children's recall of the facts when tested immediately after watching the video compared to those who watched the realistic video.

One possible reason why children recalled more facts from the anthropomorphic version of the day and night cycle lesson could be because of the novelty of the anthropomorphic characters. Children might not have been as familiar with the anthropomorphic rocket, sun,

moon, and earth as anthropomorphic animals. Such unfamiliar characters might have been more likely to be tagged as a clear violation than the subtle anthropomorphic animals which are more prevalent in children's media, and such perception could have led children to be more motivated to learn from the day and night cycle video.

Thus, there is some evidence to suggest that when subtle depiction of anthropomorphic animals is presented during an educational content and is relevant to the content, children's learning does not get hindered by the fantastical content. There is even evidence to suggest that it could facilitate children's learning. However, more research is needed to better understand how a fantastical content that is relevant to an educational content influences children's learning from a realistic narrative. Since the two studies mentioned here only examined near transfer (e.g., cued recall), it would be important to examine how a relevant fantastical content influences children's far transfer to better understand the full extent of the influence of relevant fantastical contents on children's learning.

Fantastical Contents That are Irrelevant to the Educational Content

It is also possible to have a fantastical phenomenon that is irrelevant to an educational content to be included in a realistic narrative. For instance, Hopkins and Weisberg (2020) used a story where a child protagonist's day was portrayed in two settings: one at home while performing some household chores and the other at a park while playing on a seesaw with friends. The fantastical contents (e.g., hamster walking through a wall) were presented while the child was performing chores whereas the educational content (e.g., balance lesson) was presented while the child was at the park. Even though children who were read this story might have perceived the fantastical contents as violations of their core knowledge, such contents could

have a different impact on children's learning since they were irrelevant to the educational content.

The enhanced learning after observing a violation of expectation found in Stahl and Feigenson's (2015, 2017) studies only applied to the target object that caused the violation. For the case of preschool children, learning of a novel word improved only when it was associated with the target object and not with a different object that was in the background while the violation occurred (Stahl & Feigenson, 2017). Thus, the enhanced learning was not due to an overall increase in attention but rather it was specifically tied to the violating object. Therefore, we could also expect the similar result when it comes to learning from a fantastical content; The benefit of learning from a fantastical content would only apply if the content was a part of an educational content. Thus, if a fantastical content is irrelevant to an educational content, then there should be no benefit of observing such violation on learning.

In fact, research on seductive details, interesting but irrelevant information to an educational content, suggests that such irrelevant information could negatively influence learning (for review, see Rey, 2012). Harp and Mayer (1998) suggested three explanations for why seductive details might negatively influence learning: distraction from a relevant information, disruption in coherent comprehension, and diversion from activating relevant schemata to incorporate new information. Together these explanations suggest that cognitive capacity might be of a great importance in explaining the effects of seductive details on learning.

Since a seductive detail is a part of an instructional material design, some researchers have argued that a seductive detail can be considered as an extraneous load factor (Park et al., 2011). Thus, one possible way that seductive details could influence learning is through increasing the total cognitive resources required to process an instructional material. The

increase in the extraneous cognitive load as a consequence of having some seductive details in an instructional material could in turn overstrain the cognitive capacity of a learner especially when an educational content places a heavy intrinsic cognitive load, resulting in an inadequate learning of the educational content.

Since a fantastical content that is irrelevant to an educational content is a seductive detail in nature, it could also have a similar negative impact on children's learning. For instance, when 4- to 6-year-old children watched a 2-minute video of an animated-child protagonist solving a problem which also included some anthropomorphic animals singing and dancing irrelevant to the problem, they were less likely to transfer the solution from the video to an analogical problem compared to children who watched a video that was either realistic (i.e., an animated child solving a problem without any anthropomorphic animals) or fantastical but relevant to the problem-solving task (i.e., an anthropomorphic animal helping an animated child to solve a problem by enacting the problem-solving task) (Richert & Schlesinger, 2017).

Unlike the other conditions, children who watched the video with fantastical seductive details, were faced not only with learning about a procedural knowledge to solve an unfamiliar problem (baseline children could not solve the problem), but also, they had to process the additional seductive details that was presented in the video. Such inclusion of seductive details could have placed heavier extraneous cognitive load and consequently taxed children's cognitive resources to adequately process the educational content as was explained earlier. Thus, this study suggests that fantastical seductive details could negatively influence children's learning when the educational information is complex.

One way to mitigate such negative effect of a seductive fantastical detail is through prior knowledge of a learner. According to CLT, prior knowledge of an educational content could

serve to alleviate the intrinsic cognitive load placed to process the educational content. In fact, Hopkins and Weisberg (2020) found that for an educational concept that children were more knowledgeable of (e.g., inheritance), seductive fantastical detail did not negatively influence children learning. This finding is in line with studies with adults that have demonstrated that learners with prior knowledge of an educational content were less affected by the inclusion of seductive details in educational materials (e.g., Canham & Hegarty, 2010; Park et al., 2015).

So, the results suggest that when fantastical seductive details are included in an educational media, children's learning depends on the complexity of the educational content and also on the knowledge level of the children for that particular content. When children are learning about a content that is difficult or for which they have no prior knowledge, then the fantastical seductive details may impede children's learning. However, when one has a prior knowledge of the educational content, the inclusion of fantastical seductive details might not have a negative effect. However, more research is needed to better understand whether such assumptions are true. More research needs to be conducted by varying the difficulty level of the educational content and try to see how fantastical seductive details influence children's learning.

Conclusion

The influence of fantastical contents seems to vary by how much the content overlaps with an educational content of an educational media. When it is relevant to the educational content that the story is intended to convey, then the research suggests that children's learning will not be different from a realistic content. Also, there is some evidence to suggest that it could promote learning. On the contrary, the fantastical content seems to negatively influence children's learning when it is presented as a seductive detail. However, children's prior knowledge could mitigate the negative effect of the fantastical seductive details. Thus, it seems

important to consider how to utilize a fantastical content in an educational media when it is used. However, more research is needed to establish generalizability of the findings.

Long-Term Consequences of a Fantastical Content

Most of the studies mentioned so far have tested children's immediate learning. However, since memory consolidation occurs during sleep and organization of encoded information occurs during sleep memory consolidation (e.g., Feld & Diekelmann, 2015; Stickgold & Walker, 2013), it is possible that with sleep information that was presented with a fantastical content could be tagged as fantastical resulting in children's skepticism of an educational content presented in a story. Thus, even though some of the studies have demonstrated that children's learning of an educational content does not get hindered by a fantastical content when tested immediately after learning (e.g., Bonus & Mares, 2018; Geerdts et al., 2016), it is still questionable whether a fantastical content would influence children's long-term memory and subsequently hinder transfer of the learned information to a realistic context.

A recent study suggests that a fantastical content might influence children's transfer negatively when assessed after a delay. Bonus (2019) assessed 3- to 5-year-old children's transfer of information they learned while watching a video with either real or anthropomorphic bees. Even though there was no difference in children's memory of the facts (e.g., how bees communicate) they learned immediately after watching the video, there was a significant difference in their transfer performance which was assessed after a week of delay. Children who watched the realistic version of the video extended more facts about bee communication to novel bees that they have not watched before compared to those who watched the anthropomorphic video. Just based on this study, it is not clear whether the difference in deferred transfer task was due to the time delay or the difference in the assessments (near versus far transfer) that were used

at the two time-points. However, it suggests that when an educational content is presented with a fantastical content, it could lead to less generalization to a different context with a delay.

One possible explanation for the impeded generalization could be explained by children's growing skepticism of the educational content that was presented with a fantastical content over a course of time. Bonus and Mares (2015) examined 3- to 5-year-old children's learning from a segment of *Sesame Street* by looking at the relation between children's memory, transfer, and reality judgement of the program. Children were presented with a 9-minute video clip which provided information about fiestas (e.g., food, musical instrument, and music) while featuring both human and anthropomorphized puppet animal characters. Children were tested for their memory about fiesta and asked to make a reality judgement about the video content right after watching the video and also after a 5- to 12-day delay period. Children's transfer (i.e., helping an experimenter to plan for a fiesta) was also measured after the delay.

Children learned quite well about fiesta from the video. Furthermore, there was little change in their memory about fiesta after the delay. Even though there was no change in their memory of the educational content, children's reality judgment of the educational content decreased with time. Children's reality judgement for both educational and fantastical contents were lower when measured after the delay, suggesting that children became more skeptical about both contents of the program. Additionally, children's reality rating of the program was related to their low transfer performance. Age predicted children's transfer performance via memory of the educational content of the program but only at high level of perceived reality. Similar but in an opposite direction, there was a negative relation between the memory of fantastical content and children's transfer performance such that children were less likely to transfer the learned information when they remembered more fantastical content regardless of age.

So, this study suggests that children might grow skeptical of an educational content that was presented with a fantastical content with time, and such skepticism hinders children's ability to transfer the learned information to a situation in the real life. This could also be true of the results from Bonus' (2019) study. Since the author did not measure children's reality judgement of the program after the delay, we cannot be sure whether growing skepticism would have influenced their transfer, but it does seem like a plausible explanation given Bonus and Mares' (2015) results.

In sum, examining the influence of fantastical contents on children's long-term memory could be an important factor to understand to have a clearer understanding of the impact of fantastical contents on children's learning. Even though children might not show a difference in their learning immediately after learning an educational information, their transfer of the learned information after a delay might be negatively influenced. Future research should eliminate the confounding factors that was found in Bonus' (2019) study by testing children's transfer performance at both time points so that it is clear that the decrease in transfer is not due to the difference in assessments. Also, examining how children's reality judgement of the story content changes over time will provide a better understanding of how the fantastical content influences children's long-term memory.

Summary and Future Directions

Most of educational media targeted for preschool-aged children include some fantastical elements (Goldstein & Alperson, 2019). When considering the preschool period as a time when children begin to actively construct reality-nonreality distinctions (Sharon & Woolley, 2004), fantastical components of the media could act as an obstacle for children to learn and generalize the educational content presented in these programs. It is possible for children to 'tag' the

information that is presented in a fantastical content as fantastical and fail to recognize its relevance to the real world. Furthermore, the fantastical content could be a source of an extraneous cognitive processing that could hinder children from adequately processing the educational content. Thus, inclusion of a fantastical content in children's educational media could potentially hinder children's learning. However, it is yet unclear what the impact of fantastical contents is on children's learning due to mixed results in the current literature. So, this chapter tried to provide possible explanations for the mixed results by examining the studies that have empirically compared children's learning from fantastical with realistic content.

The studies that were reviewed in this chapter differed from each other in different ways, and four factors were identified to be potential moderators for the mixed results: differences in unrealistic phenomena, learning domains, learning assessments, and depictions of fantastical contents. Among these four, the deceptions of fantastical contents, specifically for anthropomorphic animals, explained most of the inconsistences among the studies. The results of the studies that have examined the influence of subtle depictions of anthropomorphic animals (e.g., human-like facial expression but living in a naturalistic environment) suggest that children's learning does not get negatively influenced by such content (e.g., Geerdts et al., 2016). There was no difference in children's learning from biological and problem-solving domains, and in near and far transfer performances when a subtle anthropomorphic content was used. On the contrary, children's learning was negatively impacted when extremely depicted anthropomorphic animals (e.g., dining with fork and knife, sleeping on a bed with pajamas) were used (e.g., Ganea et al., 2014) similar to how sheer fantastical contents (e.g., fairy land) negatively influenced children's learning (e.g., Walker et al., 2015).

