Solving Analogies in a Fantastical Context: Preschoolers' Ability to Transfer Solutions from Fantasy to Reality

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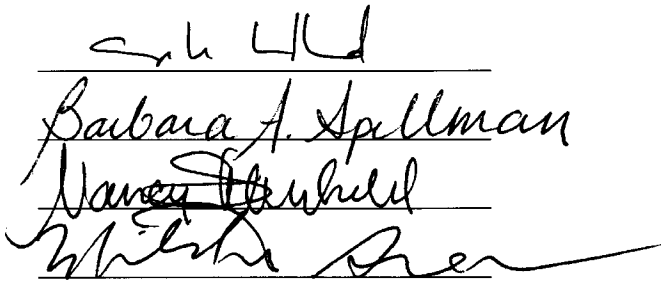

Abstract

Vygotsky (1978) characterized the imagination as a scaffold to cognition, indicating that children can achieve higher levels of cognition when engaged in imaginative thought than when engaged in thinking in the context of the real world. Research in cognitive development supports this theory. Children perform slightly better on several different types of cognitive tasks, like logical syllogisms, when the tasks are framed in a fantasy context. The present research explores whether fantasy has a facilitative effect on preschool children's ability to solve analogical problems.

In Experiment 1, 3- to 5-year-old children were presented with analogical problems in two different contexts. In one context, stories were about the children's teachers, and in the other context the stories were about fantasy characters. Children were more likely to transfer a solution to the target story if the stories were about the fantasy characters than about their teachers. This was especially true for 3-year-old children.

In Experiment 2, children were told the solution in one context and asked to transfer that solution to a different context. Thus, if children were originally told the solution in a story about the fantasy characters, they had to transfer the solution to a story about their teachers, and vice versa. The 3- to 5-year-old children were more likely to transfer the solution from the stories about the teachers to the stories about the fantasy characters, than from the stories about the fantasy characters to the stories about the teachers.

In Experiment 3, 4- to 6-year-old children were asked to transfer the solution to novel games. The older children were more likely to transfer the solution from stories about their teachers than stories about the fantasy characters to the novel games. The

results of these experiments suggest that even though children's ability to solve analogies improved when the analogy was presented in a fantasy context, children demonstrate a greater ease in transferring from reality to fantasy than from fantasy to reality. Findings are discussed in terms of their implications for children's transfer from fantasy to reality and the resulting implications for educational practices.

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> *In play, a child always behaves beyond his average age, above his daily behavior; in play, it is as though he were a head taller than himself.*
>
> Vygotsky, 1978, p. 102
>
> *It is important to cognitive excellence that we cultivate imagination in all areas of inquiry.*
>
> O'Leary-Hawthorne, 1998, p. 3

Watching children imagine something, whether in pretend play or talking with imaginary companions, offers unique insight not only into their views and perspectives on the world, but also on their cognitive abilities at different ages. In an engaging ethnography of fantasy play, Paley (1988) wrote of the play episodes that occurred within her preschool classroom. Of one particular child, Fredrick, she wrote about the difference between how he talked about grandfathers and boys and how he played about grandfathers and boys: "Fredrick responds to questions about boys and grandfathers as if they are about him and *his* grandfather. For more abstract views, I must listen to Fredrick at play. Stepping into another role, he can imagine a variety of possibilities as he explains his pretend characters to other pretend characters" (p. 10). In this analysis of Fredrick's play behavior, Paley (1988) suggests that children appear to perform cognitive feats in pretending that they do not yet perform in the real world. Preschool children do not yet tend to think abstractly or demonstrate a fully developed ability to consider multiple

alternatives to the current situation in which they find themselves; Fredrick, however, appeared to accomplish these very feats in his imagining.

Recent developmental theory has indicated the importance of the imagination for cognition in general. For example, according to Harris (2000a), "The capacity to imagine alternative possibilities and to work out their implications emerges early in the course of children's development and lasts a lifetime" (p. xi-xii). Thus, pretending is the product of the same cognitive capacity that enables children to understand and eventually converse about things not in the present. He suggests that one of the functions of pretense is that it allows children to develop abilities like counter-factual reasoning. In other words, as demonstrated in Fredrick's play, the imagination offers the possibility for fairly sophisticated, seemingly precocious, cognitive abilities in young children.

Historically, developmentalists have debated over the role that the imagination plays in cognitive development. Piaget (1948/1962) depicted play involving the imagination as essentially an immature form of cognition. For Piaget, pretense indicated that children were reworking reality to conform to their own schemas (assimilation) rather than adapting their cognitive schemas to reality (accommodation). In other words, a child pretending that a broom is a horse is not accepting the reality that the broom is actually a broom, but rather mentally changing the broom into a horse. For Piaget, this indicated an immature manipulation of reality to make it conform to how the child would like reality to be.

In contrast, for Vygotsky (1978) the imagination was primarily a form of abstract thought and was the defining characteristic of play. Vygotsky (1978) indicated that imagination was the freeing of oneself from the present perceptual experience and noted

that in play children begin to act independently of their perceptions of the real world. Play, as a novel form of behavior that liberates children from constraints, seems to be invented at the point when the child begins to experience unrealizable tendencies and is a stage between the purely situational constraints of early childhood and adult thought, which can be totally free of real situations.

Vygotsky (1978) considered the imagination as a scaffold to children's cognition, freeing them from the limits of perception of the current reality. To use the broom example, a child pretending the broom is a horse has demonstrated that he or she is no longer bound by the perception of the broom as a broom, and instead can conceive of the broom abstractly as a horse. In this sense, the imagination serves as a scaffold within the child's cognitive zone of proximal development. The concept of the zone of proximal development captures the fact that when a child interacts with a more advanced partner, that partner provides a "scaffold" that allows the child to perform at a higher level than he or she can achieve alone (Vygotsky, 1978). There is thus a continuum of a child's ability at a given age. There is that which the child can perform by herself or himself, and there is a higher level of performance when the child is engaged with a more advanced partner.

Research on children's thinking within a fantasy context suggests that children can perform better on cognitive tasks within that fantasy context, offering some support for the characterization of the imagination as a scaffold to cognition, and thus serving a similar scaffolding function as engaging in interaction with a more advanced partner. When embedding cognitive tasks within a fantasy context, children have demonstrated significant increases in performance on logical syllogisms (Dias & Harris, 1988, 1990; Hawkins, Pea, Glick, & Scribner, 1984; Leevers & Harris, 1999; Richards, & Sanderson,

1999), understanding the mentalistic aspects of pretense (Lillard & Sobel, 1999; Sobel & Lillard, 2001), computer programming (Parker & Lepper, 1992), and abstract mathematical concepts (Cordova & Lepper, 1996).

One of the areas of cognitive development lacking in research on the facilitative effects of a fantasy context is that of analogical problem solving. As will be outlined in more detail below, analogical problem solving involves the transfer of solutions from one context to another. The assumption that children can perform this kind of transfer underlies many educational practices. In particular, many teachers use a fantasy context to teach difficult concepts (Cordova & Lepper, 1996; Parker & Lepper, 1992). The beneficial effects of embedding instructional materials in a fantasy context are often attributed to the increased motivation for learning within an interesting context. Research has revealed positive correlations between how interesting children find material and how much they learn from it (e.g., Asher, 1979, 1980; Asher & Markell, 1974). Research, however, has not yet systematically addressed with appropriate controls whether these features are unique to a fantasy context or if they can be induced in realistic contexts as well. In other words, it is unclear whether teaching in a fantasy context has added benefits over other successful means of teaching using more realistic examples and what is involved in children's ability to make this transfer from fantasy to reality.

Following is a review of what is meant by the "imagination," the cognitive benefits of fantastical thinking, and children's ability to transfer from fantasy to reality. In order to provide a broad context for this discussion, a brief review of historical definitions of imaginative thought as it differs from realistic thought is provided.

Defining imagination

The question of how to distinguish imagination from realistic thoughts is not a new problem for philosophers. Many discussions of the imagination have focused on the fact that the cognition involved in imagination is basically the same cognition involved in routine thinking (O'Leary-Hawthorne, 1998). For instance, Aristotle noted that imagining is quite similar to perception (Edel, 1982), especially in the sense that we take a particular perspective when we imagine as well as when we perceive (O'Leary-Hawthorne, 1998). Kant (1872) placed large cognitive responsibilities on the imagination, claiming that it was responsible for connecting concepts and sensations leading to our perceptions of the world. According to Hume (1978), the imagination is the cognitive faculty responsible for the belief in independent continuous objects. The imagination makes faint copies of perceptions and recombines them, making it also responsible for categorization and storytelling.

Thus, many theories of imagination are posited with either the direct or indirect assumption that imagination consists of mental images (Russow, 1978). Research in cognitive psychology has lent some support to this characterization of the imagination. When participants were asked to imagine drawing a letter and then to actually draw that letter, the same area of the brain was activated, although more so in the imagination condition (Kosslyn, 1994). Russow (1978) notes, however, that there is much debate surrounding the characterization of the imagination as necessarily involving mental images. The claim that the imagination necessarily consists of mental images is often considered problematic because image theories fail to explain "what images are supposed to be, what sorts of properties they have, how we are aware of them, and how they

function" (Russow, 1978, p. 58). Thus, limiting a definition of the imagination to the potential presence or absence of mental images provides an incomplete characterization of what the imagination actually is.

Given these similarities between mental images and ordinary cognition and perception, discussions of what makes imagination a unique form of cognition have focused on the fact that imagination tends to be intentional (O'Leary-Hawthorne, 1998). For example, a key difference between imagination and perception is that imagination can be changed by the power of the will, whereas perceptions cannot (Edel, 1982; Sartre, 1948). Furthermore, whereas perception posits the presence of an object, imagination often posits the absence of an object indicating intention to withdraw from the present state of affairs (Sartre, 1948). A potential difficulty with discussions focusing on the intentionality of imagination is that it does not have to be intentional, and may often seem to progress outside of one's control (Walton, 1990). For example, one could intentionally imagine riding on the back of a unicorn, but the content of the imagination could seem to take on a life of its own as the surroundings become a mystical place with silvery grass and glittering rainbows. The consensus among philosophers appears to be, however, that the imagination is characterized as an intentional form of thinking, that may involve the creation of mental images, about things that are not currently within one's perceptual experience, separating one from the constraints of immediate reality. Imagination is also commonly assumed to be a source of cognitive inspiration (O'Leary-Hawthorne, 1998), however there is little discussion of how the imagination actually serves in this capacity.

The philosophical literature reviewed above suggests that the imagination is a rather mundane cognitive process. For example, given the definitions above, any sort of

cognition that is freed from the perceptions of the real world and involves mental images could be characterized as imagination. Thus, there is little within these theories to distinguish between imagining oneself eating an apple, and imagining that one is a fairy princess whisked away by a prince flying a silver unicorn. As Walton (1990) acknowledges, the imagination is not beholden to the world or the present state of reality, and his discussion of the fictional is especially helpful to make this point. As will be reviewed shortly, Walton's (1990) characterization of the fictional imagination provides a structure for understanding developmental theories on the imagination. He notes that we can imagine things that are both fictional and real. Walton discusses the fictional in terms of the proposition that something is true "in a fictional world" (p. 35), and posits that the world of make-believe is an ideal form of the fictional imagination: it offers the possibility for participating with someone else, the option of limitless spontaneity, a general freedom from having to consider the present reality, and it is under one's control.

Developmental theories on the function of the imagination have often centered on similar defining characteristics as those pointed out by Walton (1990). For example, Walton's (1990) observation that the imagination offers the possibility for participating with someone else is also reflected in social-emotional theories of pretense. Given that the purpose of this research is to explore the cognitive benefits of the imagination, a thorough review would not be especially useful. Briefly, however, Parten's (1932) identification of different types of social participation and Smilansky's (1968, as cited in Fein & Glaubman, 1993) distinction between two distinct forms of play, solitary play and social dramatic play, opened up researchers to the possibility of studying various aspects of the sociability of pretense separately from the cognitive sophistication involved in

pretending. Additionally, according to Vygotskian theory, higher mental functions like play were a product of social interaction with caregivers (Smolucha & Smolucha, 1998). Bretherton (1989) noted that children's tendency to use pretense to obtain emotional mastery is most beneficial within the context of sociodramatic play, and Fein (1989) advocated the study of children's emotive grammar within social play as a means of exploring the affective functions of pretense.

Much of cognitive developmental theory has focused on two other aspects of Walton's (1990) characteristics: (1) the imagination as being generally free from having to consider the present reality and (2) the option of limitless spontaneity. One common way to theoretically discuss these characteristics of the imagination is to consider it as a separate "mental space" (Harris, 2000b, p. 163). Describing the mind as consisting of "mental spaces" acknowledges that by the age of 3 or 4, children are able to think about the past, present, and future, as well as what is real and what is not. According to this characterization, children set up separate "mental spaces" that are defined by time (past, present, future) and modality (real, hypothetical). In essence, pretense as a separate mental space involves the ability to suspend objective truth and consider alternatives to reality (Harris, 2000b). In other words, the imagination frees children from having to only consider the perceptually present reality to focus on the hypothetical. Furthermore, within this "mental space," pretending is not simply manipulating reality; the content of pretense is fictional, not real, and indicates the initial exploration of possible worlds (Harris, 2000a). Thus, within the imagination, children are free to explore the impossible and the magical (Harris, 2000a).

A similar characterization of pretense as a separate mental space has also been suggested in the characterization of pretense as a "Possible World Box" (Nichols & Stitch, 2000). Representations inside this "Possible World Box" are similar to representations of beliefs and desires about the real world. Behavior in pretend play results from children's real desires about the real world that are created inside this box. This characterization is different from Harris' in an important way, however. The content of the imagination for Harris is fictional, whereas the content of the "Possible World Box" is a reflection of reality.

