Tell Me a Story: How Children's Developing Domain Knowledge Affects Their Story Construction

David M. Sobel a & Deena Skolnick Weisberg b

a Brown University
b University of Pennsylvania

Accepted author version posted online: 31 Oct 2012. Published online: 28 May 2014.


To link to this article: http://dx.doi.org/10.1080/15248372.2012.736111

PLEASE SCROLL DOWN FOR ARTICLE
Tell Me a Story: How Children’s Developing Domain Knowledge Affects Their Story Construction

David M. Sobel
Brown University

Deena Skolnick Weisberg
University of Pennsylvania

Young children distinguish between the physical and biological domains of knowledge. The current study examines how this distinction is expressed in a story construction task. Three- and 4-year-olds were shown pairs of pictures, one that depicted a normal event and one that depicted an event that violated either physical or biological causal structure. Children were asked to choose which picture to include in a story. Three-year-olds generally showed no systematic patterns of responses when constructing their stories. Four-year-olds, in contrast, made more normal than violation choices overall, and their stories were relatively consistent with regard to the fictional world’s internal coherence. When 4-year-olds did include violation events in their stories, those violations tended to be of physical rather than biological causality. These data suggest that a general understanding of impossible events is underpinned by causal domain knowledge.

Young children have an impressive store of causal knowledge about the way the world works. They can interpret correlational information in terms of causal relations (e.g., Bullock, Gelman, & Baillargeon, 1982; Shultz, 1982; Shultz & Mendelson, 1975), draw causal inferences from observations (e.g., Gopnik, Sobel, Schulz, & Glymour, 2001; Schulz & Sommerville, 2006; Sobel, Tenenbaum, & Gopnik, 2004), and explain events (e.g., Hood & Bloom, 1979; Schult & Wellman, 1997; Sobel, 2004).

This representation of causal knowledge is not unitary; children distinguish among different domains in their understanding of causal laws (e.g., Gopnik & Meltzoff, 1997; Wellman & Gelman, 1998). Notably, young children make a distinction between the causal relations that govern physical objects and those that govern biological entities. Further, they show an earlier sensitivity to physical concepts like gravity and cohesion than to biological concepts like growth and healing. Even infants have expectations about how inanimate physical objects should interact (see reviews by Baillargeon, 2002; Spelke, Breinlinger, Macomber, & Jacobson, 1992), and although paradigms that use action instead of looking time show a delay in children’s understanding (e.g., Keen, 2003), there is good evidence that children understand certain aspects of

Correspondence should be sent to David M. Sobel, Department of Cognitive, Linguistic, and Psychological Sciences, Brown University, Box 1821, Providence, RI 02912, USA. E-mail: Dave_Sobel@brown.edu
physical causality by the age of 4 (e.g., Bullock et al., 1982; Shultz, 1982). In contrast, most research on children’s biological concepts suggests that such knowledge is still developing during and after the preschool years (e.g., Carey, 1985, 1995; Hickling & Gelman, 1995; Inagaki & Hatano, 1993, 2002; Matan & Carey, 2001; Rosengren, Gelman, Kalish, & McCormick, 1991; Springer, 1995).

But how do children bring these different bodies of knowledge to bear on tasks that do not ask directly about physics or biology, and what sorts of inferences do these bodies of knowledge allow children to make? One intriguing way to ask these questions involves looking at how children think about events that are impossible in reality. If children possess a full understanding of a certain domain, then this knowledge should allow them to accurately judge which events conform to the laws of this domain and which events violate them.

Several studies have demonstrated this kind of understanding in preschoolers. For instance, 4-year-olds are more likely to appeal to physical knowledge when asked to explain a violation of physical causality and biological knowledge when asked to explain a violation of biological causality (e.g., Schult & Wellman, 1997; Sobel, 2004). These studies suggest that children understand that impossible events are impossible because they violate domain-specific causal knowledge. However, these studies show only that children’s explanations are consistent with the domain of knowledge in which the causal violation took place. These results do not compare the ways in which children reason across these two domains of knowledge.

A study by Sharon and Woolley (2004) revealed evidence that young children do reason differently about impossible events from different domains of knowledge. They asked 3-, 4-, and 5-year-olds whether real and fictional entities had biological, physical, social, and mental properties. They found that 5-year-olds, like adults, judged that real entities were more likely to obey causal laws in each domain. Four-year-olds showed this sensitivity for the physical and social characteristics but did not differ in their judgments about biological or mental properties. Three-year-olds showed no domain differences at all.