These results suggest that preschool children are sensitive to the underlying proximity of a fantastical content to the reality. When a fantastical narrative drifts farther away from the reality, children may consider the information presented in such narrative as 'fantastical' and might be reluctant to consider that information as relevant to the real world. However, the relation between the degree of anthropomorphic depiction and children's learning should be addressed in a more systematic manner in a future study. Since no study has empirically compared the influence of subtle and extreme depictions on children's learning while controlling for other possible confounding variables, it is hard to know for sure whether the different degree of depictions of anthropomorphic animals have different impact on children's learning. Furthermore, it will be important to examine whether children distinguish between subtle and extreme depictions of anthropomorphic animals and perceive one to be closer to the real world than the other. Without such understanding, it will be hard to conclude what is causing the difference in learning from subtle and extreme anthropomorphic contents.

Another moderator that seems to influence children's learning from a story with a fantastical content is how well the fantastical content is integrated with an educational content of a story. When a fantastical content is included in a more realistic narrative, the influence of such content seems to depend on whether it is relevant or irrelevant to an educational content. When it is well integrated to the educational content, it does not seem to negatively impact children's learning (Bonus, 2019; Bonus & Mares, 2018; Richert & Schlesinger, 2017). In fact, Bonus and Mares (2018) suggested that a fantastical content could facilitate learning. Such result is supported by studies that have demonstrated that children's learning is enhanced when they observe violations of their core knowledge (e.g., Stahl & Feigenson, 2017). Thus, children who

watched a fantastical content might have perceive the content as a violation of what can be expected in the narrative, and this could have triggered their learning.

Even though the results described above suggest that relevant fantastical contents have no or positive effect on learning, more research is needed to provide a better understanding of how a relevant fantastical content could influence children's learning. Future research should examine whether children's learning would be influenced differently if a relevant fantastical content is presented with an initial presentation of an educational information. Most studies examined in this chapter have utilized the fantastical content as a way to reiterate the educational content learned earlier in the story. Thus, it is not really clear how children's learning would be influenced if the initial educational information was provided with a fantastical content even though Richert and Schlesinger's (2017) study suggests that it might not matter. Second, all studies used subtle depiction of anthropomorphic animals in their stories. Since children seem to be sensitive to the degree of depiction of anthropomorphic animals, it will be important to examine whether the similar effects will hold even when the relevant fantastical content involves extremely depicted anthropomorphic animals. If not, this would suggest that when an extremely depicted anthropomorphic content is presented in a story narrative, regardless how realistic the story narrative might be, children might consider the content as irrelevant to the real world.

Contrary to the studies that have found well-integrated fantastical contents to have no (even positive) effect on children's learning, fantastical contents seem to have a negative impact on children's learning if they are irrelevant to the educational content. Children were less likely to transfer solution from a video to an analogical problem after watching a video with a fantastical seductive detail than those who watched either a realistic video or a video with a relevant fantastical content (Richert & Schlesinger, 2017). However, such negative influence of

fantastical seductive detail seems to be mitigated by children's prior knowledge of the educational content that was presented (Hopkins & Weisberg, 2020). These results align well with how cognitive load theory suggests seductive details and prior knowledge might influence learning from an instructional material: Extraneous cognitive processing required by a fantastical seductive detail could limit learning through taxing one's cognitive capacity but having a prior knowledge would alleviate the cognitive capacity burden through lowering the intrinsic cognitive load (e.g., Paas & Sweller, 2014).

In sum, there are different factors that need to be considered to understand the influence of fantastical contents on children's learning. For a fantastical story narrative, the degree of depiction of anthropomorphic content influenced children's learning: Children were less likely to be influence by a subtle than extreme depiction of an anthropomorphic content. For a realistic narrative, the degree of overlap between the fantastical and educational contents also must be considered: Children were less likely to be influenced by a fantastical content (subtle anthropomorphic animals) that was relevant to the educational content than when it was not. However, such results should be taken with a caution since the learning was only assessed immediately after children were presented with the learning materials, and the fantastical content might influence children's learning differently when assessed after a delay.

One purpose of education is for learners to maintain the learned information overtime and apply the information to a new situation whenever needed. However, there is a possibility that children might become more skeptical of an educational information when presented with a fantastical content over time (Bonus & Mares, 2015), and this could subsequently negatively influence their generalization at a later time (Bonus, 2019). Thus, in order to have a clear understanding of how a fantastical content influences children's learning from educational

media, future research should not only examine the immediate effects of fantastical contents, but also the long-term effect of fantastical contents on children's learning. It will also be important to examine how children's perception of an educational content (e.g., reality judgement) changes over time when presented with a fantastical content so that we can understand how fantastical contents influence children's learning over time.

Lastly, some studies have demonstrated that children's learning from a fantastical content gets influenced by children's individual factors (Larsen et al., 2017; Richert & Schlesinger, 2017; Richert & Smith, 2011). For instance, there was a positive association between preschool children's tendency to attribute human-like behaviors to anthropomorphic animals and their transfer after hearing an anthropomorphic story (Larsen et al., 2017). However, contextual factors have been mostly omitted in the studies even though they play an important role in children's understanding of the fantasy-reality distinction (e.g., Corriveau et al., 2015; Rosengren et al., 1994; Woolley & Cox, 2007). Thus, future research should examine the influence of contextual factors since they might have an indirect influence on children's learning from educational media with a fantastical content.

One possible contextual factor that could moderate children's learning from a fantastical content is how parents explain unrealistic phenomena to their children. Parents try to explain causal mechanism of extraordinary events with scientific explanations when asked by their children, but they sometimes may resort to using magical explanations (e.g., Rosengren & Hickling, 1994). Similarly, parents could also provide explanations of fantastical events depicted in educational media as something that only happens in TV/books while co-viewing/reading with their children. This could influence children's perception of educational media as something that is unreal and in turn impact their learning of the educational content. Thus, it will be informative

to examine parent's coviewing behaviors (e.g., how parents explain fantastical contents in media, whether they help children to recognize the relation between the educational media and the real world) and how such behaviors relate to children's learning from a fantastical educational content. Such information will allow us to understand not only how children's learning is influenced by the content presented by the media but also how the environment influences children's learning from the media.

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Appendix A

Empirical Studies on Children's Learning From Fantastical Contents

To examine the influence of fantastical contents on children's learning from educational media, results from twelve empirical articles were examined. These articles were selected for meeting the following criteria: 1) studies that included 3- to 5-year-old children as participants; 2) studies that presented educational content through a storybook (including vignettes with pictures) or video as educational material; and 3) studies that directly compared children's learning from realistic with fantastical conditions.

To search for the articles, I utilized Google Scholar and the reference of the articles that I found. For each article that I found, I looked at papers cited within the article and searched for studies that I might have missed. I repeated this process with every article until no new articles were found. Table A1 shows the twelve articles that were examined in this chapter. As a note, two articles (Weisberg et al., 2015; Weisberg & Hopkins, 2020) were excluded from this list because they were structured differently from the other studies. One (Weisberg et al., 2015) was an intervention study where children played with toys that resembled the story characters during the intervention week, and the other (Weisberg & Hopkins, 2020) examined children's generalization of information presented in a storybook to a real-life situation only after they were asked to extend the information to a different story context. Due to these reasons, the articles were excluded.

Table A1. Studies That Compared Children's Learning From Fantastical with Realistic Content (Fantasy Type by Subject Domain)

Fantasy type	Subject domain			
	Biology	Problem solving	Moral lesson	Causal reasoning

Anthropomorphic characters	• Conrad et al. (2021) • Ganea et al. (2011) • Geerdts et al. (2016) • ***Ganea et al. (2014)*** • Bonus & Mares (2018)* • ***Bonus (2019)****	• ***Richert & Schlesinger (2016)****	• **Larsen et al. (2017)**	
Violation of natural laws	• Hopkins & Weisberg (2020)			
Distant world with fantastical characters		• **Richert et al. (2009)** • **Richert & Smith (2011)**		• **Walker et al. (2015)**

Note: Studies that found a negative influence of fantastical content are bolded. Studies that found both no/positive and negative influences are bolded and italicized. * = Video was used to present an educational content.

Table A2. Studies by Fantasy Type and Narrative Type

Type of narrative	Influence of fantastical content	Anthropomorphism		Distant world	Violation of natural laws
		Subtle	Extreme		
Fantastical narrative	No or positive effect	• Conrad et al. (2021) • Ganea et al. (2011) • *Ganea et al. (2014) – Subtle depiction* • Geerdts et al. (2016)			
	Negative effect		• Ganea et al. (2014) – *Extreme depiction* • Larsen et al. (2017)	• Richert et al. (2009) • Richert & Smith (2011)	

			Walker et al. (2015)	
Realistic narrative	No or positive effect	• Bonus & Mares (2018)* • *Bonus (2019)* – Immediate recall* • *Richert & Schlesinger (2016)* – Realistic and relevant conditions*		• Hopkins & Weisberg (2020)
	Negative effect	• *Bonus (2019)* – Delay transfer* • *Richert & Schlesinger (2016)* – Irrelevant condition*		

Note: Studies that found both no/positive and negative effects are italicized. * = Video was used to present an educational content.

Chapter 3. Connecting Live-Action and Animation to Reality: Children's Analogical Problem Solving From Videos

Introduction

The majority (70%) of popular children's television programs in the United States are animated (Taggart et al., 2019). Such prevalence of animated video content for children could be because children pay more attention to such formats of video (e.g., Alwitt et al., 1980; Schmitt et al., 1999) and perceive them as a source of entertainment (Wright et al., 1994). Even though prior research has shown that children can learn and transfer from animated content (e.g., Bonus, 2019; Bonus & Mares, 2018; Mares & Sivakumar, 2014; Richert & Schlesinger, 2017; Schlesinger et al., 2016), the animated format of videos nonetheless create barriers that could limit the extent of children's transfer of the learned information from screen to real-life situations.

Transfer of educational information learned from animated video content could be particularly challenging since animations alter the perceptual features of educational content and removes it from reality. Unless children recognize the connection between the animated context on screen and the world in which they live, the information learned through animations would remain in the animated world. Therefore, it is critical to understand the impact of animation on children's transfer from screen media to real-life problems in order to maximize the educational potential of the nearly 2.5 hours per day children spend with screen media (Rideout & Robb, 2020).

Transfer of Learned Information From Videos

Fisch and colleagues proposed three cognitive processes necessary for transferring educational content from an educational program to a real-life situation: initial comprehension of

the educational content, mental representation of the content, and retrieval of the representation in a novel situation (Fisch et al., 2005). A child's initial comprehension of educational content is a prerequisite for learning. However, comprehension alone does not necessarily lead to transfer of the acquired knowledge. Assuming children have comprehended the educational content, they will need to mentally represent the information in a way that is abstract enough to be applied to a context outside of the learning environment. In addition, they will need to recognize the relevance between the encoded information and a novel real-life situation to retrieve the learned information from memory for a successful transfer. However, the animated format of educational programs could interfere with these cognitive processes and subsequently reduce the likelihood of children's transfer of learned information from videos.