Pretense has also been characterized as the child's version of the "Twin Earth" tool used in philosophical debate (Lillard, 2001). The concept of Twin Earth in a philosophical debate is the postulating of a place identical to earth, with the exception of one or more key features (Putnam, 1975/1996). Philosophers then debate the ramifications of the existence of this feature. For example, in an attempt to define the role that the imagination plays in cognition, one might consider what cognition would be like in the absence of imaginative thought on Twin Earth. It has been suggested that pretense may serve a similar function for children (Lillard, 2001). For example, in pretending to play house, a little girl may be considering what the world would be like if she was a mommy, positing that mommies do the same things in her pretense as they do in the real world. In this way, children can consider why things happen the way they do, without actually experiencing them in the world. Theoretically, a potentially important similarity between pretense and "Twin Earth," then, is that being freed from the constraints of the real world makes it is possible for higher levels of reasoning to be attained by the thinker or pretender (Lillard, 2001).

Another feature mentioned by Walton (1990) is that the fictional imagination is under one's control. Within fantastical thought, children are free to allow, and cause, their naïve theories of the world to be violated, or at least not upheld (Woolley, 1997). For example, fantastical thinking often involves reasoning about the physical world in a way that violates known physical principles (Chandler & Lalonde, 1994).

Given all of these factors, the imagination offers an opportunity for rich cognition and is an ideal breeding ground for honing skills. These features are likely a (potentially subconscious) reason that teachers embed their curriculum within a fantasy context with the general goal of creating learning contexts that are enjoyable, interesting, and intrinsically motivating (Lepper, Aspinwall, Mumme, & Chabay, 1990; Parker & Lepper, 1992). For example, teachers are encouraged to use imagery in teaching, including such practices as having children imagine themselves with special learning powers or magical powers (Allender, 1991).

In sum, according to recent developmental theory the imagination is a form of cognition that is decoupled from the real world, in which children process information without necessarily being encumbered by the constraints of reality. Thus, children's engagement in imaginative thought suggests a tendency toward abstract thinking about things that are beyond what is physically accessible to representations of the real world. The consensus appears to be that in pretense, children are freed from real world constraints and the mind is allowed to consider alternatives to reality.

If it is the case that the imagination is a distinct form of cognition, there are two very important questions about how the imagination interacts with cognitive development in general. First, how does the development of cognitive processes within the imagination

compare to cognitive processes in ordinary cognition? Second, how easily do children transfer from their imaginative thought to more ordinary cognition?

Fantastical thinking as a scaffold

In response to the first question, theoretically we may expect that the development of cognitive processes within imaginative thought are somewhat more advanced than the development of those processes in ordinary cognition. Support for this suggestion comes from theories suggesting that fantastical thinking encourages more abstract thought by freeing children from real world constraints (e.g., Dias & Harris, 1988). In other words, when children are not limited to thinking within the constraints of realistic possibilities, they will consider more options and are thus more likely to come up with the correct response. This hypothesis runs into a problematic contradiction, however. If a fantasy context allows children to consider multiple alternatives, one might expect that it would be more difficult for children to pass the cognitive tasks in 'fantasy mode' because there is no limit to what they can consider as solutions. For example, children tend to perform better on cognitive tasks when they are provided with forced choice questions limiting their response options, as opposed to open-ended questions where they can respond freely (e.g., Ganea, Lillard, & Turkheimer, 2002). Thus, allowing children to consider all possible (and impossible) options is not always cognitively beneficial, and may actually be cognitively burdensome. Furthermore, fantastical thought is not necessarily free of all constraint, but rather involves the resetting of constraints. Many researchers have noted that just because thought is "fantastical" does not mean that children consider endless possibilities; they continue to preserve much of their real world knowledge and assumptions within the imagination (e.g., Harris, 2000a). Thus, the observation that the

imagination allows for the freeing of real world constraints does not completely account for how the imagination may assist the development of cognition.

A broader perspective is that fantastical thinking is in fact a form of scaffolding, as suggested by Vygotsky (1978). This would mean that within fantastical thought children are capable of achieving their highest cognitive abilities at a given age. At its conception, the idea of a scaffold for children's behavior and cognition was a rather vague description. For the imagination to be characterized as a scaffold, two key aspects of the characterization should be clarified. First is the issue of how certain cognitive abilities develop in general and why the imagination might promote the development of those abilities. Second is the issue of why more mature forms of those cognitive abilities are only achieved in the imagination for a certain period of time.

In terms of scaffolding children's development of cognitive abilities, the imagination could be viewed as an ideal cognitive environment for the practice of cognitive abilities. The development of cognitive processes can be explained through connectionist models of the brain, which postulate that cognition is a function of many "simple processing units" (Siegler, 1998, p. 88). The strength of the connections between these processing units either increases or decreases based on experience. More specifically, input into the network of connections is processed based on the existing structure, a response is determined and then the outcome is analyzed. The connections are then strengthened or weakened depending on the success or failure of the response (Siegler, 1998). Thus, more successful practices or uses of particular mechanisms result in the strengthening of connections producing greater proficiency with those mechanisms.

The imagination provides an interesting and motivating context within which to practice using these cognitive processes, and it has been suggested that the imagination is essentially an early form of abstract thinking that likely leads to more sophisticated hypothetical reasoning and consideration of counterfactual alternatives (Harris, 2000a). As will be outlined shortly, this is likely also true for other sorts of cognitive processing, like learning to solve analogies or logical syllogisms. In other words, children are more motivated and interested in practicing some cognitive mechanisms within the imagination, which in turn strengthens the connections to using those cognitive strategies and results in greater proficiency.

Included in the characterization of the imagination as a scaffold to cognition is the observation that the demonstration of some cognitive abilities initially may be context dependent, as is the case when children are interacting with a more advanced partner. Theories of the development of specific abilities suggest that mastery of a particular ability is bracketed from other domains until the final phase of development of that ability (e.g., Karmilloff-Smith, 1992). It may be that within a fantasy context, children can achieve mastery of certain abilities through the increased use of the relevant processes in fantastical thinking. Thus, fantastical thinking provides children with the opportunity to 'hone' specific cognitive skills, scaffolding them into a form of mastery of that ability. This mastery, however, will be limited to occurring within fantastical thinking or pretend play until children have achieved a mature stage in the development of that ability.

Thus, if fantasy serves as a scaffold to cognition, framing tasks in a fantasy context should have an effect on performance on those types of cognitive elements that

are present in imagining. As was outlined above, the various philosophical and developmental discussions on the topic suggest there are a few key cognitive tasks performed in the imagination. First, in imagining, children (and adults) are often reasoning from new premises that run counter to knowledge about the real world. Turning back to the broom example, this feat of imagining would begin with the premise that this broom is now a horse. Second, in the imagination, children often create and infer characteristics of objects or entities with which they have never interacted, perhaps making them more explicitly aware of the role of their own (and other's) mental states. For example, I could just as easily pretend that the broom was a unicorn rather than a horse, even though I have never seen a unicorn in person. I may have to communicate to someone else, however, that I am pretending the broom is a unicorn and what the unicorn looks like if they have never heard of a unicorn before. Third, imagining requires mapping from one domain onto another domain. Even though children can imagine things that have never happened or events they have never experienced or entities they have never met, much of what is imagined is brought into the imagination from real world experiences and knowledge (Harris, 2000a). Thus, the imagination (especially in its early forms) often involves the mapping of the real world onto one's imaginings of it (e.g., *real mother: cooks:: imagined mother: cooks*).

In sum, in response to the question about comparisons between the development of cognitive processes within imaginative thought and ordinary cognition, theory might predict the boosting effects of a fantasy context in those cognitive circumstances when children have practice with that sort of cognition already in the imagination. Additionally,

this boosting effect should occur at the point where children are fairly close to being able to perform a particular cognitive ability in a real world context.

Cognitive benefits of fantastical thinking

Research suggests that these particular abilities are indeed the abilities in which a fantasy context seems to facilitate children's performance. Children have demonstrated improved performance on many cognitive tasks when those tasks are framed in a fantasy context, including logical syllogisms (e.g., Dias & Harris, 1988, 1990), understanding mental states involved in pretending (Lillard & Sobel, 1999; Sobel & Lillard, 2001), and transfer of learning from one context into another (Cordova & Lepper, 1996; Parker & Lepper, 1992).

The largest body of research showing that children perform better on strictly cognitive tasks if they are framed in a fantasy context has been on children's ability to solve logical syllogism problems about things that run counter to children's real world experience (e.g., Dias & Harris, 1988, 1990). In logical syllogisms, children are presented with two premises and asked to answer a question regarding those premises. For example, children younger than 6-years-old often do not respond correctly to the following syllogism: "All fish live in trees. Tot is a fish. Does Tot live in a tree?" Preschool children apparently become confused by the reality that on earth fish do not live in trees and thus respond that Tot does not live in a tree. Interestingly, children responded correctly if they were first introduced into a make-believe realm.

In one study, children were presented with logical syllogisms in which the premises were either congruent with real world knowledge, incongruent with real world knowledge, or fantastical (e.g., mythical creatures foreign to practical knowledge)

(Hawkins, et al., 1984). At the beginning all children were told to pretend that everything in the stories was true. Findings revealed that when children received the fantasy syllogisms first, they answered correctly significantly more often, and they gave more correct justifications for their answers. There were no significant differences in performance on the congruent and incongruent problems.

In another study on logical syllogisms, 4- and 6-year-old children were either told to "pretend that everything in the story is true" or told to pretend they were on another planet where certain things happen ” (Dias & Harris, 1988, p. 210). Children's levels of performance increased only when they were told to imagine being on another planet. This study indicated that there are certain features of the pretend context that are especially facilitative to children in solving logical syllogisms. These features appear to be a make-believe intonation, the context of a remote setting, and visual imagery (Dias & Harris, 1990).

Another study on children’s performance on logical syllogisms found that children were more likely to respond correctly if told to think about the problem, imagine the problem, or both think about and imagine the problem (Leevers & Harris, 1999). Furthermore, research has found that just having children pretend that the premises are true does not assist performance (Richards & Sanderson, 1999). Children were given logical syllogisms that were incongruent in one of four conditions: (1) no make-believe cue, (2) word cue (told to pretend twice), (3) fantasy planet, or (4) visual imagery. Results revealed that children in the visual imagery and fantasy planet conditions performed better than children who were given the word cue or no cue (Richards & Sanderson, 1999). This shows that simply engaging children’s imagination by

encouraging them to pretend was not sufficient to boost their performance. Children only performed better when additional steps were taken to engage the imagination in a more extreme form.

The general conclusion from these findings is that encouraging children to think within a fantasy context frees them from the constraints of thinking about the real world and allows them to consider alternatives within a make-believe world (Dias & Harris, 1988, 1990). Worded differently, children can engage in deductive reasoning when the problem is isolated from practical world knowledge by the use of fantasy material, which may affect how much children consider practical world knowledge (Hawkins et al., 1984). Thus, encouraging children to think in a fantasy context cues them to create an alternative reality where different outcomes are possible (Richards & Sanderson, 1999). Another alternative is that make-believe is a unique form of social discourse in which children are aware of the need to pay close attention to the premises in order to successfully engage in the make-believe scenario (Harris, 2000a). This alternative would appear to suggest then that the facilitative effect of fantasy is not because it has any specific cognitive benefits, but rather because it is a unique form of social interaction.

Children's increased performance on cognitive tasks is not limited to their performance on logical syllogisms, however. Studies specifically on children's understanding of pretense have indicated that children perform better on tasks if they are about fantastical characters. For example, children demonstrate slightly more sophisticated understanding of the mental states underlying pretense if that pretense is of a fantasy character as opposed to a real animal (Lillard, 1996; Lillard & Sobel, 1999; Sobel & Lillard, 2001). In one task, when asked to sort activities by whether they require

a mind, body, or both, 4-year-old children choose the "mind" box significantly more for fantasy pretense item (e.g., pretend to be the Lion King) than for ordinary pretense item (e.g., pretend to be a puppy) (Lillard, 1996, Experiment 4; Lillard & Sobel, 1999). Related research has explored when children understand that one needs to know what something is in order to pretend to be it (see summary in Lillard, 2001). Young children often respond that a character can be pretending to be something it could not know about. Yet, children were more likely to acknowledge the role that knowledge plays in pretense if the protagonist is pretending to be a fantasy character instead of a real animal (Sobel & Lillard, 2001).

A third cognitive task involved in imagining is that of transferring from one domain into another. There is noticeably less research testing the effects of a fantasy context is that of analogical reasoning. The majority of research has been conducted in regards to the effects of using a fantasy context on children's ability to learn abstract material and transfer that to a new domain. This issue indeed has important educational implications in that when something is taught in a fantasy setting, children are then expected to transfer that understanding to the real world problems given to them.

Recent experimental research in education has addressed whether framing concepts in a fantasy context actually assists children's learning (Cordova & Lepper, 1996; Parker & Lepper, 1992). For example, in teaching third- and fourth-grade students how to use a computer program, Parker and Lepper (1992) varied whether the program presented purely abstract concepts (i.e., how to draw lines connecting objects on the screen) or presented the concepts in a fantasy context (i.e., how to gather all the astronauts together into the spaceship). Children taught in the fantasy contexts were

significantly more likely to learn the procedure and to generalize it to another context. The authors attributed this increased level of performance to the fact that children are more intrinsically motivated to learn in the fantasy context because it is more fun and interesting. However, there was not a significant difference between groups that were allowed to choose their fantasy context versus those assigned to a particular fantasy context, suggesting that there may be an advantage to the fantasy context beyond the motivation of participating in something one chooses.

A follow-up study did find that allowing children some choice over irrelevant aspects of a fantasy condition as well as personalizing the fantasy condition enhanced their learning of mathematical concepts beyond a generic fantasy context (Cordova & Lepper, 1996). The reasons for the effect of a fantasy context were still unclear, however, since the experimenters did not examine whether providing children with the same types of personalization and control in a non-fantasy context would also enhance performance. Research has found that preschoolers demonstrate increased memory abilities and better cognitive organization for stories and toys that interest them (e.g., Renninger, 1990; Renninger & Wozniak, 1985). However, systematic comparison to a fantasy context has not yet been conducted.