Sharon and Woolley (2004), however, did not compare individual children’s judgments across domains of knowledge. Cook and Sobel (2011) considered this issue, asking whether children’s domain-specific knowledge influenced their judgments of what is possible. They found that 4-year-olds believed that violations of real-world physical knowledge were less likely to be possible compared with violations of real-world biological knowledge. This difference disappeared by age 6. Cook and Sobel suggested that 4-year-olds possessed a greater understanding of the physical principles that were examined compared with the biological principles, while 6-year-olds understood both the physical and biological principles that were tested (although see Shtulman, 2009, for a different take on this issue).

These results suggest that it can be fruitful to embed questions about children’s developing domain knowledge in tasks that ask about fictional events, particularly when investigating differences among children’s domain-specific knowledge. The current experiment asked 3- and 4-year-olds to construct a fictional story by choosing between pairs of events. One member of each pair was a realistic event, and the other was an event that violates an aspect of real-world causal structure. Critically, we varied whether this violation came from the physical or biological domain of knowledge. We focused on these domains for two reasons. First, previous work has found differences in the overall level of knowledge preschoolers possess, with preschoolers understanding much about the physical domain (e.g., Bullock et al., 1982; Schult & Wellman, 1997; Shultz, 1982) than about the biological one (e.g., Carey, 1985; Inagaki & Hatano, 1993, 2002; Matan & Carey, 2001; Rosengren, Gelman, Kalish, & McCormick, 1991; Springer, 1995).
Second, 4-year-olds’ judgments about these domains clearly differed with respect to fictional entities (Cook & Sobel, 2011; Sharon & Woolley, 2004). The current study also varied whether the story’s protagonist was a human being, suggesting that the story should be realistic, or an alien character from another planet, potentially allowing children to include in the story events that are impossible in reality.

This study not only deepens our understanding of young children’s domain knowledge, but it also informs our understanding of how young children conceptualize and construct fictional worlds. There is no question that exposure to stories benefits young children (e.g., Meyer, Wardrop, Stahl, & Linn, 1994), nor is there doubt that young children conceptualize the fictional worlds they are exposed to differently from reality (e.g., Woolley & Cox, 2007). The few studies that have asked how children construct their own fictional worlds have focused on school-aged children (e.g., Mandler & Johnson, 1977; Stein & Glenn, 1979); there has been little research exploring how preschoolers construct fictional worlds. Do children at this age believe that “anything goes” when they make stories, or are they more constrained in their judgments?

Certainly, 4-year-olds recognize some constraints on how similar fictional entities are to real ones (Sharon & Woolley, 2004) and on whether a novel fantasy character actually exists in the real world (Woolley, Boerger, & Markman, 2004). The current study asks whether young children systematically create particular kinds of stories that present many or few fantastical events in a structured manner, or whether their decisions to include fantastical events in stories are arbitrary. If children believe that fictional stories are not subject to any internal constraints, they may behave randomly in this task. If children believe that fictional stories do not need to be internally coherent, they might not distinguish between physically and biologically impossible events in the stories they construct.

Many studies suggest that young children generally recognize the difference between pretense or fantasy and reality (e.g., Flavell, Flavell, & Green, 1987; Morison & Gardner, 1978) and between what is possible and impossible (e.g., Schult & Wellman, 1997; Shtulman & Carey, 2007; Sobel, 2004; for reviews, see Bourchier & Davis, 2002; Weisberg, 2013). Such studies support the opposite prediction—that young children can recognize the boundaries of different kinds of fictional worlds, much in the same way that Leslie (1987) argued that young children “quarantine” pretense representations from reality. In support of this view, Skolnick and Bloom (2006) found that preschoolers distinguished among fictional worlds. Young children reported that Batman believes that Robin is real but that SpongeBob is fictional (see also Weisberg & Bloom, 2009; Wyman, Rakoczy, & Tomasello, 2009). On this view, children might have a relatively strong understanding of what kinds of events a particular fictional world allows: Certain stories license few or no fantastical events while other stories license many, a fact certainly understood by adults (e.g., Weisberg & Goodstein, 2009).