Comprehension of Animated Video Content

Children's comprehension of television is affected by their preconception of the form of the medium, whether the television is for education or entertainment. Children learn better when they watch television to learn than to have fun (Salomon & Leigh, 1984). One reason for such difference might be because of how much mental effort children invest to comprehend the content. For instance, 5-year-old children were more likely to pay more visual attention to a television program when they were instructed to remember the content for a test (Field & Anderson, 1985). This suggests that children deploy their attention differently when they are instructed to 'learn' from a video. Thus, it is possible that when educational content is presented in an animated format, children might invest less mental effort to process the content since children perceive animations as a source of entertainment (Wright et al., 1994).

Mental Representation of Animated Video Content

The extent to which children transfer from animated videos depends in part on the extent to which they mentally represent the information as real and relevant to the world rather than something that exists only on video. Theories on transfer have emphasized the importance of mental representation of newly learned information on the success of transferring to a new situation (e.g., Barnett & Ceci, 2002; Gentner, 1983; Gick & Holyoak, 1983). A mental representation of newly encoded information needs to be abstract enough for the information to be easily accessible in a different situation, but at the same time, it cannot be too abstract for it might lead to an overgeneralization of the learned information (Barnett & Ceci, 2002). On the other hand, if the information being encoded is too closely tied to its initial learning context, then this overly contextualized mental representation could prevent the encoder from recognizing the relevance of new information in a situation with a different context, making it hard to transfer (e.g., Bransford & Schwartz, 1999). This could be the case when children learn educational content from an animated context on a screen.

Young children gradually come to understand television as a medium that represents reality (Troseth, 2010). However, even by 5-years of age, children often fail to correctly judge the reality status of television programs like news and documentary, sometimes referring to such programs as something that is just on television (Wright et al., 1994). Such bias to dismiss television programs as unreal is more prevalent when the format of programs is animated. For instance, 4-year-old children claim realistic as well as unrealistic events (e.g., a boy flying in the sky) that are portrayed in an animated video as events that do not happen in the real world (Li et al., 2015). Furthermore, 5-year-old children consider animations as a form of entertainment by categorizing them as something that just happens on television and is for fun (Wright et al., 1994). When considering that preschool children's judgement of a story content depends on how

they perceive depicted images in a story (e.g., Hoffner & Cantor, 1985), children could mentally represent the educational content in an animated context as something that only happens on screen and is irrelevant to the real world.

Even though this has not been tested extensively with animated video, research on storybooks has demonstrated that preschool-aged children are less likely to transfer information learned from an unrealistic storybook to a real-life situation (e.g., Larsen et al., 2017; Richert et al., 2009; Richert & Smith, 2011; Walker et al., 2015). Some have even suggested that preschool children quarantine information learned from an unrealistic context, consequently interfering with their generalization of information learned from an unrealistic context (Richert & Smith, 2011). Even though these studies incorporated fantastical elements in the unrealistic context (e.g., anthropomorphic animals), they provide insight into how preschool-aged children might perceive and represent information that is presented in an animated video which is different from the world in which they live.

Since children are skeptical of events (and entities) that are outside of their knowledge and experiences (Woolley & Ghossainy, 2013), they might mentally represent the educational content presented in an animated video as information that is only relevant to the perceptually different animated world. Similar to how children were negatively influenced by the unrealistic content in storybooks, it is possible for them to overly contextualize the educational content, closely tying the educational information to the animated world, and fail to recognize the relevance of the information they learned in a real-world situation and transfer.

Transfer From Animated Video Content

In addition to the top-down, conceptual factors described above, there also could be bottom-up, perceptually driven factors that could interfere with children's transfer of information

learned from animated educational media. For a successful transfer to occur, encoded information needs to be recognized as applicable to a new situation and be retrieved to be used in the situation (e.g., Bransford & Schwartz, 1999). However, no matter how similar the mental representation of the encoded information and the present situation might be, if children do not recognize the similarity, then they will not be able to recall and transfer the encoded information to the present situation (Ceci & Ruiz, 1993). One factor that could make the relation between the mental representation and the present situation more transparent is the perceptual similarity between the encoding and retrieval situations. However, an animated context provides a perceptual mismatch rather than perceptual congruity to the real world. Thus, such perceptual mismatch or lack of perceptual overlap between the animated context and the real world could prevent children from recognizing the relation and retrieving the information learned from screen in a real-world setting.

One example of the importance of perceptual similarity on transfer comes from research on analogical reasoning. Even though scholars have demonstrated that the understanding of structural or relational similarity between two analogical situations promotes transfer in both adults and children (for review, see Gentner & Maravilla, 2018), perceptual or surface similarity still plays an important role in facilitating children's understanding of the analogical relation between encoding and retrieval situations by making the relation more transparent (e.g., Gentner & Toupin, 1986; Holyoak et al., 1984). For instance, 5-year-old children were more likely to solve an analogical problem by using a solution presented in a story when the goal object (object that participants were asked to obtain in their analogical problem) was superficially similar to the one used in the story (e.g., ball versus Styrofoam ball) than when it looked different (e.g., apple versus Styrofoam ball) (Daehler & Chen, 1993). Thus, surface similarity between the source

information and the target problem facilitates children's recognition of the analogical relation and makes it easier for children to transfer.

Another line of research that has demonstrated the importance of perceptual similarity is children's understanding of the representational nature of picture books and other symbolic artifacts. Prior research has demonstrated the importance of iconicity, or the level of resemblance between a symbol and its referent, in children's transfer in different domains. For instance, DeLoache, Kolstad, and Anderson (1991) demonstrated that 2.5- and 3.5-year-olds were better at transferring information obtained from a miniature model room to a life-sized room when there was a high level of iconicity between the model and real rooms. The high-level iconicity between the model room (symbol) and its referent (life-sized room) makes the referential relation more transparent, facilitating the transfer of learned information from the symbol to its referent. Such facilitation of transfer by a high-level of iconicity is also demonstrated in children's learning from picture books. Toddlers are better at extending a newly learned label of a novel object from a picture book to its referent object in the real world when they learn the label from more realistic photographs than from less realistic cartoon drawings (Ganea et al., 2008). This is also true for imitation: Realistic photographs make it easier for toddlers to imitate actions from a picture book than when they are depicted in line drawings (Simcock & Deloache, 2006). Thus, a higher level of iconicity between the symbol and its referent makes the referential relation more transparent and makes it easier for children to transfer the learned information to a real-life context, at least when learning from static images and objects.

Perceptual similarity also affects children's generalization of information learned from screen media to real-life situations. Prior research in different domains have demonstrated that children younger than 3 years of age are unlikely to transfer information from screens to a real-

life situation (e.g., Hayne et al., 2003; Krcmar et al., 2007; Roseberry et al., 2009; Schmidt et al., 2007; Troseth & DeLoache, 1998). The same is true for toddlers transferring information learned from the real-world to a situation on screen. For instance, Zack, Barr, Gerhardstein, Dickerson, and Meltzoff (2009) demonstrated that 15-month-olds were less likely to transfer information across contexts (i.e., from a screen to a real-life situation or a real-life context to a situation on screen) than when they were tested in the same context as the learning environment (e.g., screen to screen or real life to real life). Such findings suggest that the contextual mismatch between encoded and retrieval cues could lead to a negative influence on children's transfer.

Barr (2013) argued that this difficulty in children's transfer of learned information from one context to a different context (e.g., screen to a real-life scenario) is due to poor representational flexibility (e.g., Hayne, 2004). That is, children often fail to retrieve a memory in a different situation when perceptual cues change from encoded to retrieval situations (Barnett & Ceci, 2002). Such relation could also hold true for preschool-aged children when it comes to transferring from animated videos. Since there is a clear and vivid mismatch between perceptual cues in animated and real-life settings, preschool children might experience difficulty in retrieving information encoded from an animated context in a similar situation in the real world.

Individual Differences in Transfer of Animated Content

So far, we have discussed how the animated format of children's educational screen media could interfere with preschool children's transfer of learned information to a real-life situation in general. However, such effects may not be universal: Theories of young children's learning from screen media suggest that learning is moderated not only by media characteristics

(e.g., video format) but also by individual characteristics of a viewer (Fisch, 2000; Valkenburg & Peter, 2013).

There may be developmental factors that influence how a viewer perceives and transfers the screen content (Valkenburg & Peter, 2013). With age and experience, children come to understand television as a medium that represents reality (Troseth, 2010) and get better at judging the reality status of television programs (Wright et al., 1994). Furthermore, memory retrieval flexibility also increases with age (Hayne, 2004, 2006), such that older children are better at transferring information learned from videos to real-life situations (e.g., Barr, 2013). To the extent that older children have more flexible memory retrieval and better understand the symbolic relation between video and reality, they may be more likely than younger children to transfer information from animated video content to analogical real-life situations.

Another individual factor that could influence children's transfer is working memory. It has been suggested that more working memory resources are required to process unfamiliar (versus familiar) video content (Fisch, 2000; Lang, 2000) and to reconcile perceptual differences between encoding and retrieval contexts (e.g., Barr, 2010, 2013). Since an animated context is novel to children and provides mismatched perceptual cues compared to real life, an animated video format could tax children's working memory. Thus, having a higher working memory capacity could mitigate these effects.

Lastly, children's perception of the animated content could influence children's transfer. Studies have demonstrated that children's reality status judgement of a video content (Bonus & Mares, 2015) and credibility judgement of an animated character (Schlesinger et al., 2016) influence children's transfer of learned information from video. That is, preschool children were more likely to transfer when they believed the content was real and believed that the animated

character was a credible informant. Thus, children's perception of the content and characters in a video could influence children's transfer.

Overview of the Current Study

The purpose of this study was to examine the influence of animated format on preschool-aged children's transfer of information from video. As was discussed above, disruption of initial comprehension of the educational content, overly contextualized mental representation, and/or failure to retrieve information from memory could negatively influence children's transfer of learned information from the animated context to real-life problems.

In the present study, preschool-aged children ($N = 67$) were randomly assigned to an animated or live-action video format condition in which an actor demonstrated how to move toy lemons to a jar enclosed in an apparatus by using a rolled-up paper. After watching the video, all participants were provided with an analogical problem where they were asked to move some jackstones to a treasure box which was enclosed in a lager plastic container by using one of the tools that was provided to them. The influence of animated format was examined by comparing children's success at solving the analogical problem between the two video format conditions. I expected the animated format to negatively influence children's generalization of the solution learned from screen to the analogical real-life problem.

A secondary goal of the current study was to test individual factors that could influence children's transfer from the videos. In this study, we examined the influence of age, working memory capacity, and children's judgement of the video content (reality status and credibility) on children's transfer performance. Since older children might be better at generalizing from videos due to both experiential factors (e.g., experience with and understanding of screen media) and maturational factors (e.g., increased memory retrieval flexibility) (e.g., Barr, 2013), I

expected age to be a stronger predictor of transfer performance for children in the animated video condition.

Additionally, it has been suggested that encoding unfamiliar screen content places greater demands on children's working memory (Fisch, 2000; Lang, 2000). Since children watched a novel demonstration on video, higher working memory could facilitate children's transfer performance by allowing them to encode more information presented on screen and transfer to a real-life problem, especially for the animated video. Thus, I expected working memory to be a stronger predictor of transfer performance for children in the animated video condition regardless of age.