One study of analogical problem solving suggests that teaching children how to solve a problem by telling them a fantasy story may facilitate their ability to transfer that problem to a novel situation (Holyoak, et al.,1984, Experiment 3). Results revealed that preschool children's (younger than six years old) ability to transfer a solution to a target problem, set up as a game to play, improved significantly when they were originally told the solution in a story about familiar fantasy characters (Woodstock and Miss Piggy).

This was compared to their performance when the original story was about an unfamiliar (but still fantasy) genie. The authors attributed the improved performance to children's familiarity with the fantasy characters (Holyoak, et al., 1984, Experiment 3). Thus, despite growing findings indicating that embedding abstract concepts in a fantasy context is a helpful teaching tool, it is not yet clear if the fantasy context itself facilitates learning beyond an equally interesting, enjoyable, motivating realistic context.

To summarize, several studies in various cognitive domains have demonstrated increased levels of performance when those tasks are framed in a fantasy context, suggesting that fantastical thinking provides cognitive benefits to children. Fantasy as a form of thinking about things not based in reality may actually provide a forum for higher levels of reasoning (Lillard, 2001), perhaps by providing children with an interesting and motivating context in which to "hone" their abstract thinking abilities. If this is the case, fantastical thought in childhood would not indicate immature cognition, as suggested by Piaget (1948/1962), but rather the early capacity for engagement in abstract thought, as suggested by Vygotsky (1978).

This growing body of research suggests that providing children with a fantasy context in which to think may boost their cognitive processing abilities. This overall boosting effect of fantasy may also help to explain why teachers have found that embedding material in fantasy contexts facilitates children's learning. Since the imagination often involves the mapping of the real world onto one's current imaginings of it, it is already a form of analogical reasoning, thus children should have practice in this context with transferring between contexts already. Therefore, it should be easier in this cognitive environment for children to solve analogies. There has been no systematic

exploration, however, of children's ability to solve analogical problems within a fantasy context. As is covered in more detail shortly, the study of analogical reasoning can also provide answers to the second question regarding the interaction of the imagination with cognitive development: how easily do children transfer from their imaginative thought to more ordinary cognition?

Analogical thinking

Analogical thinking has been defined as "the process of understanding a novel situation in terms of one that is already familiar" (Gentner & Holyoak, 1997, p. 32). An analogy is thus comprised of two parts. The familiar part is most often termed the source (or base) analog, and the unfamiliar part is most often termed the target analog. Analogies can be based on superficial relations between surface features. One example of this type of analogy led to the invention of Velcro. This followed Georges de Mestral's observation that burdock burrs, coarse flower heads with prickly hairs, clung to his dog's fur (Goswami, 2001). In this case, the appearance of the small hairs on a burdock burr were mapped onto the superficially similar prickly side on Velcro, both of which result in adhesion. Even though analogies can be created based on superficial, surface features, they are essentially relational. A classic example is the analogical insight that led to the theory that the molecular structure of benzene is a ring (Kekule, 1865, as cited in Goswami, 2001). Kekule dreamed of a snake biting its own tail, which led him to theorize that the carbon atoms in benzene could have a circular arrangement. In this case, there is no apparent superficial similarity between the snake and the benzene ring; the similarity is strictly relational.

As summarized by Gentner and Holyoak (1997), analogical reasoning can be broken into several basic processes. First, a relevant source analog must be retrieved from memory. Second, this familiar source analog must be systematically mapped to the target analog according to relevant relational correspondences between the individual parts of the two analogs. Chen (2002) discusses three types of similarity that are necessary in the mapping of a source analog onto a target analog in problem-solving situations. *Superficial* similarity is similarity in the surface features of the analogs (e.g., context, characters). *Structural* similarity refers to the deeper causal relationships (or solution principle) among the features in the analogs. *Procedural* similarity indicates the similar procedures necessary to execute the solution. Once similar features are mapped from the target analog to the source analog, this mapping allows for analogical inference regarding the target analog, which in turn creates new knowledge and understanding. The inference can then be analyzed and adapted for the unique features of the target analog. This analogical process can result in "the generation of new categories and schemas, the addition of new instances to memory, and new understandings of old instances and schemas that allow them to be better accessed in the future" (p. 33). Thus, in order for a successful analogy to be created, one must map systems of relations from one (familiar) domain onto another (novel) domain (Gentner, 1983). This mapping can be useful in problem solving, explaining novel material, and constructing arguments (Gentner & Holyoak, 1997).

The development of analogical thinking

Current study of the development of analogical thinking can be traced back to Piaget's research on children's ability to solve classical analogies (Piaget, Montagangero,

& Billeter, 1977). For example, children were asked to complete the puzzle *bicycle: handlebars:: ship: ?*, with the correct response being *rudder*. Using this method, Piaget concluded that children did not develop analogical reasoning abilities before reaching the phase of formal operations in early adolescence. However, given the complex nature of the analogies, this research may provide an inaccurate assessment of children's analogical abilities. Children may have lacked the relevant knowledge about the elements in the analogies to draw the correct relational connections (Goswami & Brown, 1989, 1990). Research on more age-appropriate classical analogies by Goswami (1996) has revealed that preschool aged children can respond correctly to analogical puzzles if the children understand the elements within the analogy. If presented as a game in which children are asked to choose a picture to finish a pattern, 4-year-olds correctly responded above chance that a *dog house* picture would complete the sequence *bird: nest:: dog: ? (dog house).* Furthermore, even 3-year-olds could respond correctly above chance on analogical puzzles involving simple transformations, like *chocolate: melted chocolate:: snowman: melted snowman* (Goswami, 1996). Thus, recent research on children's ability to solve classical analogies has demonstrated that with the relevant knowledge, children as young as three can produce a correct analogical solution. As Gentner and Holyoak (1997) have suggested, the ability to perform classical analogies indicates the cognitive potential for recognizing common relations between two separate domains and transferring relations from one domain to another.

DeLoache (1987, 1989, 1995) developed an analogy task that explores children's ability to use a classical analogy in a hide-and-seek game situation. In the scale-model task, children are asked to find a toy hidden in a room based on where a small version of

that toy was hidden in a simple scale model of that room. The scale model contains several pieces of furniture that are miniatures of pieces in the room. The procedure for the typical scale-model task is as follows: First, the child is oriented to the concept that the model represents the room. Then, s/he observes an experimenter hide a miniature toy behind or under one of the pieces of furniture in the model. The child is then told that a larger toy was hidden in the room in the same place as in the model. Finally, the experimenter escorts the child into the room, and the child searches for the toy. After successfully finding the toy in the large room, the child returns to the scale model and retrieves the hidden toy miniature. In terms of an analogical problem, the task could be spelled out as *little Snoopy: little couch:: big Snoopy: ? (big couch)*.

Most 2 ½-year-old children do not understand the model-room relation (DeLoache, 1987), unless the salience of the scale model as an object is reduced. For example, children were convinced of the effectiveness of a shrinking machine that could shrink not only toy trolls, but also entire rooms. In this specific case, 2 ½-year-old children successfully retrieved the toy. This is likely because they thought of the model and the room as one thing, not separate things (DeLoache, 1995). Most 3-year-olds demonstrate a fragile understanding of the model-room relation that is supported by explicit instruction about how room and model are related (DeLoache, 1989). When the experimenter did not orient children to the model-room relation, 3-year-olds dropped to chance responding. The understanding of 3-year-olds also decreases if there is a time-lapse between viewing the hiding in the scale model and being asked to find the toy in the room (Uttal, Schreiber, & DeLoache, 1995). Thus, the ability of 3-year-olds to successfully use the scale model as a symbolic representation of the room is fragile and

context-dependent. 3 ½-year-olds can use scale model symbolically with out much help, but still need an introduction to the relation between the model and the room. Four- and 5-year-olds successfully use a scale model without any introduction or help (DeLoache, in press). Thus, around age 4 children demonstrate the ability to spontaneously map the relations from the model room to the larger room in order to find the hidden toy.

A particularly useful application of the ability to recognize relations is in the potential for inferring solutions to novel problems (Gentner & Holyoak, 1997). Children constantly encounter new situations in which they are faced with new obstacles (Siegler, 1998), and it has been argued that one of the most helpful cognitive tools for successfully circumventing these new obstacles is that of analogical thinking (Gentner, Ratterman, Markman, & Kotovsky, 1995). As opposed to solving classical analogies, to solve an analogical problem, one must transfer a solution from an initial story or situation (the source analog) to solve a similar problem in a new context (the target problem) (Holyoak & Thagard, 1995). Identifying the common structures requires abstracting the relevant features of the source analog and target problems and mapping them onto each other to infer a solution to the novel problem. If performed correctly, analogical thinking leads to more efficient processing by helping children apply an old solution to a new problem.

By two years, children can transfer solutions if the surface characteristics of the source and target analogs are similar, or the relationship is very simple (Holyoak & Thagard, 1995). For example, 1- and 2-year-old children were able to transfer the solution that a rake would help them pull a toy to within reach, after learning in a prior interaction that a cane could serve that purpose (Brown, 1989). In this case, children were not misled by the differing appearances of the rake and the cane, which was painted red

and white. They instead were able to map the similarity of action (pulling) from the source problem to the target. Using a similar task, Chen and Siegler (2000) analyzed the changes in children's tool-use strategies for obtaining an out-of-reach toy. In their studies, very few toddlers spontaneously used a tool to get an out-of-reach toy. By the final testing phase, however, 90% of children were using tools if an experimenter had given them a hint to use a tool or modeled using the tool. Thus, even toddlers learned to transfer a strategy to new situations.

Research on preschool children's ability to transfer problem solutions often employs the paradigm developed by Holyoak and colleagues (Holyoak, Junn, & Billman, 1984). In this paradigm, children are told a story (the source analog) in which a problem is solved and then introduced into a situation in which they could use the solution for a novel problem. For example, in the original set of studies, children were told the story of a genie who wanted to transfer his jewels from one bottle into another and could not drop any of the jewels. In order to achieve this goal, the genie used a magic staff to pull one bottle closer to the other bottle and then drops the jewels into it. Children were then presented with a ball problem (the target analog) in which they could use any number of tools (a walking cane, a large piece of posterboard, a hollow tube, scissors, string, tape, paper clips, and rubber bands) to transfer balls from one bowl in front of them to an out of reach bowl.

Preschool children are able to transfer the solutions from the source analog to the target analog only under certain facilitative circumstances: prior experience with other analogical problems, recognizing the relevant relations among the features of the source and target analogs, and familiarity with the characters. Brown and Kane (1988) explored

the facilitative nature of prior experience in children's ability to solve analogical problems. For example, 3-year-old children were provided with three pairs of analogical stories, six stories in total. In each of these pairs, an animal in both the source and target stories employed the same defense mechanism against danger (strange markings, color change, or shape change). In this study, 75% of 3-year-olds were able to successfully transfer the defense mechanism from the source story to the target story in the last pairing if they had received the other two pairings first. Only 10% of children were able to solve the problem, however, if they were only provided with one source story and asked to infer how the animal could defend itself.

A likely reason that prior experience assists children's ability to solve problems is that more exposure to solutions helps children to develop a solution schema. Chen (1999) administered variations on Luchins' (1942, as cited in Chen, 1999) classic water jar problems, to children ages 8 to 12. In these problems, children practiced a series of problems in which they could derive a certain amount of water with a specific formula. For example, children were given three measuring cups that could hold 4, 6, and 7 cups of water. They were then asked to produce 5 cups of water. Children practiced solving this problem with the formula 7 – 6 + 4 (or A – B + C). Results revealed that practicing solving the problems with various formulas increased the likelihood that older children would correctly solve a more complex target problem. Additionally, children were more likely to transfer solutions if they had been provided with practice problems with various materials (e.g., volume, length, area). These findings suggest that prior experience with similar problems contributes to the development of more general problem-solving schemas that assist children's ability to transfer solutions to novel problems.

Another condition that facilitates children's ability to transfer solutions is when relevant features of the source and target analogs are emphasized. For example, 4- to 5-year-old children were told a source analog story about a genie transferring jewels from one bottle into another through a posterboard tube (Brown, Kane, & Echols, 1986). Approximately 70% of the children used this solution to solve the target problem in which they had to transfer balls from one bowl into another only if asked explicit questions about the central features of each story. This is compared to 50% of the children who responded correctly if they were simply asked to recall the story, and 20% of the children who responded correctly if simply given the target problem.

A third feature of analogy tasks that assists children is their familiarity with the source analog. In the Holyoak and colleagues (1984, Experiment 3) example cited above, about 50% of 4- to 5-year-old children produced the analogical solution when the characters in the source story were familiar fantasy characters. This was an improvement from about 30% of children in Experiment 1 of that study who produced the analogical solution after hearing a story about a genie, and 10% of children who came up with the analogical solution without hearing a story at all. The authors attributed children's improved likelihood of transferring a solution to children's familiarity with the fantasy characters (Holyoak, et al., 1984, Experiment 3). The true nature of the facilitative effect of using familiar fantasy characters in the source story is unclear, however (Holyoak, et al., 1984, Experiment 3). It is possible that children's increased levels of performance were because of the fantastical nature of the characters rather than their familiarity with the characters. Children at this age may be uncertain about the fantasy status of genies, or whether genies are real, given their uncertainty about the reality status of other fantasy

characters like Santa Claus, monsters, and fairies (Sharon & Woolley, 2002). Therefore, genies may or may not represent true fantastical entities for children. If the children in the study believed that genies were real, but knew that Woodstock and Miss Piggy were fantasy characters, it could be that the fantastical nature of the source analog was the reason for the improved performance, rather than familiarity. It is therefore unclear whether the facilitative effect of a fantasy context for analogy problems is merely because of children's familiarity with the source analog or because of the fantastical nature of the protagonists.

Analogical reasoning and fantastical thought

Given the literature on the development of analogical problem solving skills and the facilitative effects of fantasy, studying the effects of a fantasy context on children's ability to solve analogical problems should provide answers to the two questions posed above about how the imagination interacts with cognitive development. Recall the first question about how the development of cognitive processes within the imagination compare to cognitive processes in ordinary cognition. As was reviewed above, children have demonstrated better performance on a number of cognitive tasks if those tasks are framed in a fantasy context. Theoretically, we should expect these effects to extend to analogical problem solving situations as well. This has not yet been tested, however. As was discussed above, one experiment by Holyoak, et al. (1984) indicated that children performed better on analogical problems framed in the context of familiar fantasy characters. They suggest that children in their experiment performed better on their fantasy items because they were familiar with the characters, not because they were

fantasy characters. Experiment 1 tests this assertion by comparing children's analogical problem solving with familiar fantasy and familiar real characters.

The second question asked about how easily children transfer from their imaginative thought to more ordinary cognition. Various developmental theories on fantastical thinking have characterized the imagination as a unique form of cognition (Harris, 2000b; Lillard, 2001; Nichols & Stitch, 2000). Analogical problem-solving provides a useful paradigm for assessing how children use this form of cognition by exploring how easily children transfer from fantasy to reality and from reality to fantasy.

On one had, children may be expected to have unique difficulties in transferring from a fantasy story. Theoretically, in order for children to recognize that a fantasy story can be used as a source analog, they would have to be able to recognize that the story can have a dual function: it can be entertaining, but may also contain information that can be generalized to other situations as well. A related hypothesis is DeLoache's (1995) dual representation hypothesis for children's symbolic development. According to the dual representation hypothesis, young children demonstrate difficulty in recognizing the symbolic relationship (that one thing is intended to stand for something else) between concrete objects when the symbols are interesting as objects themselves and when the relationship between the objects is not made explicit. Thus, negotiating the symbolic relationship between things may be difficult for young children because some objects are interesting regardless of their symbolic function. This suggests that it is challenging for young children to look past the intrinsically interesting features of the object to its symbolic function (DeLoache, 1995). Therefore, children may consider fantasy stories to

be context dependent and therefore may not spontaneously think to transfer a solution from the fantasy stories.

On the other hand, as was reviewed above, engaging children's imagination has proven facilitative for a number of cognitive tasks. Thus, having children imagine right at the start of the problem-solving interaction with the source story may itself serve a facilitative function. Alternatively, children may demonstrate equal likelihood of transferring the solution, since the element of fantasy will be present in both the source and target stories in different conditions. Experiment 2 explores this question. Experiment 3 explores whether children differentially transfer from a fantasy story or a story about their teacher to a real world problem with which they are faced.

The stories used for all three of the following experiments were based on those reported in Holyoak, et al. (1984) and Brown, et al. (1986). In these experiments, children were presented with a story in which the analogical solution was to roll up a piece of paper and put marbles through it. In these studies, only 10 to 20% of 3- to 5-year-old children produced that solution without the prior source story, suggesting that children who did produce the analogical solution were transferring from the source stories. As will be described in more detail below, a similar solution type was used for this experiment. In this case, however, rather than rolling items through a paper tube to move them from one point to another, the solution involves wrapping something up in a towel to move it from one point to another. Given the findings in prior research, it is unlikely that children would suggest this type of solution on their own. In order to implement a within subjects design, a new solution type was designed as well in which the problem could be solved by stacking dominoes under a block to make it the same height as another block. For each

experiment, the likelihood that children would produce the analogical solution was compared to ensure that the problems were equally difficult for children. If both solution types are equally difficult for children, then it will be assumed that the majority of children who produce the analogical solution of either type were indeed transferring that solution from the source context.

In conclusion, past research on the development of analogical problem solving abilities has outlined three facilitative conditions under which children are able to solve analogical problems at an earlier age: past experience with the analogical problems, recognizing the relevant features of the source and target analogs, and familiarity with the characters in the stories. Children's familiarity with the characters is confounded with fantasy, however. It might be that embedding those tasks in a fantasy context had the facilitative effect. Thus, the facilitative effect of fantasy has not clearly been demonstrated in children's analogical thinking, since it has not been compared to a non-fantasy task with familiar characters.

Experiment 1

Experiment 1 is based on the analogical problem-solving paradigm outlined above (Holyoak, et al., 1984). In this basic methodology, children are presented with the solution to a problem in one context (the *source story*), and then presented with another context in which they can successfully solve a problem using a similar solution (the *target story*). The analogical tasks were made as simple as possible for children by including multiple features that have been known to help them pass similar tasks. These features include familiarity with the characters (Holyoak, et al., 1984), similarity between

the source and target stories (Holyoak & Thagard, 1995), and understanding the relevant features of the source and target stories (Brown, et al., 1986).

The important manipulation in Experiment 1 is the fantastical nature of the protagonist of the source and target stories. In the fantasy condition, children were told a story about Mike and Sulley of the recent Disney movie *Monsters, Inc.* In the real condition, children were told a story about their school teacher. Additionally, since the task is based in story-telling, children were administered the *Peabody Picture Vocabulary Test* (PPVT) as a measure of children's receptive language ability. Children ages 3 to 5 years old were tested for this experiment, because prior research has shown that there is variability in children's ability to correctly respond to analogical problems within this age range.

Method

Participants. Sixty-four children ages 3 to 5 (M = 4;1, range = 3;0 to 5;6) were recruited from preschools and day care centers in a small university town. There were 36 girls and 28 boys. Permission letters were sent home with parents, and those children whose parents signed the permission letter were asked if they wanted to participate. Children were divided into two groups, a younger group (n = 32, M = 3;6, range = 3;0 to 3;11, 21 girls and 11 boys) and an older group (n = 32, M = 4;7, range = 4;0 to 5;6, 15 girls and 17 boys).

Materials. Materials for the source stories included eight pictures, one of the *Monsters, Inc.* characters Mike and Sulley and one of each of the teachers from the seven schools included in the study, to assist in story-telling. See Appendix A for the fantasy picture and a sample teacher picture. For the target portions of the procedure, two sets of

materials were used. Materials for the *wrap target story* included marbles, a towel (analogical solution: wrapping), small spoon, blue block, twistie, paper clips, a binder clip, and rubber bands. Materials for the *stack target story* included a blue block and an orange block (in descending order, respectively), two dominoes (analogical solution: stacking), a spool of string, paper, tape, paper clips, and rubber bands. Te *Peabody Picture Vocabulary Test* (PPVT) was also administered. The PPVT is a standardized measure of children's receptive vocabulary abilities.

Procedure. Children whose parents had signed and returned a permission slip were invited to go with the experimenter to look at some pictures and listen to some stories. All children were tested on two analogical problems and administered the *PPVT* between the problems. Each analogical problem had two phases, a *source story* phase and a *target story* phase (see Appendix B). The source stories varied by type (fantasy vs. reality) and by solution (wrap vs. stack). Each child heard two stories that were counterbalanced by type and solution (See Appendix A for all possible stories). Thus, each child heard both a fantasy story and a reality story, and each child heard one story with the stacking solution and one story with the wrapping solution. Additionally, which type and solution were presented first was counterbalanced by children.

To preface the *source story*, the experimenter showed the child the picture of his or her teacher and asked, "Who is this?" After the child responded that it was the teacher in the picture, the experimenter told the child, "I am going to tell you a story about your teacher. Listen closely to the story, okay. Because when I'm done telling it to you, I'm going to have you tell it back to me." With the picture of the teacher displayed so the child could see it, the experimenter proceeded to tell the following story, in this case the

teacher-wrap story: "(Teacher's name) told me that one day she was in the classroom handing out snack and wanted to get all of the apples from the table to all of the students. She realized she couldn't carry them all without dropping any. She looked and looked for something to help her move the apples. Then she had a great idea. She decided to wrap the apples up in the blanket. That way, she could fit all of the apples into the blanket, carry them all at the same time to the tables, and hand them out." To verify that the child understood the key elements of the story and that the relevant elements were encoded, the experimenter asked the child, "Can you tell the story back to me?" If the child left out something important, the experimenter asked one of the relevant prompts, either "What was (teacher's name) trying to do?" or "How did (teacher's name) get all of the apples to the students?"

Once children had recounted the relevant elements of the source story about the teacher, the experimenter told the child the target story about the teacher, which is a highly similar context. In the *wrap target story* phase, the experimenter placed the materials for the wrap game on the table (marbles, a towel, a small spoon, a blue block, a twistie, paper clips, a binder clip, and rubber bands) and explained to the child that she was going to tell another story about the time the teacher won a game. The teacher won a bunch of marbles and wanted to get them home without dropping any. Children were told that the teacher found all of the materials in front of them and were asked to come up with as many solutions as they could for ways the teacher could get the marbles home. If children did not spontaneously choose the analogical solution (wrapping the marbles in the towel), the experimenter asked, "Do you remember the story I told you? Does

anything from the story help?" The game ended when the child responded that he or she could not come up with another way to accomplish the goal.

To lessen the likelihood that children's performance on the first analogy problem would influence their performance on the second analogy problem, children were administered the PPVT after the first analogical problem. After completing the PPVT, children were told that the experimenter had another story to tell them. They were again asked to pay close attention, because they would be asked to tell the story back to the experimenter. Continuing with the current order example, following the teacher-wrap story a child would have been shown the picture of the characters from *Monsters, Inc.* and asked, "Who is this?" If children correctly named the characters, they were told the following fantasy-stack source story: "Let's imagine that one day Sulley and Mike were shopping for some fruit. Sulley wanted to give the apple to the monster up in the window. He realized he couldn't reach the window. He looked and looked for something to help him reach the monster in the window. Then he had a great idea. He decided to put the lunch boxes into a stack and stand on them. That way, he was the same height as the monster in the window and could give him the apple." Children were asked to repeat the story and given the same prompts as with the first story.

Following this story, children were told to imagine that there was a time when Sulley and Mike were building a tower (*stack target story)*. Children were told, "The other day Mike and Sulley were building a tower with some blocks. They wanted to make the top of this orange block the same height as the top of this blue one. They looked and looked for something to help them with the blocks. These were the things that they found. Can you think of a way that Mike and Sulley found to make the blocks the same height?"

The experimenter then placed a blue block, an orange block (in descending height, respectively), two dominos, a spool of string, rubber bands, a binder clip and paper clips on the table. Children were again encouraged to come up with as many solutions as possible and prompted to think about the story if they did not perform the analogical solution (stacking the dominoes under the orange block) spontaneously.

Results

Scoring. Children's responses to the analogical problems were coded on a 3-point scale. Children received a score of 0 if they did not produce the analogical solution, a score of 1 if they produced the analogical solution after the prompt to think about the source story, and a score of 2 if they produced the analogical solution spontaneously.

Analyses. Wilcoxon Signed-Ranks analyses, a non-parametric test for ordinal data, were conducted comparing the likelihood of producing the analogical solution for the two solution types within the story contexts. There were no significant differences, thus the solution types were collapsed together for further analysis. To assess whether it was necessary to include children's language ability as a covariate in analyses, Univariate Analyses of Variance (ANOVAs) were conducted to see whether the PPVT scores varied by correct responses. Thus, separate Univariate ANOVAs were conducted on PPVT scores using children's total score, fantasy-context score, and real-context score as between-subjects variables. There were no main effects for the scores, thus the PPVT information was not used in further analysis.

The number of children in each age group receiving scores of 0, 1, and 2 in the fantasy and reality conditions are listed in Table 1. To test whether there was a significant difference in likelihood of receiving one of the scores, Chi-Square analyses were

conducted using a priori expected values. Thus, the expected values for the frequency of receiving a 0, 1, or 2 for the real story were set to be the frequency of receiving those scores for the fantasy stories. The expected values were then compared to the actual observed values of the categories for the real stories. There was a significantly different pattern of responding by story type overall (χ^2 [2, N = 64] = 30.47, $p < .001$), as well as for the older children (χ^2 [2, N = 32] = 16.07, $p < .001$) and younger children separately (χ^2 [2, N = 32] = 16.34, $p < .001$). As is shown in the table, this indicates that children were more likely to receive a score of 1 or 2 for the fantasy stories than for the real stories.

An important question is whether receiving a score of 1 or 2 actually indicates that children were transferring the solution from the source context. Looking at the number of tries children attempted before producing the analogical solution indicates that of the 43 children who received a score of 2 in the fantasy context, 32 children (74%) chose the analogical solution on the first try. Similarly, 30 of the 37 children (81%) who received a score of 2 in the real context chose the analogical solution on the first try. Of the 14 children who chose the analogical solution after the hint, receiving a score of 1, 12 (86%) did so on the first try.

			Real Story Type			
			0	1	2	Total
Fantasy Story Type	0	3-year-olds	4	1	3	8
		4-year-olds	1	0	1	2
	1	3-year-olds	1	0	3	4
		4-year-olds	0	2	5	7
	2	3-year-olds	12	0	8	20
		4-year-olds	6	0	17	23
	Total	3-year-olds	17	1	14	32
		4-year-olds	7	2	23	32

Table 1. *Number of children from Experiment 1 who received a score of 0, 1, or 2 for the fantasy or real story types.*

To further probe the differences in responding, Wilcoxon Signed Ranks Tests for ordinal data were conducted to compare responses in the fantasy and real story conditions. The percentage of children in each age group receiving scores of 0, 1, or 2 is shown in Figures 1 and 2. This analysis revealed significant differences overall between the fantasy and real conditions ($Z = 2.51$, $p = .01$). In other words, collapsing across ages, more children chose the analogous response in the fantasy condition. When the children were separated into age groups, the difference was also significant for the younger age group ($Z = 2.13$, $p < .05$), but not for the older group. Thus, the 3-year-old children were more likely to choose the analogous response, receiving a score of 1 or 2, in the fantasy condition than in the real condition, but the 4-year-old children were equally likely to choose the analogous response in both conditions.