Lastly, prior research suggests that preschool children are more likely to transfer from video when they perceive the content as real (Bonus & Mares, 2015) and perceive a screen character as a credible informant (Schlesinger et al., 2016). Such a view of the video content in the current study could promote children's transfer. Thus, I expected children's judgement of the video content and generic characters to be positively related to their transfer from both conditions.

Method

Participants

Data from 67 preschool-aged children were used in the study (M = 51.41 months, range = 36 – 67.50, female = 34). Seven additional children (5 animated condition, 2 live-action condition) participated but were excluded due to incomplete data. Of the 7 children who were excluded, only 1 child in each condition transferred the target solution from the video. Children who were excluded did not differ significantly from the rest of the participants in terms of age (M = 46.81 months, M =51.41 months respectively; $t(7.50) = 1.59$, $p = .15$). Participants were

recruited from a children's museum and preschools in a small Upper-Midwestern city in the United States. Data were collected between October 2019 and March 2020.

A power analysis using G*Power (Faul et al., 2007) was performed to determine the target sample size. An odds ratio of 3.80 (calculated from a previous study which compared children's transfer performance from a realistic versus unrealistic story; Richert & Smith, 2011) for a logistic regression model with predictors including a binary variable ($\alpha = .05$, 80% power) indicated a recommended sample of 77. We had to stop collecting the data before reaching the target sample size due to the COVID-19 pandemic. A post-hoc power analysis suggests that this study was underpowered. Based on the odds ratio (2.60) that was observed in the current study, approximately 147 samples would be needed to obtain statistical power of .80.

Among the sixty-six parents (98.5%) who completed a demographic survey, the majority identified their child's race and ethnicity as White/Caucasian/non-Latino ($N = 57$). Other parents identified their child's race and ethnicity as Asian/Pacific Islander ($N = 1$), Native American ($N = 1$), and other or multiple ($N = 7$). As a proxy for socioeconomic status, parents were asked to indicate their highest level of education. The majority (82%) of the parents earned at least a bachelor's degree.

Design and Video Stimuli

Participants were randomly assigned to one of two formats of audiovisual stimulus: live-action ($N = 33$) or animated ($N = 34$) video. In both video formats, a child actor demonstrated how to transfer toy lemons to a jar that was enclosed in a clear storage container (see Figure 1). First, the actor was presented on screen with some lemon toys on her right and the storage container and jar on her left. Then, the actor pointed to each object as she explained that she wanted to put the lemons in the enclosed jar. The opening of the container was several inches

away from the jar. Thus, the actor verbally explained and physically demonstrated that the lemons could not be moved to the jar by simply dropping the lemons through the opening. The actor then explained that she would put the lemons in the jar by using a piece of paper that was in front of her: 'I will show you how to put these lemons (pointing to the lemons) in the jar (pointing to the jar) through this hole (pointing to the hole) by using this (pointing to the paper).' The actor then rolled-up the paper into a tube and inserted it through the opening in the container at an angle, allowing her to roll the lemons along the tube and into the jar. When every lemon was moved to the jar, the actor ended the video by exclaiming, "Tada!".

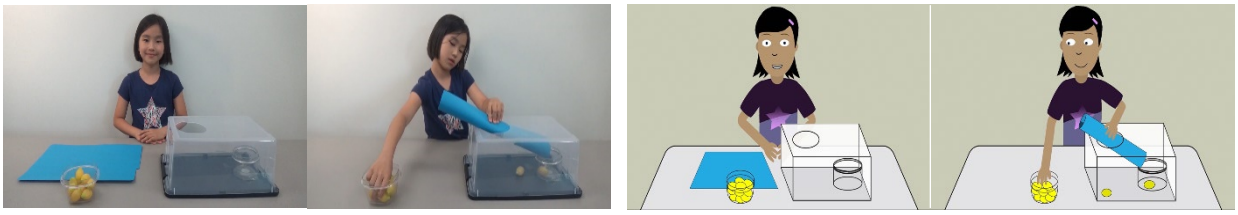

Figure 1. a) Screen shots of live-action video; b) Screen shots of animated video

In order to make the live-action version of the stimuli, a female child was recruited to enact the storyline described above (see Figure 1a). After making the live-action version of the video, the animated version was made using *Adobe Character Animator* using the live-action video as the reference. In this animated version, an illustrated actor was animated to perform the same demonstration as the live-action actor (see Figure 1b). The same audio file was used for both versions of the video, and the software's facial motion capture function was used to match mouth and eye movements with the live-action stimulus. Both versions of the video were 56-seconds long, and they were presented on a Samsung Galaxy Tab 10.1 with a 25.7-cm display (1280x800 pixels).

Procedure

Participants for this study were recruited from two local preschools ($N = 21$) and a children's museum ($N = 46$). To recruit families from preschools, recruitment packets which included a consent form and parent survey were distributed to families. The families were asked to return the signed consent form and completed survey if they wished their child to participate in the study. At the museum, families were recruited by research assistants who actively approached families and provided information about the study. For families who agreed to participate, they were guided to a quiet part of the museum and parents were asked to sign the consent form and complete the parent survey.

The study was conducted at a quiet part of a preschool or the museum. Once the child appeared to be comfortable, the experimenter asked the child whether they would like to watch a short video and play some games. Upon obtaining their verbal assent, the participant viewed their assigned video (animated or live-action). Then, they completed two sets of questions that assessed children's perception toward screen characters including reality-status judgement of the video actor and credibility judgements of unfamiliar characters as an informant (see Assessments below).

After the questions on characters, the participant was asked to complete a problem-solving task that was analogical to the problem that the actor in the video solved to measure children's transfer performance (see Figure 2). The following script was used for the transfer task: 'Yesterday, a friend asked me to solve a problem, but I don't know how to solve the problem. Can you help me to solve the problem? She asked me to move these jackstones (pointing to the jackstones) to the treasure box inside this box (pointing to the treasure box) by using one of these tools (showing the tools). I have this (putting one tool at a time on a table). I

don't know which tool to use to move these jackstones. Which tool should I use? Can you show me how to solve this problem?'

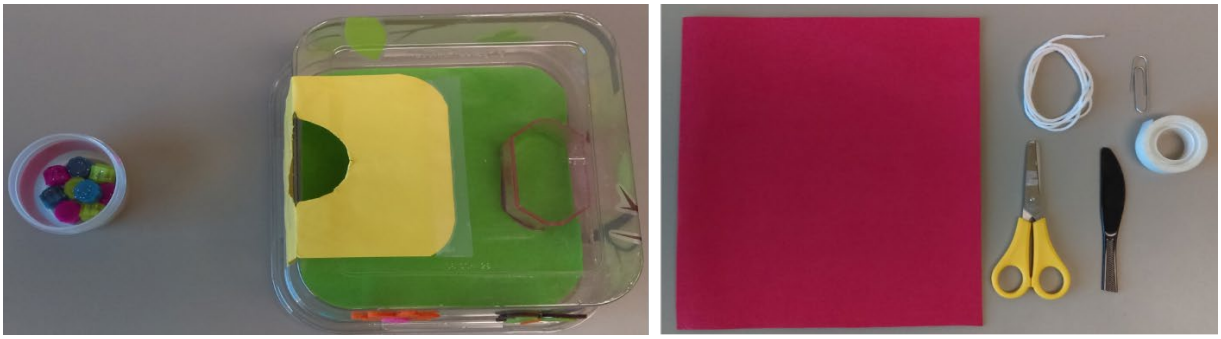

Figure 2. Left: Jackstones and apparatus presented for transfer task. Right: Tools presented for transfer task.

Once the participant completed the analogical transfer task, a video comprehension assessment was administered (described later). Lastly, a working memory assessment was administered to measure children's working memory capacity. The study took about 15 minutes on average, and participants were thanked and received a small gift for their participation after the competition of the study. Data for all participants were coded in real time by a research assistant who was blind to the study hypotheses.

Assessments

Reality judgement assessment. Based on prior research examining children's perception of the reality status of story characters (e.g., Corriveau et al., 2015; Woolley & Cox, 2007), participants were asked to categorize the actor that they watched in the video as real or not real. To prime participants to think about whether someone is real, they were first asked if they, themselves, are real and then asked whether the experimenter is real. All participants except one correctly perceived themselves as a real person. For the one participant who did not answer the question correctly, they were asked again after correctly answering the reality status of the experimenter. They correctly answered the question the second time. Then, participants were presented with a picture of the actor whom they saw in the video and asked if the actor is real

(i.e., ‘Do you remember her from the video (showing a picture of the actor)? Is she real?’). Participants’ answer was coded as ‘Yes’ or ‘No’.

Character credibility endorsement assessment. Based on prior research examining children’s selective trust of informants (e.g., Corriveau & Harris, 2009; Schlesinger et al., 2016), character credibility was measured by asking two types of questions about objects (whether a character would know what the object is called and how it works) in two different ways (forced-choice and multiple-choice questions).

Forced-choice questions: Participants were shown a picture of an object and asked to choose a character who would know the name of the object and how it works. Children chose from a pair of color headshots of a real-life child and a gender-matched, illustrated child. There were 4 trials using each of 4 objects (2 photographs of objects (i.e., old cassette tape player, antique wall-mount telephone) and 2 illustrations of objects (i.e., airplane-shaped submarine, cube-shaped spacecraft). The order of the objects was counterbalanced with the constraint that the first and the last objects that were presented were realistic objects. For questions on the first two objects, participants were presented with a female pair with the real-life child on the left. For last two objects, participants were presented with a male pair with the real-life child on the right.

Multiple-choice questions: Participants were shown 2 additional objects (photograph of gramophone-shaped speaker and illustration of hybrid school bus-submarine) one at a time and were asked whether a character would know the name (and how it works) by prompting them to answer either verbally ‘Yes’, Maybe’ or ‘No’ or by choosing an image that corresponded to these answers (smiley face, neutral face, or sad face, respectively). The gramophone was used as the first object, and it was paired with female characters whereas the illustrated image was paired with male characters.

To calculate a credibility endorsement score for the real-life characters (versus illustrated characters), participants' choice of real-life characters from the forced-choice questions (8 total) and 'yes' choices from the multiple-choice questions (4 total) were summed. An analogous rule was applied for calculating a credibility endorsement score for the illustrated characters. Thus, the credibility endorsement scores ranged from 0 to 12.

Analogical problem-solving task. An analogical problem-solving paradigm was used to test children's transfer of the target solution depicted in the video (animated versus live action) to an analogical real-life problem. This paradigm has been used extensively in studies with 2- to 5-year-old children (e.g., Chen & Siegler, 2013; Richert & Schlesinger, 2017; Richert & Smith, 2011; Schlesinger et al., 2016). We adapted and revised Holyoak and colleagues' (1984) genie-and-carpet task, asking children to move objects from one place to another using one of the tools provided.

After watching the video, participants were presented with an analogical problem to solve by themselves. They were presented with some jackstones and a decorated plastic container that enclosed a pink treasure box. Then, they were asked to move the jackstones to the enclosed treasure box by using one of the provided tools: foam sheet, tape, string, scissors, paper clip, and plastic knife (see Figure 2). If the participants transferred the target solution from the video, then they would have rolled up the foam sheet into a tube and inserted it into the opening of the plastic container at an angle to move the jackstones. For those who tried all the tools provided but could not solve the problem or were hesitant in solving the problem, they received a prompt: 'Think about the video that you just watched. Is there anything from the video that could help you to solve this problem?'