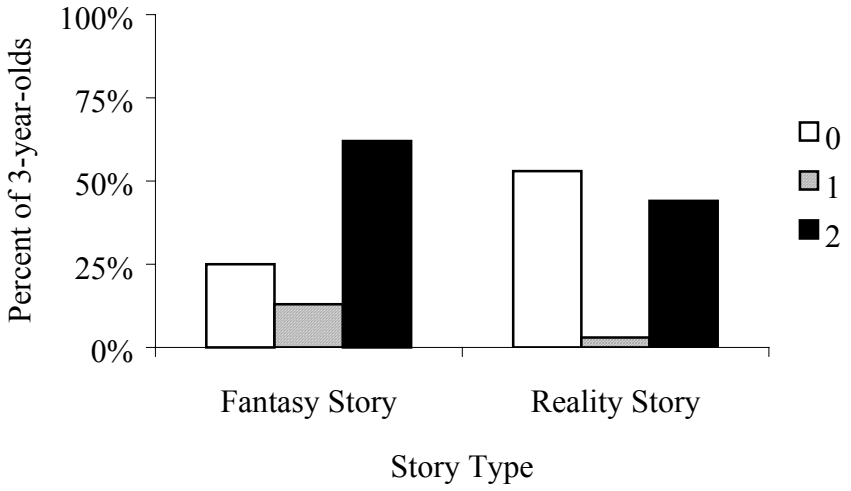

Figure 1. Percentage of 3-year-olds in Experiment 1 who received a score of 0, 1, or 2 for the fantasy and reality stories.

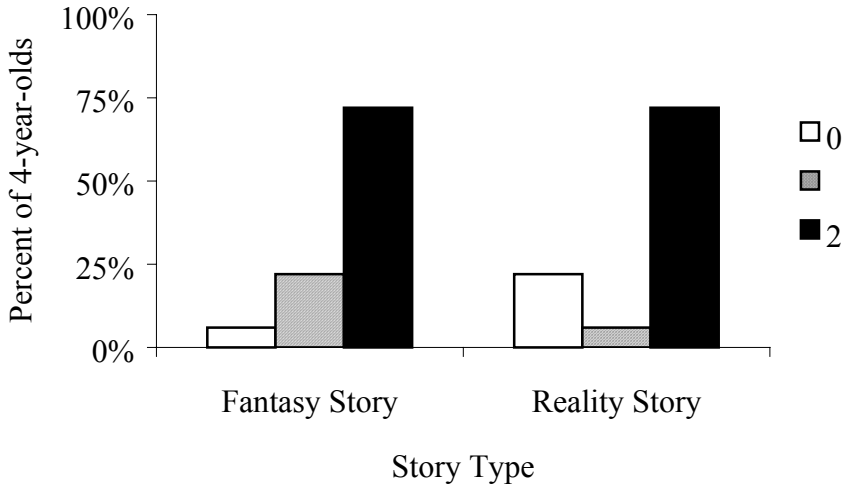

Figure 2. Percentage of 4-year-olds in Experiment 1 who received a score of 0, 1, or 2 for the fantasy and reality stories.

Mann-Whitney *U* tests, another non-parametric test for independent samples of ordinal data, were conducted comparing responses for older and younger children. Collapsing across conditions, the older group of children was more likely than the younger group to choose the analogous response ($U = 312.00$, $p < .01$). This difference was also significant in the real condition, with a higher percentage of the older children than the younger children choosing the analogous response ($U = 354.50$, $p < .05$). The differences in the percentage of younger and older children choosing the analogous response were not significant in the fantasy condition, however. This makes sense, given that the younger children performed significantly better in the fantasy condition than in the real condition.

Discussion

Experiment 1 examined whether framing an analogical problem in a fantasy context would facilitate children's performance beyond the help of other known facilitative features (e.g., familiarity with the characters and similarity between the source and target contexts). Prior studies have demonstrated that children are more likely to transfer an analogical solution when they are familiar with the characters in the source stories (Holyoak, et al, 1984), when there is a high degree of similarity between the source and target stories (Holyoak & Thagard, 1995), and when they understand the features of the source story most relevant to producing the analogical solution (Brown, et al., 1986). Thus, children were presented with analogical problems in two different contexts. They were either told source and target stories about fantasy characters or about their teacher. The other facilitative features of analogical problem solving were

maintained in the problems: familiarity was maintained by using characters that children already knew, namely their teacher and the characters from *Monsters, Inc.*, similarity was maintained by giving children the source and target stories in the same context, and children were asked control questions following the source story to ensure that they knew the relevant parts of the story necessary to make the analogical transfer.

Despite all of the facilitative features embedded in both types of analogical problems, children demonstrated higher likelihood of transferring the solution when the analogical problems were framed in a fantasy context as opposed to a real context. This suggests that the fantasy context may have had a boosting effect on children's analogical problem solving ability, beyond the effect of the other facilitative features of the analogical problems. In addition, these results were stronger for younger children than for older children. This offers further support for the scaffolding hypothesis, which suggests that a fantasy context can boost children's performance to a higher level than they might normally perform at a given age. There is potentially a ceiling effect for the older children. Thus, the older children may be demonstrating the same higher level in both contexts, and therefore are not especially assisted by a fantasy context because of the other facilitative features. In contrast, the younger children were significantly assisted by the fantasy context, above and beyond the potential facilitative effects of familiarity and similarity.

Additionally, both younger and older children were more likely to produce the analogical solution following a hint to think about the previous story in the fantasy context than in the real context. This suggests that perhaps the hint helped the children to view the fantasy source story in a new way, and thus create a mapping of the source

solution onto the target problem. The children helped by the hint were likely on the verge of being able to produce the analogical solution on their own. Since the hints were not as helpful for the realistic stories, this again suggests that children were demonstrating slightly more advance analogical problem solving skills in the fantasy context.

In sum, the results of Experiment 1 suggest that the facilitative effects of familiarity and similarity on children's performance on an analogical reasoning tasks seen in prior studies were even more pronounced when the familiar characters were fantasy characters (e.g., Brown, et al., 1986; Holyoak, et al., 1984; Holyoak & Thagard, 1995). It is unclear, however, if this added facilitative effect is because the initial problem and solution were presented in a fantasy context, or because the target problem was presented in the fantasy context. In other words, is the scaffolding effect established when the source story is told or during the target phase of the analogical problem? Experiment 2 explores this question in more detail by testing whether removing one of the other facilitative effects, similarity between contexts, will disrupt the facilitative effect of fantasy.

Experiment 2

The purpose of Experiment 2 is to explore whether children can transfer a solution from a problem framed within a fantasy context to an analogical problem framed in a real context. In addition, this experiment tests whether framing the initial problem in a fantasy context has a facilitative effect over framing the initial problem in a real context. It is anticipated that the mismatch between the source and target stories will eliminate the ceiling effect for the older children and that children will demonstrate higher levels of performance transferring the solution from a fantasy story to a real story

than from a real story to a fantasy story. This outcome, children transferring more often when the source is framed in a fantasy context, would be predicted by theories that suggest that children view fantasy as a unique form of social discourse and thus pay more attention to the premises (e.g., Harris, 2000). In this case, children may more actively encode the relevant features of a fantasy source story than a story set in a real context, and therefore demonstrate a greater likelihood of transferring the solution to the target problem.

Three other response patterns are also possible. First, children may be more likely to transfer the solution from a real context to a fantasy context, rather than from the fantasy context to the real context. This may be the case, since children more often transfer from reality into fantasy than from fantasy into reality in early pretend play (Harris, 2000a). Second, children may transfer the analogical solution for all target stories. In other words, children may demonstrate the ability to transfer solutions from stories framed in both fantasy and real contexts equally well. This is possible given the facilitative features still embedded into the procedure. First, children will still be familiar with the characters in both stories (the teacher and Mike and Sulley from *Monsters, Inc.*). Previous research has suggested that children are able to perform better on analogical problems when they are familiar with the characters in the stories. Second, within each analogical problem given to children, at least one of the stories told to children will be a fantasy story. Since the hypothesis is that framing stories within a fantasy context boosts children's performance, the manipulation may work equally well if the target story is framed in a fantasy context, rather than the source story. The third possible pattern of results is that children may not be able to transfer the analogical solution at all. This

finding would suggest that the mismatch between the source and target contexts disrupts children's ability to provide the analogical solution, perhaps because the superficial similarity between the source and target contexts is disrupted. A likely interpretation of this finding would be that the boosting effect of a fantasy context is contingent upon other facilitative features (e.g., similarity between the source and target stories).

Method

Participants. Thirty-two children ages 3 to 5 (M = 4;2, range = 3;5 to 5;1) were recruited from preschools and day care centers in a small university town. There were 17 girls and 15 boys. Children were divided into two groups, a younger group (n = 16, M = 3;8, range = 3;5 to 3;11, 8 girls and 8 boys) and an older group (n = 16, M = 4;8, range = 4;3 to 5;1, 9 girls and 7 boys).

Materials. Materials for this study were the same materials used in Experiment 1.

Procedure. The procedure was similar to the procedure for Experiment 1. The same stories about the *Monsters Inc.* characters and the teachers developed for Experiment 1 were used for Experiment 2. Implementing a within-subjects design, children were given two analogical problems to solve, and in between the two problems children were administered the PPVT. Which story type and solution children were given first was systematically varied. Thus, whether children receive a fantasy or reality story first and a wrap or stack solution first was counterbalanced across and within participants. Since the focus of this experiment was to test children's ability to transfer solutions across contexts, the key manipulation for this experiment was the mismatch between the contexts of the source and target stories. If children received the fantasy story as the source story, the target story was framed in the real context (*reality-target* condition).

Conversely, if children were told the source story within a real context, the target story was framed in a fantasy context (*fantasy-target* condition).

Results

Scoring. Children's responses to the analogical problems were coded on the same 3-point scale used for Experiment 1. Children received a score of 0 if they did not produce the analogical solution, a score of 1 if they produced the analogical solution after the prompt to think about the source story, and a score of 2 if they produced the analogical solution spontaneously.

Analyses. Wilcoxon Signed-Ranks analyses comparing the likelihood of producing the analogical solution for the two solution types within the story contexts were again non-significant, so the solution types were collapsed together for analyses. There were no significant differences, thus the solution types were collapsed together for further analysis. Separate Univariate Analyses of Variance (ANOVAs) were conducted on PPVT scores using children's total score, fantasy-target score, and real-target score as between-subjects variables. As was the case in Experiment 1, there were no main effects for the scores, thus the PPVT information was not used in further analysis.

The number of children in each age group receiving scores of 0, 1, and 2 in the fantasy-target and reality-target conditions are listed in Table 2. The same Chi-Square format used for Experiment 1 was used to analyze possible significant differences in the likelihood of receiving one of the scores. This was again achieved by a priori declaring that the expected values for the frequency of receiving a 0, 1, or 2 for the *real-target* story were equal to the frequency of receiving those scores for the *fantasy-target* stories. The expected values were then compared to the actual observed values of the categories

for the *real-target* stories. Similar to the findings of Experiment 1, there was a significantly different pattern of responding by story type overall (χ^2 [2, N = 32] = 18.32, $p < .001$), as well as for the older children (χ^2 [2, N = 16] = 6.29, $p < .05$) and younger children separately (χ^2 [2, N = 16] = 9.63, $p < .01$). As can be seen in Table 2, children were more likely to receive a score of 2 for the *fantasy-target* stories than for the *real-target* stories.

			Real Target			
			0	1	2	Total
Fantasy Target	0	3-year-olds	2	1	0	3
		4-year-olds	0	1	1	2
	1	3-year-olds	0	0	0	0
		4-year-olds	0	0	1	1
	2	3-year-olds	6	1	6	13
		4-year-olds	6	1	6	13
	Total	3-year-olds	8	2	6	16
		4-year-olds	6	2	8	16

Table 2. *Number of children from Experiment 2 who received a score of 0, 1, or 2 for the fantasy-target or reality-target story types.*

As in Experiment 1, the results again suggest that when children respond correctly, in both the *fantasy-target* and the *reality-target* conditions, they are indeed transferring the solution from the source problem. In the *reality-target* problems, of the 14 children who produced the analogical solution on their own (receiving a score of 2), 13 (93%) did so on the first try. For the *fantasy-target* problems, of the 26 children who produced the analogical solution on their own, 19 (73%) did so on the first try. All of the five children who chose the analogical solution after the hint did so on the first try.

Wilcoxon Signed Ranks Tests were conducted comparing the responses in the *fantasy-target* and *reality-target* conditions (see Figures 3 and 4). There was a significant difference overall between responses in the *fantasy-target* and *reality-target* conditions ($Z = 2.95$, $p < .01$). In other words, collapsing across ages, the likelihood of choosing the analogous response in the *fantasy-target* condition was significantly greater than the likelihood of choosing the analogous response in the *reality-target* condition.

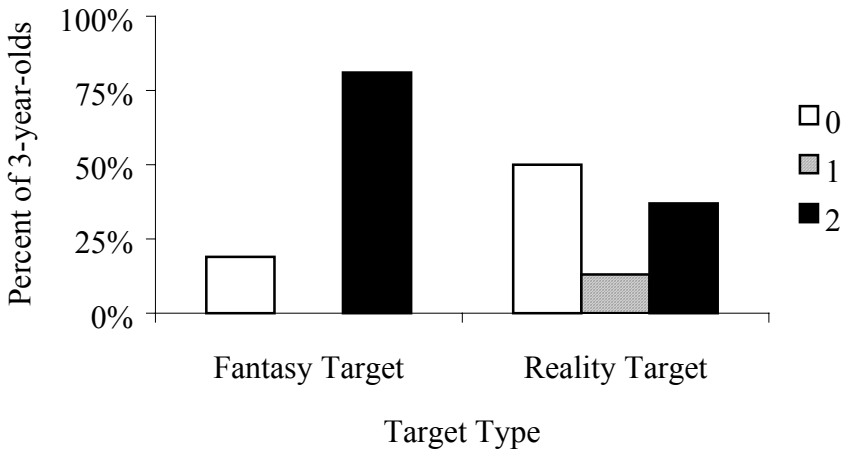

Figure 3. Percentage of 3-year-olds in Experiment 2 who received a score of 0, 1, or 2 for the fantasy and reality target stories.