For a conservative score, participants received a score of 1 only if they solved the problem by spontaneously using the target solution from video. For a generous transfer score, they received a score of 1 if they solved the problem spontaneously or after the prompt.

Video comprehension assessment. Participants' comprehension of the video was assessed by asking three forced-choice comprehension questions: a) What did the actor try to move in the video?; b) What did the actor use to move the objects?; and c) Where did the actor try to move the objects to? Before asking the questions, participants were presented with a picture of the actor whom they saw in the video and asked, 'Do you remember her from the video?' Then, they were presented with three images for each question where only one of the images was the correct answer. For example, when asked, 'What did she try to move in the video?', children were presented with images of yellow balls, yellow cubes, and yellow lemon toys. The format of these images was varied by video format condition: Photographs of real objects were used in the live-action condition and Photoshop-rendered illustrations of the photographs were used in the animated condition. A correct answer was given a score of 1 and an incorrect answer was given a score of 0. Thus, the total comprehension score ranged from 0 to 3.

Working memory assessment. A simplified version of the Corsi Block Tapping Task (Corsi, 1973) was used to measure visuospatial working memory capacity (Simmering & Perone, 2013). Participants were asked to tap a block sequence in the same order as presented by the experimenter. The task consisted of four increasingly challenging rounds of the block-tapping game with square blocks placed on a paper grid. Each of four rounds began with a practice trial followed by two performance trials for a total of eight scored performance trials. In round one and round two, four blocks were placed on the grid and participants were told to copy the experimenter by watching the experimenter tap blocks and then repeating the sequence. The

experimenter used a round block to tap a sequence on the square blocks, giving the round block to the participant after each trial. For the first two rounds, participants were asked to copy either a one-block tapping sequence (round 1) or two-block tapping sequence (round 2). After round two, four more blocks were added to the grid for a total of eight blocks. Rounds three and four consisted of two- and three-block tapping sequences, respectively, across the eight blocks. For each sequence, participants were given a score of 1 if they correctly copied the sequence and 0 if they did not identically repeat the sequence. Thus, the possible total score range was 0 to 8.

Other individual and contextual variables. Other contextual variables were also collected for exploratory purposes. However, since they are beyond the scope of this paper, they are included in Appendix A. These variables include enjoyment judgement of generic characters, TV and app usage at home, parent TV mediation, parent coviewing, child-initiated questions, and parent education.

Analytical Approach

Descriptive statistics and zero-order bivariate correlations were included in preliminary analyses to provide a relation between individual factors and children's transfer performance. I then compared children's comprehension of the video content by video format by conducting a Mann-Whitney U test for the total comprehension score and chi-square test for individual comprehension questions. Lastly, a generalized linear model with logit link function was used to test whether animated video format influences preschool children's transfer from video since transfer performance was measured as a binary outcome. Additionally, individual factors that were correlated with children's transfer performance were included in the model to identify potential child-level factors that moderate transfer from video.

Results

Descriptive Statistics and Preliminary Analyses

Children's Transfer Performance

Since only 6 participants transferred after hearing the prompt and were equally divided into the two conditions (3 from each condition), generous transfer score was used for the analysis. Even when conservative score was used, the general pattern of the results was held.

About 43% of the total participants ($N = 29$) transferred the solution from the videos; 55% of the participants ($N = 18$) transferred the solution from the live-action video whereas only 32% of the participants (N = 11) transferred the solution from the animated video. Transfer performance was significantly correlated with age, working memory, and total comprehension score [$r_{pb}(65) = .50$, $p < .001$; $rs(65) = .43$, $p < .001$; $rs(65) = .28$, $p < .05$ respectively], but not with reality judgement or credibility endorsement scores [$\phi = .09$, $p = .465$; $rs(63) = .03$, $p = .799$; $rs(63) = -.20$, $p = .102$ respectively] (see Table 1). Age and working memory were correlated with transfer performance even after controlling for each other [$r_{pb}(65) = .35$, $p < .01$; $rs(65) = .22$, $p = .072$ respectively], whereas total comprehension score was not correlated with transfer performance after controlling for age [$rs(65) = .15$, $p = .228$].

Table 1. Descriptive and Zero-Order Correlation Table for Transfer and Individual Factors

	Descriptives		Correlations					
	%	*M (SD)*	1.	2.	3.	4.	5.	6.
1. Transfer	43.28							
2. Age (months)		51.41 (7.71)	0.50***					
3. Working memory		5.69 (1.52)	0.43***	0.54***				
4. Comprehension		2.25 (0.86)	0.28*	0.32**	0.37**			
5. Reality judgement	64.06		0.09	-0.25*	-0.30*	-0.34**		

6. Credibility (Real-human)	7.23 (2.60)	0.03	0.18	0.11	0.09	0.03	
7. Credibility (Animated)	6.29 (2.64)	-0.20	-0.12	-0.02	-0.10	-0.18	-0.42***

Note. Variables included transfer performance (0 = no, 1 = yes), child age (months), gender (0 = boy, 1 = girl), working memory (possible range from 0 to 8), total comprehension score (possible range from 0 to 3), demonstration actor reality judgement (0 = not real, 1 = real), and generic character credibility endorsement scores (possible range from 0 to 12). Phi correlations are presented for pairs of dichotomous variables (e.g., transfer, reality judgement), Point-biserial correlations are presented for pairs of dichotomous and continuous variables (e.g., age, transfer); Spearman correlations are presented for the rest of the pairs.

Children's Comprehension of the Video

Out of three comprehension questions that formed the total comprehension score, a majority of children (82%) got at least 2 questions correct [$M = 2.25$ ($SD = .86$)]. This was also true for each condition: 91% of children in the animated condition and 73% in the live-action condition got at least 2 questions correct [$M = 2.41$ ($SD = .66$), $M = 2.09$ ($SD = 1.01$) respectively].

Since the total comprehension score was composed of three individual comprehension questions, I conducted an exploratory analysis to examine the relation between the individual comprehension questions and children's transfer performance. Among the three questions, I precited the 'How' question ('What did the actor use to move the objects?') to be strongly related to children's transfer performance because remembering what the actor used to achieve her goal in the video could help children in solving their analogical problem. As can be seen from Table 2, the 'How' question was the only comprehension question that was significantly correlated with transfer performance [$\phi = .57$, $p < .001$]. 'What' and 'Where' questions were not significantly correlated with transfer [$\phi = -.05$, $p = .688$; $\phi = -.05$, $p = .677$ respectively]. Since the 'How' question was significantly correlated with children's transfer performance even after controlling for age and working memory [$r(65) = .52$, $p < .001$; $r(65) = .51$, $p < .001$

respectively], this specific comprehension item was used in further analysis instead of the total comprehension score.

Table 2. Descriptive and Correlation Table for Video Comprehension

	% Correct	Correlations						
		Transfer	Age	WM	Real char.	Comp	'What'	'How'
'What' question	88.06	-0.05	0.13	0.19	-0.25*	0.50***		
'How' question	65.67	0.57***	0.27*	0.34**	-0.06	0.75***	0.22	
'Where' question	71.64	-0.05	0.20	0.24	-0.34**	0.68***	0.18	0.17

Note. Variables included child age (months), transfer performance (0 = no, 1 = yes), working memory (possible range from 0 to 8), demonstration actor reality judgement (0 = not real, 1 = real), total comprehension score (possible range from 0 to 3), 'What' question: What did the actor try to move in the video? (0 = incorrect, 1= correct), 'How' questions: What did the actor use to move the objects? (0 = incorrect, 1= correct), and 'Where' question: Where did the actor move the objects to? (0 = incorrect, 1= correct). Phi correlations are presented for pairs of dichotomous variables (e.g., transfer, 'What' question); Point-biserial correlations are presented for pairs of dichotomous and continuous variables (e.g., age, 'What' question); Spearman correlations are presented for the rest of the pairs.

Children's Reality Judgement of the Actor in the Video

The majority of children judged the demonstration video actors as real (64%). When looking at the conditions separately, most children (87%) in the live-action condition judged the live-action actor as real, whereas less than half of the children (42%) in the animated condition judged the animated actor as real [χ^2 (1, N=67) = 11.98, $p < .001$].

Across the entire sample (both conditions), reality judgement was significantly correlated with age and working memory, [r_{pb} (62) = -.25, $p < .05$; rs(62) = -.30, $p < .05$ respectively], but not with transfer performance or the 'How' comprehension question [$\phi = .09$, $p = .465$, $\phi = -.06$, $p = .627$ respectively] (see Tables 1 and 2). To determine whether associations between reality judgements, age, and working memory varied by video format, these correlations were examined separately for the live-action and animated video actors. In the animated video condition, the likelihood of judging the animated actor as real decreased with age and working memory [r_{pb}(31)

= -.45, $p < .01$; $rs(31) = -.47$, $p < .01$ respectively]. However, there was no such relation between reality judgement and age and working memory for the live-action actor [$r_{pb}(29) = .02$, $p = .905$; $rs(29) = .11$, $p = .554$ respectively]. Together, children who watched the animated video were less likely to judge the actor they watched in the video as a real person than those who watched the live-action video, and children in the animated condition were less likely to judge the video actor as a real person with increase in age and working memory as can be seen in Figure 3.

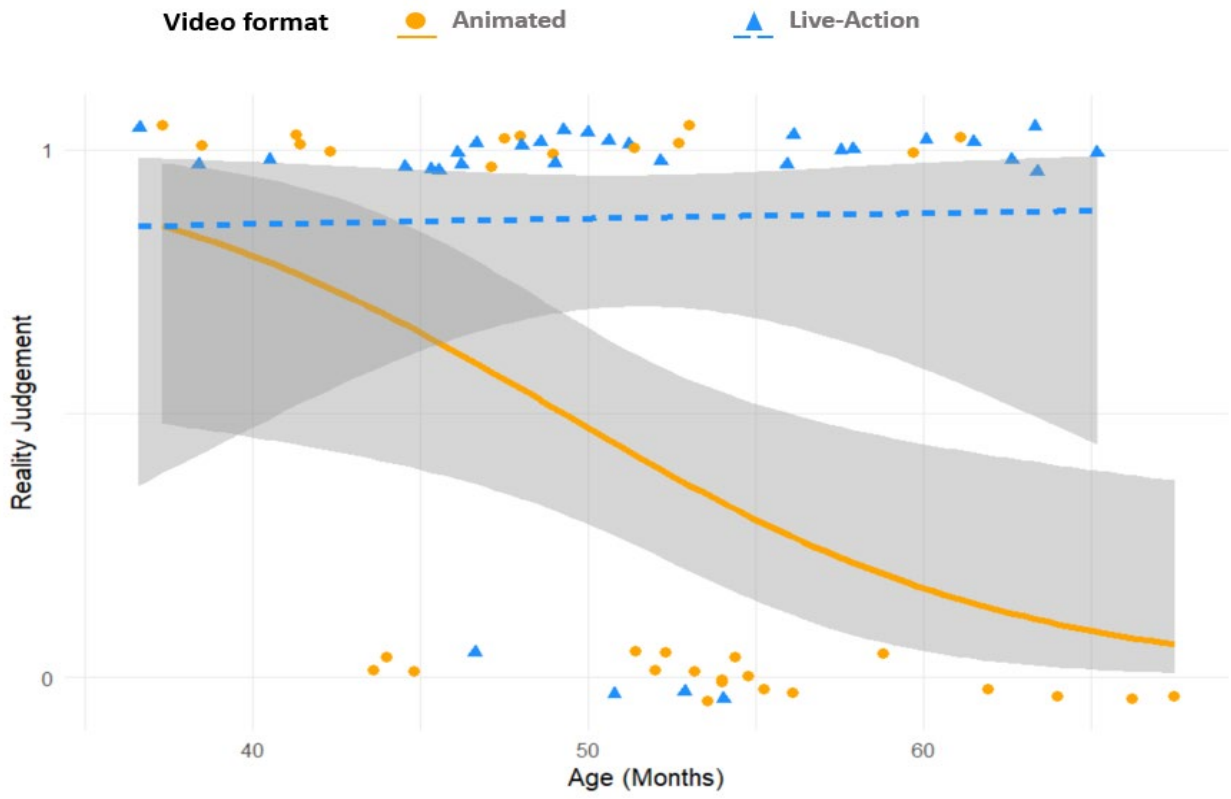

Figure 3. Children's reality judgement of the video actor by age and video format. Age in months. Reality judgement: 1 = Real; 0 = Not real. Shaded area represents 95% confidence band.