As was true in Experiment 1, this difference was significant for the younger age group ($Z = 2.42$, $p < .05$), but not significant for the older group. There was a trend in the older group, however, with the likelihood of choosing the analogous response being greater in the *fantasy-target* condition than in the *reality-target* condition ($Z = 1.75$, $p = .08$). Thus, children were more likely to choose the analogous response, receiving a score of 1 or 2, in the *fantasy-target* condition than in the *reality-target* condition.

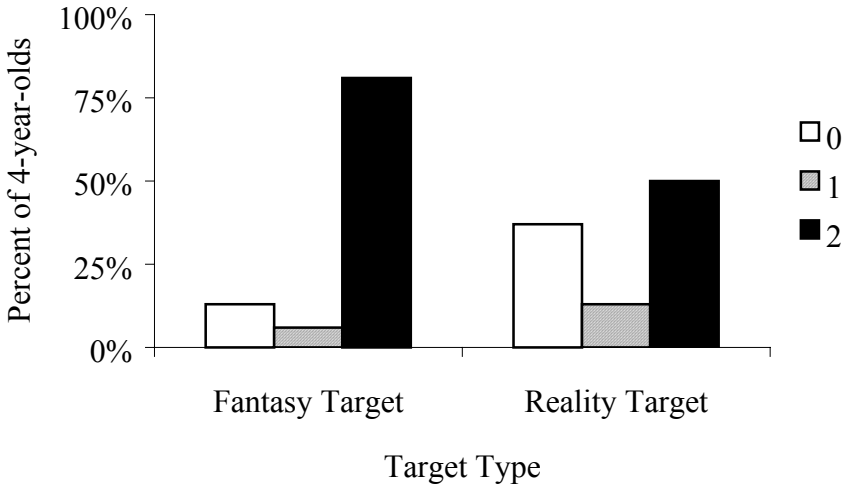

Figure 4. Percentage of 4-year-olds in Experiment 2 who received a score of 0, 1, or 2 for the fantasy and reality target stories.

Mann-Whitney *U* tests were conducted comparing responses for older and younger children. Collapsing across conditions, there was no significant difference in the likelihood of choosing the analogous response based on age group. There were also no significant age group differences when broken down by condition.

Discussion

In contrast to Experiment 1, which tested children's ability to solve analogical problems completely within fantasy or reality contexts, Experiment 2 tested children's ability to transfer a solution between contexts. Thus, if children were presented with the solution to a problem embedded in a fantasy story they were asked to transfer that solution in a story about their teacher. The initial hypothesis was that teaching the solution to children in the fantasy context would increase children's attention to the solution, thus increasing the likelihood that children would retrieve the solution in the

target phase. Contrary to the initial hypothesis, findings revealed that for both age groups of children, there was a greater likelihood of transferring the solution from the story about the teacher to the story about the fantasy characters than vice versa.

Explanations for the differences in likelihood of transfer from fantasy to reality and reality to fantasy could focus either on children's likelihood of looking for an analogical solution based on the target context or on their initial encoding of the solution based on the source context. In terms of the target context, it may be that children have an especially difficult time solving analogies for their teachers. Perhaps they view teachers as people who know everything and who would already know how to solve the problem. There are two pieces of evidence against this explanation. First, recall that the fantasy context was not as facilitative for the older children in Experiment 1 because they were able to transfer the solution in general, indicating that they were equally likely to transfer the solution for their teacher as for the fantasy characters. Second, even though children did not choose the analogical solution, they did suggest alternative solutions. Of the 18 children who received a score of 0 or 1 for the reality-target problems, indicating they did not transfer the solution at all or that they transferred the solution after a hint, 14 (78%) of the children offered alternative solutions, and only 4 (22%) children said they couldn't think of a solution.

Although the findings contradict the initial hypothesis that engaging children's imagination at the start would increase the likelihood of transfer, they do make sense in light of the fact that the imagination (especially in its early forms) often involves the mapping of the real world onto one's imaginings of it, and is therefore a form of analogical reasoning (e.g., *real mother: cooks:: imagined mother: cooks*). Thus,

children's early use of analogy within the imagination is most often in the direction of mapping the real world onto their imagination of it, rather than vice versa, so children should have practice with this form of analogical reasoning already. This suggests that in cases of cross-context mapping, children should perform better when solving the problem for the fantasy characters (*fantasy-target*) since they are more accustomed to that form of mapping, rather than from fantasy to real world (*real-target*).

Furthermore, children may not view fantasy as an appropriate source analog for a real world situation, possibly because of a difficulty in moving beyond the interestingness of the story similar to the dual representation problem (DeLoache, 1995). Thus, a related question is whether children view fantasy as an appropriate source analog for real world problems they face. Experiment 3 tests whether children are more likely to transfer a solution from a fantasy story or from a story about their teacher to game in which they must solve a problem, rather than to a story about fantasy characters or about their teacher.

Experiment 3

The purpose of Experiment 3 was to explore whether removing the fantasy and teacher contexts from the target games would affect the likelihood that children will transfer from source stories that are told in either a fantasy context or a reality context. This experiment tested children's level of performance in transferring from source stories either about the fantasy characters or their teacher to a game situation, to explore whether they differentiate between contexts as appropriate sources for problem solutions. Given that children in Experiment 2 were less likely to transfer if the source story was about the

fantasy characters, the hypothesis is that children will be more likely to transfer a solution to a novel problem if they are told the original solution in a story about their teacher.

As for Experiment 2, three other response patterns are possible. First, children may be more likely to transfer the solution if the source problem is framed in a fantasy context. This may suggest that perhaps the unique social discourse of make-believe does increase children's attention to the solutions, but having the target stories be about the teachers inhibited children's ability to transfer the solutions in Experiment 2 because teachers are people who know everything and do not normally need problems solved for them. Second, children may be unlikely to transfer the solution at all, given the removal of any sort of familiarity in the target contexts and the further reduction in similarity between the source and target stories. This would indicate that the extent of reducing the similarity between source and target removed any beneficial effects that a fantasy context may have. Third, children may be very likely to transfer the solution both from stories about their teachers and stories about fantasy characters to the analogical games. This response pattern would be surprising because, as was reviewed above, 3- to 5-year-old children generally demonstrate a fragile ability to solve analogical problems of this type (e.g., Brown, et al., 1986). This finding, however, would support the Holyoak, et al. (1984) suggestion that familiarity in general with the characters in the source stories facilitates children's ability to solve analogical problems.

As was reviewed above, the key transition age for solving analogies of this type appears to be from 4 to 6 (e.g., Holyoak, et al., 1984). Because pilot testing revealed that 3-year-old children did not transfer the solution at all, only 4- to 6-year-old children were recruited for this study.

Method

Participants. Thirty-two children ages 4 to 6 (*M* = 4;11, range = 4;1 to 5;7) were recruited from preschools and day care centers in a small university town. There were 14 girls and 18 boys. Again, permission letters were sent home with parents, and those children whose parents signed the permission letter were asked if they wanted to participate. Children were divided into two groups, a younger group (*n* = 16, *M* = 4;6, range = 4;1 to 4;11, 7 girls and 9 boys) and an older group (*n* = 16, *M* = 5;3, range = 5;0 to 5;7, 7 girls and 9 boys).

Materials. Materials for this study were the same as those used in Experiments 1 and 2.

Procedure. The procedure was similar to the procedures for Experiments 1 and 2 and used the same stories about the *Monsters Inc.* characters and the teachers developed for Experiment 1. Children were given two analogical problems to solve, and in between the two problems children were administered the PPVT, again using a within-subjects design. Whether children receive a fantasy or reality story first and a wrap or stack solution first was counterbalanced across and within participants. As in Experiment 2, the contexts of the source and target stories were mismatched. In this experiment, however, key variation was that the contexts of the source stories were either fantasy or real and the transfer problem was always introduced as a game for the children to play, rather than a story in which they have to come up with solutions for another person's problem.

After being told either of the source stories with the wrap solution, children were introduced in the following way to the *wrap game*: "Now I have a game for us to play. For this game we use all of these pretty marbles." The experimenter dumped the marbles

onto a pile on the table and then said, "What we do in this game is find a way to carry all of these marbles without dropping any of them. You can use anything here that you want to." The experimenter then placed the following items on the table in front of the child: a towel (analogical solution: wrapping), a small spoon, a blue block, a twistie, paper clips, a binder clip, and rubber bands.

If children were told a source story with a stacking solution, they were introduced to the following *stack game*: "Now I have a game for us to play. For this game we use these two blocks." The experimenter placed two blocks of differing heights side by side on the table and then said, "What we do in this game is find a way to make the top of this orange block be the same height as the top of this blue one. You can use anything here that you want to." The experimenter then placed the following items on the table in front of the child: two dominoes (analogical solution: stacking), a spool of string, a piece of paper, paper clips, a binder clip and rubber bands.

As in Experiments 1 and 2, if children did not spontaneously choose the analogical solution (wrapping the marbles in the towel or stacking with the dominoes), the experimenter asked, "Do you remember the story I told you? Does anything from the story help?" The game ended when the child responded that he or she could not come up with another way to accomplish the goal.

Results

The same coding scheme from the previous experiments was used to code children's transfer of the solution to the target game. As in Experiments 1 and 2, Wilcoxon Signed-Ranks analyses revealed no significant differences in the likelihood of producing the analogical solution for the two solution types within the story contexts, so

solution types were again collapsed. The number of children in each age group receiving scores of 0, 1, and 2 in the *fantasy-source* and *real-source* conditions are listed in Table 3.

			Real Story Type			
			0	1	2	Total
Fantasy Story Type	0	4-year-olds	6	1	0	7
		5-year-olds	2	1	3	6
	1	4-year-olds	0	1	1	2
		5-year-olds	0	0	2	2
	2	4-year-olds	2	1	4	7
		5-year-olds	0	3	5	8
	Total	4-year-olds	8	3	5	16
		5-year-olds	2	4	10	16

Table 3. *Number of children from Experiment 3 who received a score of 0, 1, or 2 for the fantasy or real source story types.*

The same Chi-Square procedure used for Experiments 1 and 2 was used to analyze possible significant differences in the likelihood of receiving one of the scores. By fitting a model that set the expected frequency of receiving a 0, 1, or 2 for the *real-source* stories to the frequency of receiving those scores for the *fantasy-source* stories, the expected frequencies were compared to the actual observed frequencies of the categories for the *real-source* stories. The pattern of responding was significantly different for the older children (χ^2 [2, N = 16] = 9.40, $p < .01$), but not for the younger children and not when collapsing ages. The older children were more likely to receive a score of 1 or 2 for the *reality-source* stories than for the *fantasy-source* stories.

Results again suggest that when children responded correctly, in both the *fantasy-source* and the *reality-source* conditions, they were indeed transferring the solution from

the source problem. In the *reality-source* problems, of the 15 children who produced the analogical solution on their own (receiving a score of 2), 10 (67%) did so on the first try. For the *fantasy-source* problems, of the 15 children who produced the analogical solution on their own, 13 (87%) did so on the first try. All of the eleven children who chose the analogical solution after the hint did so on the first try.

The percentage of children in each age group receiving scores of 0, 1, or 2 for the *fantasy-source* and *reality-source* conditions are shown in Figures 5 and 6. As in the analysis for the previous experiments, Wilcoxon Signed Ranks Tests were conducted comparing the responses in the *fantasy-source* and *reality-source* conditions. There were no significant differences in the likelihood of choosing the analogous response for the *fantasy-source* and *reality-source* conditions, either overall or when broken into age groups. Thus, children were no more likely to choose the analogous response, receiving a score of 1 or 2, in the *fantasy-source* condition than in the *reality-source* condition.

Mann-Whitney *U* tests were conducted comparing responses for older and younger children. Collapsing across conditions, the mean number of correct responses for the older group ($M = 2.63$, $SD = 1.36$) was not significantly greater than for the younger group ($M = 1.81$, $SD = 1.68$). There was a significant age group difference, however, in the *reality-source* condition ($U = 75.00$, $p = .05$), with the mean number of correct responses for the older group ($M = 1.50$, $SD = .73$) being significantly greater than for the younger group ($M = .81$, $SD = .91$). This difference was not significant for responses in the *fantasy-source* condition.

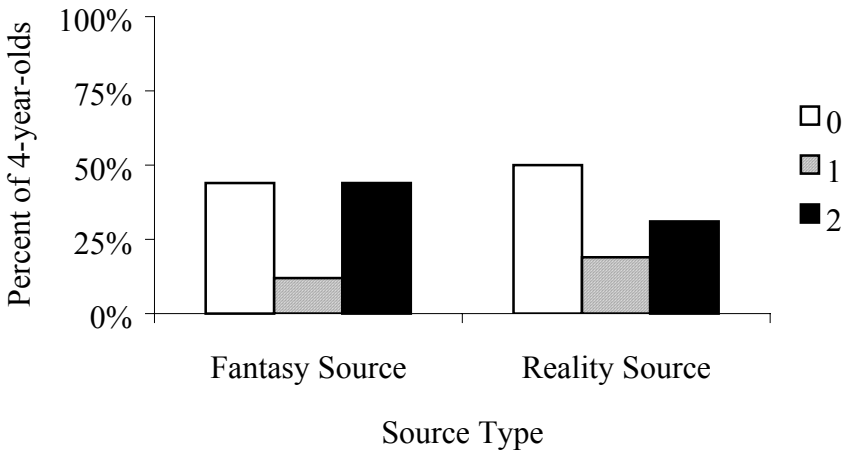

Figure 5. Percentage of 4-year-olds in Experiment 3 who received a score of 0, 1, or 2 for the fantasy and reality source stories.