Children's Credibility Endorsement of Characters in General

Since credibility endorsement scores were not normally distributed, a Wilcoxon sign-ranked test was used to compare the difference in children's endorsement by character type. Children were equally likely to endorse generic real-life and illustrated characters to be a knowledgeable informant in general [$z = 1.78$, $p = .074$; *Mdn(SD)* = 8(2.60), *Mdn(SD)* = 6(2.64)

respectively]. However, when the type of object (photograph versus illustrated) was examined separately, children were more likely to endorse real-life characters (versus illustrated characters) to know more about objects in the photographs [$z = 2.24$, $p < .05$; *Mdn(SD)* = 4(1.35), *Mdn(SD)* = 3(1.42) respectively], whereas children showed no preference when the objects were unrealistic illustrations [$z = .78$, $p = .436$; *Mdn(SD)* = 4(1.54), *Mdn(SD)* = 4(1.46) respectively]. Credibility endorsements for both illustrated and real-life characters were not significantly correlated with transfer performance, age, working memory, reality judgement, or the 'How' comprehension question (all *ps* > .05, see Tables 1 and 2).

Children's Comprehension of Video Content by Video Format

Before examining the influence of video format on children's transfer performance, we examined whether there was a difference in children's comprehension of the video content by the video format. A Mann-Whitney U test was conducted to examine the difference in children's total comprehension score by condition [Animated: *Mdn* = 2.5 (*SD* = .66), Live-action: *Mdn* = 2 (*SD* = .1.01)]. The condition effect was not significant [$U = 640.5$, $Z = 1.08$, $p = .27$]. This was also true for the individual comprehension questions (see Table 3). There was no significant difference between 'What' and 'How' questions by the video format [χ^2 (1, N=67) = 2.41, p = .121; χ^2 (1, N=67) = .47, p = .494 respectively]. However, children in the animated condition were more likely to get the 'Where' question correct than children in the live-action condition [85% versus 58% respectively; χ^2 (1, N=67) = 6.33, $p < .05$]. This was also true even when controlling for age and working memory ['What': $\beta = -1.25$, $SE = .87$, odds ratio = 0.29, $p = .148$; 'How': $\beta = .52$, $SE = .56$, odds ratio = 1.69, $p = .349$; 'Where': $\beta = -1.48$, $SE = .61$, odds ratio = .23, $p < .05$]. Together, the findings indicate that children in the animated condition were more likely than those in the live-action condition to correctly identify the jar

from the video they watched, regardless of age and working memory. Yet, there was no condition effect for correctly identifying the objects that were moved or the tool used to move them.

Table 3. Number (Percentage) of Children Answering Comprehension Questions Correctly by Video Format

Question types	Animated	Live-action	χ^2
	Number (%)	Number (%)	
'What'	32 (94%)	27 (82%)	2.41
'How'	21 (62%)	23 (70%)	0.47
'Where'	29 (85%)	19 (58%)	6.33*

Note. Question types: 'What' question: 'What did the actor try to move?'; 'How' question: 'What did the actor use to move the objects?'; 'Where' question: 'Where did the actor move the objects to?'. Number = number of participants who got the question correct.
* $p < .05$

Influence of Video Format on Children's Transfer From Video

In order to examine the impact of video format and children's transfer performance, a logistic regression (Model 1) was fit with age, working memory, and the 'How' comprehension question as covariates. Age and working memory were centered around their mean. Reality judgement and credibility endorsement scores were excluded because they were not significantly correlated with transfer performance. Table 4 presents the results from the logistic regression model with animated video condition as the reference group.

Table 4. Model 1: Logistic Regression

Predictors	*Odds Ratio*	*CI (95%)*	*p*
(Intercept)	0.01	0.00 - 0.19	0.001**
Age (months)	1.14	1.01 - 1.28	0.034*
Working memory	1.73	0.90 - 3.32	0.098†

'How' question	32.79	3.27 - 329.11	0.003**
Video format: Live	7.64	1.38 - 42.21	0.020*
Observations	67		
R^2 Tjur	0.547		
AIC	56.761		

Note. Reference group = Animated video condition. CI = Confidence Interval.
† $p < .10$. * $p < .05$. ** $p < .01$.

Video format significantly predicted children's transfer of the target solution from video after controlling for age, working memory, and comprehension. The odds of children transferring the target solution from video to an analogical real-life problem were significantly higher for those who watched the live-action video than those who watched the animated video [β = 2.03, *SE* = .87, odds ratio = 7.64, $p < .05$]. That is, the live-action video format improved preschoolers' generalization of learned information from video to a real-life problem.

In addition to video format, children's age and comprehension of the video content significantly predicted children's transfer from video. The odds of children transferring from the video to an analogical real-life problem were significantly higher with age [β = .12, *SE* = .05, odds ratio = 1.14, $p < .05$]. Furthermore, children who remembered what the actor in the video used to move the lemon toys (i.e., the 'How' comprehension question), had significantly higher odds of transferring the solution from video to the real-life problem [β = 3.49, *SE* = 1.17, odds ratio = 32.79, $p < .01$]. However, working memory did not significantly predict children's transfer performance [β = .55, *SE* = .33, odds ratio = 1.73, p = .098].

Exploratory Analysis: Influence of Individual Factors by Video Format on Children's Transfer

Since preschool children's age and working memory could influence children's transfer differently by the video format, we used logistic regression to examine the extent to which age and working memory moderated the effect of video format on children's transfer (see Table 5).

Table 5. Model 2: Logistic Regression With Interaction Terms

Predictors	*Odds Ratio*	*CI (95%)*	*p*
(Intercept)	0.01	0.00 - 0.16	0.002**
Age (months)	1.02	0.88 - 1.19	0.808
Working Memory	3.06	0.97 - 9.66	0.057†
'How' question	60.66	3.10 - 1188.33	0.007**
Video format: Live	13.16	1.78 - 97.49	0.012*
Age x Video format: Live	1.37	0.97 - 1.93	0.072†
WM x Video format: Live	0.38	0.08 - 1.78	0.217
Observations	67		
R^2 Tjur	0.587		
AIC	55.440		

Note. Reference group = Animated video condition. CI = Confidence Interval.
† $p < .10$. * $p < .05$. ** $p < .01$.

Similar to Model 1, the video format significantly predicted children's transfer of target solution from video [$\beta = 2.58$, $SE = 1.02$, odds ratio = 13.16, $p < .05$]. The odds of children transferring the target solution after watching the live-action video was significantly higher than that of children who watched the animated video. Also, children's comprehension significantly predicted the likelihood of children transferring the solution from video [$\beta = 4.11$, $SE = 1.52$, odds ratio = 60.66, $p < .01$].

For the interaction terms, there was a marginally significant interaction between age and video format [$\beta = .31$, $SE = .17$, odds ratio = 1.37, $p = .072$], such that transfer increased with age

in the live-action condition [β = .33, *SE* = .16, odds ratio = 1.39, p = .036] but remained relatively low regardless of age in the animated condition [β = .02, *SE* = .08, odds ratio = 1.02, p = .814]. Figure 4 illustrates this interaction, showing the change in children's transfer performance with age by video condition. However, the interaction between working memory and video format was not significant [β = -.98, *SE*= .79, odds ratio = .38, p = .217]. To test whether including the interaction terms provide a better mode fit, a model comparison was conducted. The model comparison between Model 1 and 2 was marginally significant [AIC for Model 1 = 56.76, AIC for Model 2 = 55.44, LLR χ^2 (2) = 5.32, p = .069] indicating that the interaction model (Model 2) does not necessary provide a better fit for the data.

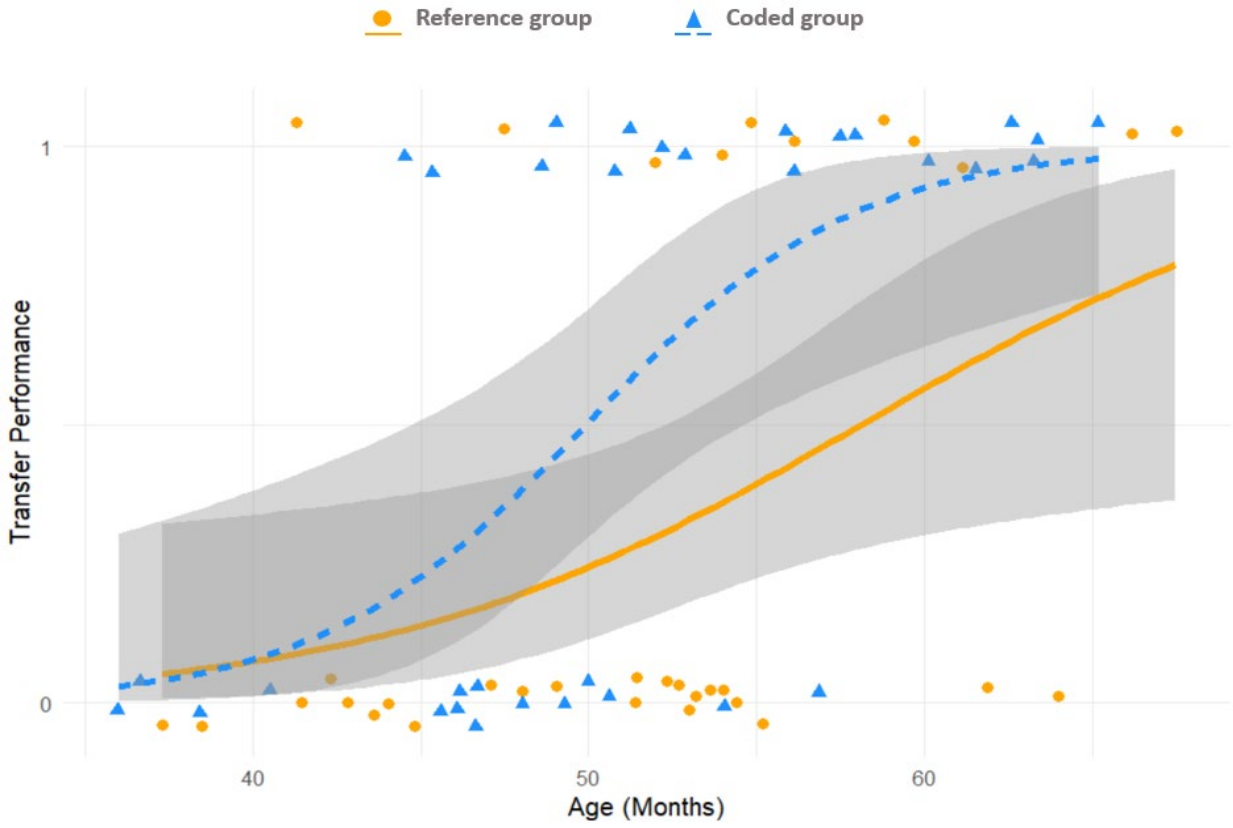

Figure 4. Interaction effect of age and video format on children's transfer performance. Age in months. Shaded area represents 95% confidence band.