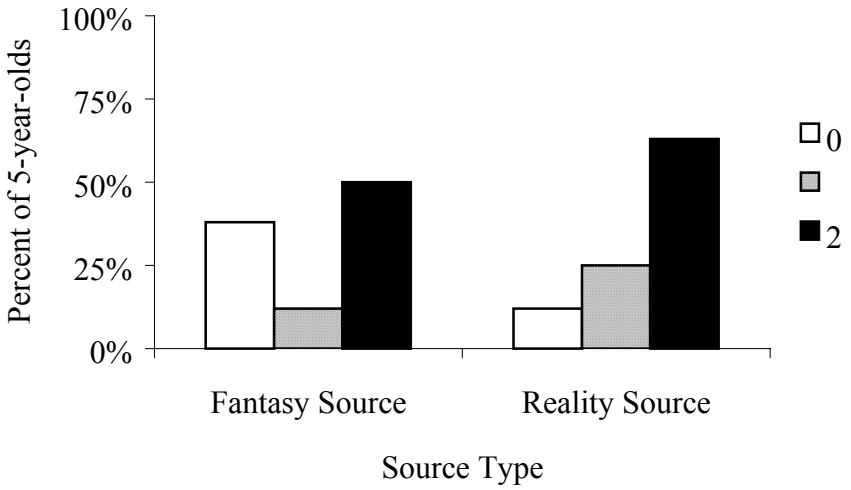

Figure 6. Percentage of 5-year-olds in Experiment 3 who received a score of 0, 1, or 2 for the fantasy and reality source stories.

Discussion

The purpose of Experiment 3 was to test whether children differentially used solutions from source analogs presented in stories about fantasy characters and about

their teachers in trying to solve a novel problem. To this end, 4- and 5-year-old children were told a story in which either their teacher or Mike and Sulley from *Monsters, Inc.* solved a problem. The children were then presented with an analogous problem framed as a game with a particular goal. Results revealed that the 5-year-old children were more likely to transfer the solution than the 4-year-old children when the source story was about the teacher. This developmental pattern is similar to that in other research on children's analogical problem solving (e.g., Holyoak, et al., 1984). Furthermore, even though there were no differences overall in mean number of correct responses for transferring the solution from the stories about the fantasy characters or about the teachers, the Chi-square analysis for the older children suggests that older children were more likely to transfer the solution if the source story was about their teacher rather than about the fantasy characters.

For many of the children, the ability to use analogical sources to solve problems was not context specific. As is demonstrated in Table 3, 18 out of the 32 children (56%) responded consistently for both the *reality-source* and *fantasy-source* problems. The percentage of children producing the analogical solution is similar to that of the Holyoak, et al. (1984) study, in which performance improved to approximately 50% of 4- to 5-year-old children producing the analogical solution when the source context was one of familiar fantasy character. Thus, these findings provide support for the suggestion that familiarity with the characters in the stories, whether fantastical or real, does facilitate children's ability to solve analogical problems.

Of those children who were inconsistent in their transfer of the solution, eight (25%) performed better if the source story was about the teacher, and six of the children

(19%) performed better if the source story was about the fantasy characters. This may reflect individual differences in how children view the appropriateness of various characters (teachers vs. fantasy characters) as sources for problem solutions. Even though there was no overall effect of order of stories, however, of these 14 children, nine (64%) performed better on the second analogical problem than on the first, again suggesting that for this particular type of analogical problem, the source context does not matter, but prior experience with analogical problems does (Brown & Kane, 1988).

This suggests that framing the solution initially in a fantasy context did not facilitate children's performance in transferring that solution, beyond the other facilitative features of the analogical problems. Recall that one of the theories on why children perform better on cognitive tasks framed on a fantasy context is that setting up a make-believe scenario is a unique form of social discourse to which children pay close attention (Harris, 2000a). If this was the case, children should have performed better on the analogical problems when the solution was presented in a fantastical source story, since they would have been paying more attention to the elements of the story. Thus, the theory that fantasy boosts performance because it is a unique form of social discourse does not seem to account for the findings in this experiment.

There wan an age difference, however, in children's use of their teacher as a source. This may reflect the fact that in school, children are likely increasingly exposed to novel situations in which they can draw from prior observations of way the teacher has solved similar problems. As in the results for Experiment 2, this suggests that children differentiate between the types of situations they consider as appropriate sources for solutions to novel problems.

General Discussion

Given the prevalence of imaginative thought in early childhood, it is often hypothesized that the developing ability to imagine plays an important role in cognitive development in general (e.g., Harris, 2000a; Lillard, 2001). Two keys issues regarding the role that imagination plays in cognitive development were explored in these experiments. First was the issue of how reasoning in a fantastical context compares to reasoning in more realistic situations. The second issue was how easily children transfer from fantasy to realistic situations.

In terms of this second issue, acquiring the ability to transfer knowledge, whether gained through experience or instruction, to new situations is an important developmental task. Without this ability, each time children were faced with new obstacles to overcome, they would have to derive new solutions, likely through trial and error. This would be a very inefficient method of solving problems. A more efficient approach for children is to learn to recognize the similarities between the new problem and a problem they have previously encountered, and to transfer the successful solution of that problem to the new situation.

As reviewed in the introduction, past research on the development of analogical problem solving suggests that certain task conditions facilitate children's ability to transfer solutions from one situation to another. The first facilitative condition in which children are more likely to transfer a solution from one story to another is if they have had past experience with other analogical problems (Brown & Kane, 1988). A second facilitative condition is that of recognizing the relevant features of the source and target analogs (Brown, et al., 1986). A third facilitative condition to analogical problem solving

is familiarity with the characters in the stories (Holyoak, et al., 1984). Interestingly, in the Holyoak, et al. (1984) experiment, the familiar characters in the stories were also fantasy characters, leaving open the question of whether the facilitative effect was from the familiarity of the characters or their fantastical nature.

Relatedly, research in education suggests that another possible facilitative condition for children's ability to transfer learning from one context to another is to teach the material in a fantasy context (Cordova & Lepper, 1996; Parker & Lepper, 1992). Children in these studies were more likely to generalize their learning of abstract mathematical concepts and computer programming if they were taught these skill through computer programs that were set up as fantasy games. Interestingly, research has found that children perform better on a variety of other cognitive tasks, like the ability to solve logical syllogisms (e.g., Dias & Harris, 1988, 1990) and to understand the mental states involved in pretending (e.g., Sobel & Lillard, 2001) if those tasks are framed within a fantasy context.

Despite the apparent benefits of framing cognitive tasks in a fantasy context, as of yet there are no strict comparisons of the influence of a fantastical context on children's ability to solve analogical problems. Studying the influence of a fantasy context on analogical problem solving is addresses two key issues. First, children have demonstrated an increased likelihood of solving other types of problems when those problems are framed in a fantasy context. Comparing children's analogical problem solving abilities in real and fantasy contexts provides a measure of how children's use of analogical reasoning within imagination compares to their use of analogical reasoning in more realistic settings.

Second, children often transfer knowledge from the real world into the world of their imagination, and many teachers are encouraged to embed instructional materials in a fantasy context to assist in increasing children's attention and motivation, with the assumption that children will then transfer that learning into the necessary classroom or real world setting (Allender, 1991). Thus, analogy is a key component of children's negotiation between the real world and their imaginary one, and the study of children's analogical problem solving informs our understanding of how easily children transfer from fantasy to reality. The goal of these experiments was to systematically explore the influence of fantastical thinking on children's analogical problem solving abilities, both in terms of their ability to solve analogical problems within a fantasy context and to transfer from fantasy to reality.

Experiment 1 tested whether 3- to 5-year-old children would be more likely to transfer a solution from one story to another if the stories were framed in the context of familiar fantasy characters rather than framed in the context of stories about a familiar real person, their teacher. Other than familiarity with the characters, which has been suggested to be a facilitative factor in children's ability to solve analogical problems (Holyoak, et al., 1984), the source and target contexts were also highly similar, which is another factor that increases the of transferring a solution (Holyoak & Thagard, 1995). The findings revealed that children were more likely to transfer the solution in the analogies framed in the fantasy context than in the analogies framed in the real context. This was especially true for the 3-year-old children. These results suggest that using the fantasy characters as protagonists in the analogical problems was indeed facilitative to

children's ability to solve analogical problems, over and above other facilitative features embedded in the procedure.

The increased likelihood of the 3-year-old children to use the analogical solution in stories about the fantasy characters may have occurred for three possible (not necessarily mutually exclusive) reasons. First, the facilitative effects of the fantasy context may have occurred through a scaffolding effect of framing both the source and target analogs in fantasy contexts. As was suggested in the introduction, a scaffolding effect in which an ability appears to be context specific might occur through increased practice of that ability, in this case within imaginative thinking. On the other hand, the facilitative effects may have been analog specific. In other words, perhaps framing the initial solution in the fantasy context was the key facilitative feature, possibly by increasing children's attention to the story (Harris, 2000a). Thirdly, perhaps having children solve the problem for fantasy characters in the target analog was the reason for the facilitative effects. Children may be better at solving problems in general within a fantasy context. Indeed, research on the encoding and retrieval of memories has suggested the importance of considering both the context in which a memory was originally encoded as well as the context in which the memory was retrieved (e.g., Baddeley, 1983). Similarly, the likelihood of transferring solutions in analogical problems can be explored by separating the contexts in which children encode or retrieve the solutions.

To clarify whether the findings of Experiment 1 were due to the source or target context, in Experiment 2 children were tested on their ability to solve the analogical problem in a different context than the one in which they originally heard the solution.

More specifically, 3- to 5-year-old children were tested on their ability to transfer a solution from a fantasy story context a real story context, or from a real story context to a fantasy story context. In this case, the source and target stories were no longer as superficially similar, but the characters in the source and target stories were still all familiar. Results revealed that children were more likely to transfer the solution from the real story context to the fantasy story context, than vice versa. This was again especially true for the 3-year-old children.

These results suggest that the facilitative effect of the fantasy context in Experiment 1 was not solely due to framing the original solution in a fantasy context. In fact, in Experiment 2 children were more likely to transfer solutions from stories framed in the real context than stories framed in the fantasy context. Similar to Experiment 1, children were more likely to use the analogical solution in target stories about fantasy characters than in target stories about a real person. Thus, children's increased likelihood of transferring the solution could either be from a facilitative effect of transferring *from* source stories about real people or from a facilitative effect of transferring *to* target stories about fantasy characters.

To further clarify the question of whether the context for the source story is having the facilitative effect, in Experiment 3 the target context was held constant by introducing children to a game in which they have to solve a problem. This manipulation removed the character context from the target analogs, so 4- to 6-year-old children were told the solution to a problem either in a story about a real person or about fantasy characters and then given a real world problem, framed as a game, to solve. Findings

revealed that the older children were slightly more likely to transfer from source stories about a real person than source stories about the fantasy characters.

In summary, the findings from these three experiments revealed that children were more likely to transfer a solution to an analogical problem if both the source and target were framed in a fantasy context than if they were framed in a real context. If the source and target contexts were not the same, children were more likely to transfer from a story about a real person to a story about fantasy characters than vice versa, as well as from a story about a real person to a novel problem that they must solve.

The findings from Experiments 2 and 3 may at first appear contrary to the findings in studies on the use of fantasy contexts in education, where children were more likely to transfer learning of abstract concepts if the instructional material was embedded in a fantasy context (Cordova & Lepper, 1996; Parker & Lepper, 1992). There are a few key differences between these studies and the experiments presented here, however. One key difference between the education studies and Experiments 2 and 3 is that the children in the education studies were aware that they should be learning something. Perhaps if we had made children aware that they would be learning something to use later, fantasy would have influenced performance by increasing attention. Another difference is that the children in the education studies ranged in age from 8 to 12 years, which is quite a bit older than the children in these studies. It may be that using a fantasy context has different effects on children's ability to transfer at different ages. Additionally, since the comparison conditions to which performance in the fantasy conditions were compared were very generic and mundane, they cannot be considered comparably interesting. Thus,

Experiments 2 and 3 present a more strictly controlled test of the influence of a fantasy context on children's analogical problem solving ability.

The findings from Experiments 2 and 3 were also contrary to the original hypothesis that children would be more likely to transfer from fantasy stories, perhaps because children pay more attention to the details of fantasy stories because it is an interesting context (Harris, 2000a). Because analogy involves the successful mapping of the relevant features of two analogs, paying more attention to the details of a story would facilitate the successful mapping of that story onto a related story. If fantasy does indeed facilitate performance through increased attention, the children in Experiments 2 and 3 should have been more likely to transfer from stories about fantasy characters. In actuality, children were more likely to transfer from stories about a real person, both to fantasy stories and to real world problems that they faced. Thus, whether or not children were paying more attention to the fantasy stories, they were unlikely to use the information from the fantasy stories in deriving a solution for the target stories and games, suggesting that something beyond level of attention was influencing the likelihood of transfer.

An interesting possibility is that children's decreased likelihood of transferring from fantasy stories may reflect that children do not view fantasy as an appropriate analog for real world situations. Other research has indicated children's inability to recognize that something that is very interesting in and of itself can be a source of information for where a toy is hidden (e.g., DeLoache, 1995). In the case of Experiments 2 and 3, children were more likely to transfer solutions from stories about real people than from stories about fantasy characters, suggesting that children may not view fantasy

as an appropriate source analog for information on solving real world problems. Similar to children's dual representation problem in the development of symbolic understanding, children may initially view fantasy as an inappropriate source of information about the real world.

These findings also have implications, then, for when children distinguish between fantasy and reality. There is an interesting debate in the developmental literature about when and how children differentiate between fantasy and reality (see reviews in Bourchier, & Davis, 2002; Woolley, 1997). Methods for testing children's ability to distinguish between fantasy and reality vary from interviewing children on their belief in fantasy figures like Santa Claus (e.g., Clark, 1995), the prevalence of imaginary companions (e.g., Taylor, 1999), and belief in the plausibility of magical events (e.g., Rosengren, Kalish, Hickling, & Gelman, 1994). Combined, these methods of studying children's distinction between fantasy and reality suggest that sometime between the ages of 3 and 8 children consistently distinguish between fantasy and reality. Woolley (1997) has suggested that the reason for the large age span is that different tests of children's ability to make this distinction involve differing task demands as well.