Discussion

In order for children to generalize knowledge from an educational video to a real-life scenario, three cognitive processes are necessary: initial comprehension of the educational content, mental representation of the content, and retrieval of the representation at a novel situation (Fisch et al., 2005). However, an animated context could potentially act as an obstacle for children to generalize the information to a situation in the real world by interfering with all three cognitive processes. Thus, the main purpose of this study was to examine the influence of an animated video format on children's learning by comparing children's generalization of information acquired after watching either a live-action or animated version of a video to a real-life analogical problem. As a secondary goal, moderating effects of individual factors on transfer performance were also examined.

Children's transfer performance differed by the format of video that they watched. Children who watched the animated video were less likely to transfer the target solution from the video to their analogical problem than children who watched the live-action video. Such a difference does not seem to be due to children's memory of the video content. In fact, children in both video conditions were equally likely to remember what the video actor used to solve her problem. However, such knowledge of the target solution was less likely to be utilized by children who watched the animated video to solve their problem. Richert and Smith (2011) also found an analogous result for children's transfer from realistic and fantastical events from a storybook. Even though children showed no difference in their recall of the story content by the story type (unrealistic versus realistic story), children in the unrealistic story version were less likely to transfer the target solution from the storybook to their own problem. Thus, even though preschool-aged children remembered the story content that they watched or heard when asked

about the story, they were less likely to apply the acquired information to their own lives when the story content did not align with the world they live.

Consistent with studies that have examined children's ontological judgement of entities presented in storybooks (e.g., Corriveau et al., 2009; Woolley & Cox, 2007), children in the current study were able to correctly discern the reality status of the video actors. Children in the live-action condition were more likely to judge their actor as real than those in the animated condition. However, children's reality judgement of the actor was not related to their learning. Reality judgement was not correlated with children's comprehension of the main problem-solving strategy (i.e., the 'How' question) or children's transfer performance. These results are inconsistent with prior studies that have found a relation between reality judgement and children's learning from video content (Bonus & Mares, 2015; Mares & Sivakumar, 2014). Critically, unlike the other studies, this study did not include any fantastical content (e.g., anthropomorphic animals). Even though children might have perceived an animated-human character as unreal, the animation might not have been a salient character feature that would have negatively influenced children's representation of the video content since the demonstration that was performed by the character was otherwise realistic.

Also, children did not consider generic illustrated characters as less credible informants when learning about an object even though they perceived the animated video actor as an unrealistic character. Although children were more likely to endorse real-life characters (versus illustrated ones) as more credible informants for objects in photographs (versus illustrations), they endorsed both illustrated and real-life characters as knowledgeable informants for objects in general. Furthermore, credibility endorsement was not significantly associated with children's transfer. This result is inconsistent with a previous study where children who judged an animated

actor from a video as a credible informant recalled more video content (Schlesinger et al., 2016). The difference in the results could be due to the difference in target character about whom the credibility questions were asked. That is, rather than asking about the credibility of the actor from the demonstration video, children were asked about generic illustrated and real-life characters in the current study. Since children are sensitive to the perceptual appearance of story characters (e.g., Hoffner & Cantor, 1985), their credibility judgement might be more associated with their transfer if they were asked to judge the actor whom they saw in the demonstration video.

In addition to children's perception of the video content, I have examined the moderating effects of working memory and age on children's transfer performance. Working memory has been suggested to be important in the process of encoding unfamiliar video content (Fisch, 2000; Lang, 2000) and of reconciling the perceptual differences between the encoding and retrieval contexts (e.g., Barr, 2010, 2013). Since animations present unfamiliar and perceptually mismatched contexts, I expected working memory capacity to moderate children's transfer performance in the current study. However, even though working memory was positively correlated with children's transfer, there was no main effect or interaction effect of working memory on children's transfer by video condition. Such null effects could be attributed to the high correlation between working memory and age found in the current study. Thus, it is not really clear whether working memory has effects independent of age-related change.

I also expected age to be a stronger predictor for animation than live-action video due to both children's experience with screen media and maturational factors (e.g., increased memory retrieval flexibility) (e.g., Barr, 2013). There was a significant main effect of age on transfer performance such that older children had higher odds of transfer than younger children in

general. There also was a marginally significant interaction effect such that transfer was predicted by children's age only after watching a live-action video; Transfer remained relatively low regardless of age in the animated condition.

Overall, the results of this study suggest that age may have a different relation to children's transfer performance depending on the video format, and unlike what I have expected, the animated video format might be difficult to generalize from even for older preschool children. Thus, an animated video format might render transfer more difficult and protract the age at which children transfer from video to analogous real-life problems. However, this interpretation should be taken with caution since the interaction effect was only marginally significant.

Limitation and Future Directions

The current research has some limitations that should temper the conclusions drawn. First, in order to control for the content of live-action and animated videos and other possible confounding factors, commercially available videos were not used in the current study. One disadvantage to using personally made animation is that there are limitations to the quality of the video. Specifically, the animated video lacked visual cues to convey the depth and three-dimensionality of the objects in the video compared to the live-action video. Since visually impoverished cues place greater processing demands on learners (e.g., Carver et al., 2006; Kirkorian et al., 2016), transfer from this animated video may have been particularly challenging in the current study. In order to test this possibility, future research should use a professionally produced animated video to compare the influence of animation with live-action video.

Another limitation to this study is that the study was underpowered. This was mainly because in-person data collection had to be halted prematurely due to the COVID-19 pandemic

and the observed effect size in the current study was smaller than that observed in a prior study. Since it was impossible to transition the current study to an online study without making a significant change to the study protocol, it was impossible to continue to collect data. So, it is crucial for future studies to replicate the findings from this study with a larger, more diverse sample in order to state with certainty that the animated video format impedes children transfer from videos.

One key area of future direction is exploring whether a different character type (human versus non-human character) in an animated video would influence children's learning differently. For instance, would children's learning of an educational information that is conveyed through an anthropomorphic character (e.g., Daniel Tiger from *Daniel Tiger's Neighborhood*) versus a human character (e.g., Miss Elaina from *Daniel Tiger's Neighborhood*) be different? It is possible for children to consider the anthropomorphic character as irrelevant to the real world and fail to recognize the lesson as relevant to the real world. Alternative, it is also possible for them to consider both characters as irrelevant to the real world since they are both in an animation. Thus, such research would provide a clarity on how children perceive and learn from different character types when presented in an animated video format, and it will benefit the society in general by helping educational TV producers to produce an optimal educational TV program for children.

Conclusion

The current study examined the impact of an animated video format on preschool-aged children's generalization in order to provide a better understanding of children's learning from screen media. The results suggest that when educational information is presented in an animated context, children are less likely to transfer what they have learned from video to a real-life

situation compared to when the same information is presented through a live-action video. Furthermore, the results suggest that even older preschool-aged children are impacted by the animated format; Unlike live-action videos, transfer performance of children remained relatively low regardless of age after watching the animated video. Since the purpose of this study was to explore whether the animated video format negatively influences children's transfer from a video content, it is not clear which mechanisms are responsible for such impeded transfer performance. Thus, future research needs to elucidate the reasons why an animated video format hinders children's transfer and also the developmental time-course of transfer from live-action video versus animation.

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Appendix A

Influence of Exploratory Contextual Factors on Children's Transfer From Video

Assessments for Contextual Variables

Video enjoyment assessment. In order to assess children's enjoyment of the live-action and animated video formats, participants were presented with eight pairs of generic character images (full-color headshots of a real-life child and an illustrated child) and asked to choose one that they would like to watch for fun: 'These are TV characters from different TV shows. Which one would you like to watch for fun?' The gender of the pairs was always matched, and the order of the pairs were counterbalanced such that sometimes the illustrated image was presented on the left and sometimes it was presented on the right.

Similar to the character credibility endorsement assessment, participants were also asked multiple-choice questions where they had to judge whether they would like to watch a character (one male and one female character for both character types) for fun by indicating either verbally 'Yes', Maybe' or 'No' or choosing an image that corresponded to these answers (smiley face, neutral face, or sad face respectively). The total enjoyment score for each character type was calculated by adding the number of forced-choice responses choosing that character type (8 maximum) and the number of 'yes' choices from the multiple-choice questions (2 maximum). Thus, the enjoyment endorsement scores had a possible range from 0 to 10.

TV and App use at home. As a part of parent survey, parents were asked about their child's media use at home. Parents were asked to indicate how often their child uses screen media (i.e., TV, App) at home in a typical month (5-point Likert-scale; 1 = 'Never', 5 = 'Everyday') and how much time (in minutes) their child spent using screen media during the previous day.

Joint media engagement. The joint media questions were adapted from the Television Mediation Scale (Valkenburg et al., 1999). Parents were asked questions about joint media engagement: How often they mediate their child's media use (e.g., How often do you explain what something on screen really means?) and coview screen media with their child (How often do you watch screen media with your child?); and how often their child initiates questions about screen content they watch (How often does your child ask about programs s/he watches on screen?). There were 7 items in all: 5 items for instructive mediation questions, 1 item for coviewing, and 1 item for child-initiated question. The items were scored on a 5-point Likert scale (1 = 'Never', 5 = 'Always').

Relation Between Contextual Factors and Children's Transfer

None of the contextual variables were significantly correlated with children's transfer except for App use (see Table A1). The frequency of app use was significantly correlated with both the 'How' comprehension question and transfer performance [$rs(60) = .32$, $p < .05$; $rs(60) = .26$, $p < .05$]. However, when controlling for working memory, these correlations were no longer significant [$rs(60) = .19$, $p = .134$; $rs(60) = .15$, $p = .249$ respectively].

Table A1. Descriptive and Correlation Table for Exploratory Contextual Variables

	Descriptives			Correlations			
	%	*M*	*SD*	Transfer	Age	WM	How
Gender	51.52			0.00	0.08	-0.04	-0.01
Enjoy real-life character		4.58	2.56	0.10	0.19	0.22	0.03
Enjoy illustrated characters		5.88	2.69	-0.20	-0.22	-0.12	-0.14
TV use (Frequency)		4.58	0.59	0.01	0.03	0.20	-0.04
App use (Frequency)		3.18	1.36	0.26*	0.16	0.33**	0.32*
TV use (Duration)		40.85	30.55	-0.08	0.08	0.06	-0.06
App use (Duration)		8.15	15.12	0.01	0.13	0.23	0.14
Parent mediation		3.16	1.01	0.03	0.15	0.01	-0.07

Parent coviewing	3.23	1.05	0.07	-0.01	0.05	0.00
Child initiated question	2.65	1.07	0.19	0.17	0.17	0.01
Parent education	5.17	1.17	0.24	-0.02	0.14	0.14

Note. Variables included gender (0 = male, 1 = female), character enjoyment scores (possible range from 0 to 8), frequency of TV and App use in a typical month (5pt Likert-scale; Never to Always), TV and App use duration yesterday (in minutes), and joint media engagement questions (5pt Likert-scale; Never to Always). Phi correlations are presented for pairs of dichotomous variables (e.g., transfer, gender); Point-biserial correlations are presented for pairs of dichotomous and continuous variables (e.g., transfer, App use (Duration)); Spearman correlations are presented for the rest of the pairs.

Children's Enjoyment Judgement

Since the enjoyment scores were not normally distributed, a Wilcoxon sign-ranked test was used to compare the difference by character type. Children perceived generic illustrated characters to be more fun than real-life characters [$z = 2.12$, $p < .05$, *Mdn(SD)* = 6(2.68), *Mdn(SD)* = 5(2.56) respectively] (see Table A1).

When examining by question type, children were significantly more likely to judge illustrated characters as more enjoyable than real-life character for the forced-choice questions [$Z = 2.24$, $p < .05$; *Mdn(SD)* = 5(2.50), *Mdn(SD)* = 3(2.50) respectively] (see Table A2). However, for the multiple-choice questions, even though a majority of children judged both real-life and illustrated characters as fun (66% and 59% respectively), children were more likely to consider real-life character as fun [$Z = 2.06$, $p < .05$, *Mdn(SD)* = 1(.75), *Mdn(SD)* = 1(.80) respectively].

Table A2. Children's Enjoyment Score by Question Type

Character type	Forced-choice	Multiple-choice		
	M(SD)	Yes	Maybe	No
			%	
Real-life	3.28(2.50)	66%	17%	17%
Illustrated	4.72(2.50)	59%	21%	20%

Note. % = percentage of questions that were answered 'Yes', 'Maybe', or 'No' for each character type (total number of answers = 132)

Children's Credibility Endorsement by Question Type

Wilcoxon sign-ranked tests were also used to compare the difference in children's credibility endorsement by character type for each presentation. Overall, there was no difference in children's credibility endorsement by character type for both types of questions (forced-choice and multiple-choice 'Yes') in general [$Z = 1.46$, $p = .144$; $Z = -.34$, $p = .737$ respectively]. This was also true for photograph and illustrated objects [objects in photographs: forced-choice $Z = 1.69$, $p = .091$; multiple-choice $Z = 1.01$, $p = .310$; in illustrations: $Z = .92$, $p = .356$; $Z = -1.44$, $p = .150$ respectively].

Table A3. Children's Credibility Endorsement Score by Character and Object Type

Presentation of objects	Character type	Forced-choice	Multiple-choice		
		M(SD)	Yes	Maybe	No
			%		
Photo	Real-life	2.26(1.13)	68%	17%	15%
	Illustrated	1.74(1.13)	64%	18%	18%
Illustration	Real-life	2.17(1.30)	68%	17%	15%
	Illustrated	1.83(1.30)	75%	14%	11%
Overall	Real-life	4.42(2.19)	68%	17%	15%
	Illustrated	3.58(2.19)	70%	16%	14%

Note. Photo = photograph of objects; Illustration = illustration of objects; Overall = sum of objects (both types of presentation) by character type; % = percentage of answers that were answered 'Yes', 'Maybe', or 'No' for each character type (total number of answers = 260)

Chapter 4. General Discussion

Children's educational TV programs have a great potential to serve as a cost effective educational tool (e.g., Mares & Pan, 2013). However, most of these programs are animated and incorporate some sort of unrealistic elements (e.g., anthropomorphic animals), and it is not yet clear how such factors influence preschool-aged children's learning from screen media. Thus, it is important to understand the impact of animated video format and unrealistic content to have a clearer understanding of the influence of educational TV programs on children's learning. This dissertation contributes to the existing literature by identifying specific factors that influence children's learning from unrealistic media content and empirically examining the influence of animated video format on children's learning.

The influence of unrealistic contents on children's learning from media depends on multiple factors. First, it depends on whether the overall story narrative involves ordinary events or not. If it depicts an unrealistic narrative throughout the story arc, then the degree of fantasticalness of the narrative seems to determine children's learning; Children tend to transfer better when the content is closer to the reality (e.g., animals depicted in upright position with human-like facial expressions in a naturalistic setting) than when it portrays a sheer fantastical world (e.g., monster, human-like animals eating at a dining table with a fork). This explanation also aligns with the relation between individual difference in how children perceive unrealistic phenomenon and learning. For instance, children who attributed human characteristics (e.g., sleeping on a bed) to anthropomorphically depicted animals were more likely to transfer information from an extremely depicted anthropomorphic storybook to a real-world situation than those who judged the anthropomorphic animals to behave like other ordinary animals (Larsen et al., 2017). Thus, not only does the unrealistic phenomenon itself influence children's

learning, but also children's own perception of the unrealistic phenomenon moderates their learning.

Second, when a story narrative is realistic, the influence of unrealistic contents depends on its relation to the educational content. When it is aligned with the educational content, it seems to have no negative impact on children's learning (Bonus, 2019; Richert & Schlesinger, 2017). Children were as likely to learn from a fantastical content as from a realistic content when it was relevant to an educational content presented in a realistic narrative. Furthermore, there also was some evidence to suggest that an unrealistic content could facilitate learning by signaling the relevant content as a learning opportunity. Similar to situations where children learned better after observing an event that violated their expectations in a real-world setting (Stahl & Feigenson, 2015, 2017), children learned better when an unrealistic event occurred in a narrative that seemed realistic other than the event itself (Bonus & Mares, 2018). Together, the research suggests that when an unrealistic content is incorporated appropriately, it could potentially enhance children's learning from media.

On the contrary, while some research suggests that well-integrated fantastical content has no effect (or even a positive effect) on learning, fantastical contents that are irrelevant to an educational content can act as a seductive detail. Just as interesting but irrelevant features negatively impact learning (e.g., Rey, 2012), irrelevant unrealistic contents also impacted children's learning negatively when included in a realistic narrative (Richert & Schlesinger, 2017). Thus, the extraneous cognitive processing that is required to encode the irrelevant information could have taxed children's cognitive resources and limited processing of the educational information (e.g., Fisch, 2000; Sweller, 2011). However, children's prior knowledge of the educational content seem to mitigate such negative influence (Hopkins & Weisberg,

2020). With more content knowledge, children's cognitive resources might be less taxed by the unrealistic content.

In sum, it seems not every unrealistic content has the same impact on children's learning. It depends on the overall story narrative setting, the degree of fantasticalness of an unrealistic content, the relation between an unrealistic content and educational information, and individual characteristics that a child brings to the table (e.g., prior knowledge, working memory). However, even though all the studies that were reviewed in chapter 2 of this dissertation were comparing children's learning from an unrealistic content to a comparable realistic content, the realistic contents were not truly realistic in terms of how they were depicted (except for Richert et al., 2009). Instead of using realistic photographs or live-action videos, illustrations or animated videos were used. Thus, prior studies have demonstrated the influence of unrealistic contents on children's learning by comparing to an illustrated or animated content rather than to a realistic content.

It is possible to find no change in the results when a realistic photograph or live-action video content is used instead as a comparison group. However, this seems unlikely given the results from the empirical study of this dissertation (chapter 3). The results suggest that children are less likely to transfer from an animation even in the absence of an unrealistic content when compared to a live-action video, and age has less of an influence on children's transfer performance when learning from an animated video content. Thus, it may be that an animated format renders transfer more difficult, even among older preschoolers and in the absence of an unrealistic content, protracting the age at which children transfer from video to analogous real-life problems.

The results of my empirical study suggest an alternative interpretation for the results of studies that have compared the influence of unrealistic and realistic contents from animated videos. Some have suggested that there is no difference in children's learning (Bonus, 2019; Bonus & Mares, 2018; Richert & Schlesinger, 2017) while others (Bonus & Mares, 2018) have suggested that the unrealistic content could facilitate children's learning from screen. However, since children are less likely to transfer from an animated video in the absence of an unrealistic content compared to a live-action video, it becomes unclear what the impact of animated unrealistic video content would be on children's learning when compared to a live-action video. When compared to a comparable live-action video, the null and positive effects of unrealistic content might not be found. In fact, it seems more plausible that an animated unrealistic video content would negatively influence children's learning when compared to a live-action video based on the results of the empirical study. Thus, future research needs to compare an unrealistic animated content with a realistic live-action content to better understand the influence of unrealistic contents on children's learning from videos and this is also true for storybooks.

Another key area of future direction is examining contextual factors that might moderate learning from unrealistic video contents. Research has demonstrated that when children and parents have an active conversation (i.e., instructive mediation) about a video they watch, children are more likely to comprehend and learn from the content (e..g., Rasmussen et al., 2016; Strouse et al., 2013). While I did not find an effect of parents' overall instructive mediation in my empirical study (see Appendix A of chapter 3), it is possible that parents who provide instructive mediation while watching a video could scaffold their child's learning by pointing out the information that can be applied in their child's everyday live through making a connection between the video content and the real world even though the content might be unrealistic. Thus,

in order to understand the influence of contextual factors on children's learning from unrealistic animated videos, future research should examine the parent-child interaction while watching a video and how such interaction relates to children's learning of an unrealistic video content. This interaction would include not only the instructive mediation, but also how parents explain the unrealistic content presented in a video. Since children's perception of unrealistic events/entities is influenced by their parent and the culture they are in (e.g., Prentice et al., 1978; Rosengren & Hickling, 1994; Woolley & Cox, 2007), such social factors could indirectly influence children's learning from educational media with unrealistic contents (Valkenburg & Peter, 2013). Parents' encouragement in belief of fantasy could moderate children's acceptance of fantastical events/entities depicted in a video. Thus, examining the contextual factors will provide a greater understanding of how children learn from unrealistic video contenta and future research should address the contextual piece to have a fuller picture of how an unrealistic video content influences children's learning.

In sum, sheer fantastical narrative content and animated video format appear to negatively influence children's learning from educational media. However, there are many different factors (e.g., degree of fantasticalness of a fantastical content to video format to individual differences) that need to be taken into consideration in order to understand the influence of unrealistic contents presented through animated videos on children's learning. Thus, future research should systematically examine the different factors to provide a better understanding of the influence of educational TV programs on children's learning. As an initial step, a follow-up study to this dissertation will examine the influence of different video formats and the degree of anthropomorphism (live-action human, animated human, subtle anthropomorphic character, and extreme anthropomorphic character) on children's learning of

science concepts. Through this study, I hope to replicate the findings of the empirical study with a different educational content and examine the influence of unrealistic content on children's learning when compared to a live-action video. This will also allow to systemically test whether there is a difference in children's learning from subtle and extreme depictions of anthropomorphic characters while controlling for other confounding variables. Lastly, such research will be beneficial to the society in general by helping educational TV producers to produce more optimal educational TV programs that can facilitate children's learning of the educational content from educational media.

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