The results from the experiments on the effect of fantasy on children's analogical problem-solving are suggestive of a potentially less demanding test of children's distinction between fantasy and reality. While further experiments should be conducted to pinpoint more specific reasons for children's decreased likelihood to transfer from the fantasy stories, the fact that 3- and 4-year-olds were less likely to use the fantasy story as a source analog suggests they may have be differentiating at some level between the appropriateness of the fantasy stories and the real stories. In fact, recent research on what

sorts of information children take from books suggests children do differentiate among the contexts in which they encounter information (Woolley, 2001; Woolley & Park, 2003). For example, if children learned about a novel entity from a fantastical looking book, they were likely to claim the entity was not real. In contrast, if they learned about the novel entity in a scientific looking book, they were more likely to claim the entity was real (Woolley, 2001; Woolley & Park, 2003).

The suggestion that children may not transfer as easily from fantasy to reality may at first appear to contradict theories on the early function of pretend play. Recall that Nichols and Stitch (2000) characterize pretense as a "Possible World Box" in which children enact real desires they have about the world. Similarly, Lillard (2001) suggests that pretending is like the philosopher's Twin Earth, in which children manipulate one or two aspects of reality and imagine the ramifications. Both of these theories suggest that children transfer what they learn from pretend to reality and that pretense is in essence a mental practice space for dealing with situations. The ultimate goal of this mental practicing is to transfer the solutions into the real world.

The findings from these experiments do not necessarily contradict these theories. If the imagination and pretending really do operate as a "separate mental space" for children (e.g., Lillard, 2001; Nichols & Stitch, 2000) of which the content is explicitly pretend and not real (Harris, 2000a), then we might expect that the ability to transfer from pretending into reality is itself something that must develop along with the development of analogical reasoning. It may be that children are unable to successfully transfer that which they learn or figure out in their imaginations to the real world until they have a more stable mastery of analogical reasoning in general. Literature on analogical

reasoning suggests that this ability continues to develop from ages 6 to 11 years (e.g., Chen, 1999; Holyoak & Thagard, 1995), so research with children in this age range would clarify when children consistently use fantasy stories as analogs for real world problems.

One possible way to study this question is to provide children with analogical problems that have two possible solutions. Children could be introduced to the two solutions through two source stories in different contexts, for example one about a fantasy character and one about a real person. If it is the case that younger children do not initially view fantasy stories as an appropriate source analog, the younger children would privilege the solution from the story about the real person, but older children would be equally likely to choose either one of, or both of, the solutions.

A number of other questions remain in these findings as avenues for future research. First, in Experiments 1 and 2, children were more likely to produce the analogical solution when the target stories were about the fantasy characters than when they were about the real characters, and the children in Experiment 3 were comparatively less likely to produce the analogical solution when the character contexts were removed from the target stories. This pattern might suggest that it was the framing of the target stories in a fantasy context that was most facilitative to children's performance, and might be predicted by theories explaining fantasy as a cognitive environment in which children are freed from real world constraints and can consider many possible alternatives (e.g., Dias & Harris, 1988). Future research should explore this issue by having children simply solve the target problems in fantasy or realistic story contexts in the absence of presenting the solution in a source story.

One might predict that children would be equally likely to solve the target problems in the real and fantasy contexts, since the characterization of the imagination as having unlimited possibility is not as relevant to analogical problem solving. Recall the important feature in solving analogies is not in having an unlimited number of options, but in recognizing that one's options can be narrowed by looking to another source for the solution. Perhaps fantasy then is not the freeing of all constraints, but the resetting of certain constraints. On the other hand, children's differential performance on problems framed in fantasy or real contexts would address more specifically the issue of how children's problem solving abilities within an imaginative context compare to those abilities in a realistic context. If children perform better in the fantasy context, this may offer more support to the characterization of imagination as a general scaffold to cognition.

Second, since the characters in the stories were always Mike and Sulley from *Monsters, Inc.* or the child's teacher, future studies should examine whether these findings would generalize to other fantasy or real contexts. Children may be expected to treat solutions learned in stories about the teacher differently than solutions learned in stories about other unfamiliar real people, since the teacher is a person that children often go to for help and who instructs them on a daily basis. If it is the case that children differentiate between the appropriateness of solutions learned from stories about fantasy characters and stories about real characters, they may also be expected to differentiate between different types of real characters as well (for example, their teacher and a baby). This is also true for the fantasy stories. If children differentiate between source contexts

as relevant sources of information, they may be more likely to transfer a solution from a more knowledgeable fantasy character.

Reltatedly, a third issue is children's level of attention to the different stories. One possibility is that children were paying more attention to stories about their teachers than stories about the fantasy characters. In this case, children would have been more likely to hear and encode the solutions told to them in the teacher stories than in the fantasy stories. This is unlikely, given the research suggesting that fantasy contexts are more interesting for children than realistic contexts (e.g., Cordova & Lepper, 1996), however future research should test whether children's level attention is the same for source stories framed in real or fantasy contexts, perhaps by including some sort of distracting features into the procedure.

A fourth issue is that of possible intervening factors to children's performance. Findings revealed that there were no differences based on PPVT scores, suggesting that children's language ability did not interact with their ability to solve the analogical problems. There may be other possible covariates, however. One possibility is that children who are more prone to pretending and fantastical thought would perform better. Some research has suggested possible measures of fantasy orientation that include measures of children's predisposition toward fantastical thinking, for example, whether children have imaginary companions and whether they use objects symbolically in pretending (e.g., Woolley, Boerger, & Markman, 2002). It may be that children who are more oriented toward fantasy would demonstrate a stronger scaffolding effect of a fantasy context, since they likely practice these cognitive tasks more in their imagination than children less prone to fantastical thinking.

Lastly, these findings have implications for education. If it is the case that children, at least at early ages, do not transfer that easily from fantasy into reality, teachers may need to be careful in their use of fantasy as a teaching context. It may be that the fantasy context increases children's attention, but other factors may be necessary to help facilitate children's transfer. This is not simply a problem for formal education, either. We often assume that children learn moral lessons from fantasy storybooks and religious parables. Future research should explore whether children have unique difficulties transferring from these contexts. It may be that better hints would assist children's transfer of learning from these contexts into their real lives. The findings from the experiments presented here suggest that hints to think about the previous story were helpful when transferring from fantasy context to fantasy context, but less helpful in other situations. Future research should examine the effects of providing children with different types of hints to determine what is most effective in assisting children's transfer. Another possible method for researching this issue is to explicitly interview children on why they choose different solutions. One possible method for interviewing children of this age on justifications for different responses is to have them explain why another child might have chosen that response (Siegler, 1996). Children's responses may indicate whether or not they used, or knew they were using, the source story.

In conclusion, the findings from these experiments only offer tentative support for Vygotsky's (1978) characterization of the imagination as a scaffold to cognition, specifically for analogical reasoning. Children did perform better on analogical problems when solving for problems framed in a fantasy context. Framing solutions in a fantasy context, however, did not increase the likelihood that children would use those solutions

to solve novel problems not framed in a fantasy context. In fact, children were slightly more likely to transfer solutions from stories about their teachers, not stories about fantasy characters, to novel problems. These findings suggest that although children may demonstrate precocious cognitive abilities in their imaginative thought, and that in some situations they may, perhaps unconsciously, differentiate between fantastical and realistic scenarios at quite young ages, these abilities may not easily transfer to novel problems. Thus, further research into children's transfer from the imagination will illuminate how children negotiate the world into which they are born with the worlds that they create.

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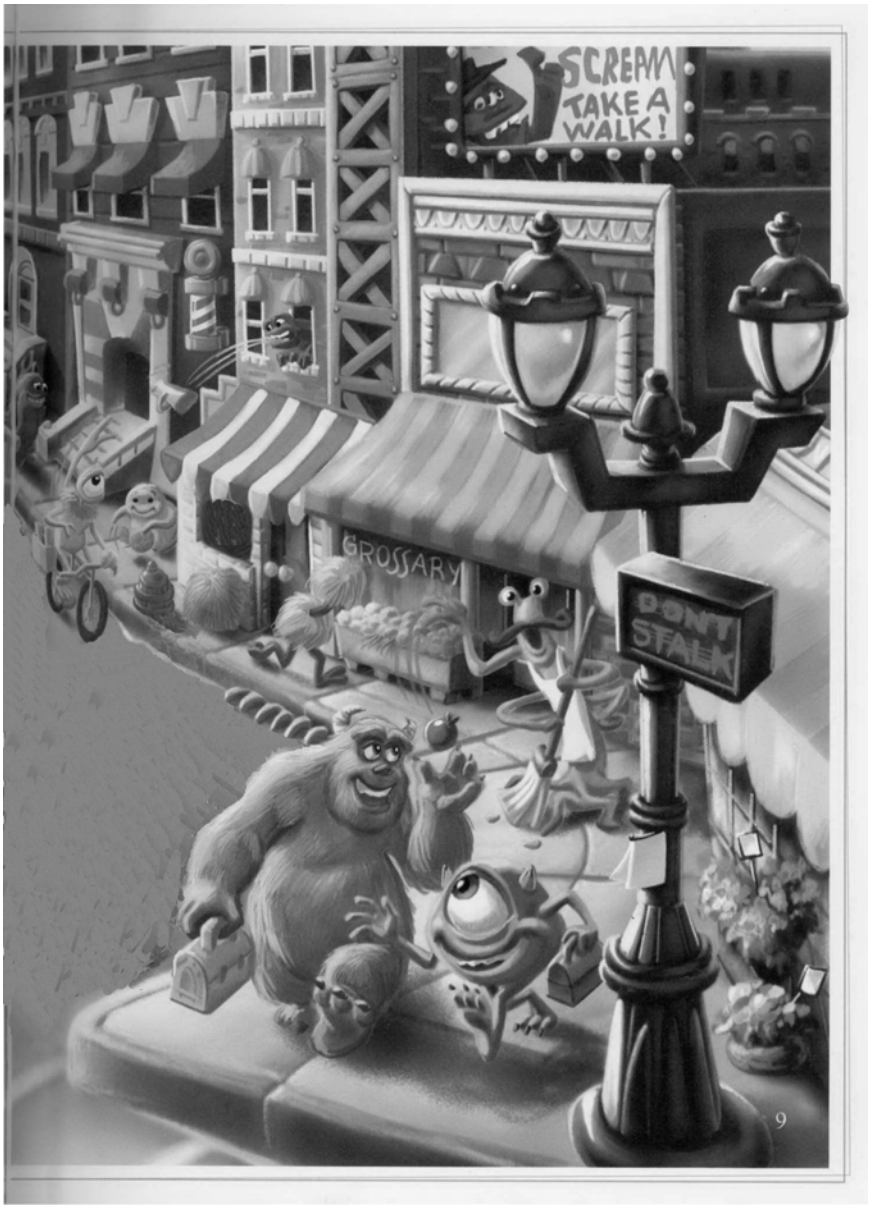
Appendix A: Pictures used for experiments



Appendix A, cont'd

Appendix B: Source and Target Stories for Experiments 1 and 2

		Fantasy	Reality
Wrap	Source Story	Let's imagine that one day Mike and Sulley were shopping for some oranges for the rest of the monsters at Monsters, Inc. They wanted to get all of the oranges back to their friends, but they realized they couldn't carry them all without dropping any. They looked and looked for something to help them move the oranges. Then Sulley had a great idea. He decided to wrap the oranges up in one of the coverings outside the store. That way, they could fit all of the oranges into the covering, carry them all at the same time to Monsters, Inc., and give them to the other monsters.	(Teacher's name) told me that one day she was in the classroom handing out snack and wanted to get all of the apples from the table to all of the students. She realized she couldn't carry them all without dropping any. She looked and looked for something to help her move the apples. Then she had a great idea. She decided to wrap the apples up in the blanket. That way, she could ft all of the apples into the blanket, carry them all at the same time to the tables, and hand them out.
	Target Story	One day Mike and Sulley were playing marbles on the street of the monster world with some friends. They won all of the marbles, but they realized they couldn't carry them all without dropping any. They looked and looked for something to help them move the marbles. These were the things that they found. Can you think of a way that Mike and Sulley found to carry their marbles back? Objects on the table: towel (analogical solution: wrapping), small spoon, blue block, twistie, paper clips, a binder clip, and rubber bands	The other day your teacher was playing marbles with the other teachers. She won all of the marbles, but she realized they couldn't carry them all without dropping any. She looked and looked for something to help her move the marbles. These were the things that she found. Can you think of a way that your teacher found to carry her marbles back? Objects on the table: towel (analogical solution: wrapping), small spoon, blue block, twistie, paper clips, a binder clip, and rubber bands

Appendix B: Experiment 1 Source and Target Stories (cont'd)

	Source Story	Let's imagine that one day Sulley and Mike were shopping for some fruit. Sulley wanted to give the apple to the monster up in the window. He realized he couldn't reach the window. He looked and looked for something to help him reach the monster in the window. Then he had a great idea. He decided to put the lunch boxes into a stack and stand on them. That way, he was the same height as the monster in the window and could give him the apple.	(Teacher's name) told me that one day she was in getting ready for lunch. She wanted to get this apple to the top of the shelf to eat it. She realized she couldn't reach the top of the shelf. She looked and looked for something to help her reach the top. Then she had a great idea. She decided to put some books into a stack and stand on them. That way, she was the same height as the top of the shelf and could get the apple.
Stack	Target Story	The other day your Mike and Sulley were building a tower with some blocks. They wanted to make the top of this orange block the same height as the top of this blue one. They looked and looked for something to help them with the blocks. These were the things that they found. Can you think of a way that Mike and Sulley found to make the blocks the same height? Objects on the table: two dominoes (analogical solution: stacking), spool of string, paper, tape, paper clips, and rubber bands	The other day (teacher's name) was building a tower with some blocks. She wanted to make the top of this orange block the same height as the top of this blue one. She looked and looked for something to help her with the blocks. These were the things that she found. Can you think of a way that your teacher found to make her blocks the same height? Objects on the table: two dominoes (analogical solution: stacking), spool of string, paper, tape, paper clips, and rubber bands