Thus, the current study asks is whether children will construct stories that respect domain boundaries. That is, if children choose to include events that violate real-world causal structure in their stories, will they do so consistently within a domain? Given the research reviewed earlier, which demonstrated a difference in how knowledge of physics and biology develops, we predict that 3-year-olds will be generally less likely to do this compared with 4-year-olds. Moreover, we ask whether children will differ in which types of violation events they include in their stories: physical ones or biological ones. We predict that children will be more likely to be consistent about events in the physical domain than the biological one, reflecting their deeper understanding of those events. In addition, we predict that children in the current study
will infer that a story about an alien can license more violations of real-world causal structure than a story about a human character. Indeed, several studies have shown that such a fantasy context affects how children reason (e.g., Dias & Harris, 1988, 1990; Lillard & Sobel, 1999; Richert, Shawber, Hoffman, & Taylor, 2009). We thus hypothesize that children who see the alien character will be more likely to construct stories that violate real-world causality compared with children who see the human character.

METHODS

Participants

Thirty-two 3-year-olds (19 girls, $M_{age} = 3;6$, $SD = 3.01$ months) and thirty-two 4-year-olds (14 girls, $M_{age} = 4;7$, $SD = 3.42$ months) were recruited from a set of preschools, with flyers posted at other preschools, and from a list of hospital births. Seven additional children were tested but excluded from the final analysis because of experimental error ($n = 1$), refusal to participate ($n = 2$), or for generating a pattern of responses inconsistent with their understanding the procedure ($n = 4$; see Procedure section below). The ethnic breakdown of the sample was as follows: 60 children were Caucasian, 2 were Asian, 1 was Latino/Hispanic, and 1 child was of mixed descent. No direct measure of socioeconomic status was taken, but all children appeared to be from middle- to upper-class families.

Materials

Four sets of six pictures were constructed. Two sets depicted a human character ("Moe") engaging in an action; the other two sets depicted an alien character ("Zoltron," a blue carrot-shaped humanoid with purple hair) engaging in the same action. In one set of pictures for each character, the actions and events were all ordinary—they could occur in the real world and represented real, familiar events. In the other set of pictures, the actions and events were all impossible and violated an aspect of real-world causal structure while accomplishing the same goal as in the normal pages. For example, in the pictures shown in Figure 1, the human or alien character goes outside, either by walking through a door or by walking through a wall.

Three additional pictures of each character were also generated. Each showed the character not engaged in any action and were used to introduce and conclude the story. The first two of these pictures were affixed by a metal binder ring that had a gap such that more pictures could be added to make a story.

Procedure

Children were tested in a quiet room of their preschool or in the laboratory by a male experimenter with whom they were familiar. Half of the children in each age group were randomly assigned to the realistic condition; the other half were assigned to the fantastical condition. In the realistic condition, they built their story around the human character Moe. In the fantastical condition, they built their story around the alien character Zoltron. In both cases, children
were told that they were going to write a story with the experimenter. The experimenter brought out the first two pictures attached with the metal binder ring and read the child the narrative of these two pictures, which introduced the character and said that the story would follow the character around to see what he did (see the Appendix for the full testing script, including the specific order in which the picture pairs were presented).

Children were then shown six pairs of pictures, one pair at a time. Each picture in the pair either described a new aspect of the character or showed the character engaging in an action. In one picture, that description or action did not violate any aspect of real-world causal structure (normal choice). In the other picture, the end state of the story narrative was the same, but the character violated an aspect of real-world causal structure to advance the story (violation choice). We further manipulated the nature of the violation pictures. Three of the violation choices involved a violation of an aspect of real-world physical causality (i.e., Moe/Zoltron flies in a rocket ship vs. drives in a car, walks through walls vs. through an open door, moves a ball without touching it vs. throws it to his friend). The other three violation choices involved a violation of real-world biological causality (i.e., Moe/Zoltron has 63 mommies and daddies vs. 1 mommy and daddy, never sleeps vs. needs to sleep, and never grows up vs. grows up). Although we did not explicitly ask children whether the violation events were impossible, almost all of these events have been judged to be impossible in previous studies with children of this age,
while all of the normal events have been judged to be possible (e.g., Schult & Wellman, 1997; Sobel, 2004).

After being read the two introductory pages in the story, children were read the description of the pictures in each choice pair. They were then asked which of these two pictures they wanted to choose to continue the story. Because the story had an ordered narrative, the six picture pairs were presented in a specific order for all participants, and this order was determined randomly prior to the start of the experiment. Children made their choices among the six pairs, and then the experimenter brought out a final picture, which concluded the story and the procedure.

The placement of the violation picture alternated between the left and right position (initial position counterbalanced). A minority of children (n = 4) always chose the picture in one spatial location (three on the right, one on the left). The data from these children were replaced, because it was not clear whether they understood the procedure or simply responded on the basis of a side bias.

RESULTS

Children received a score of 0 for each normal page they chose and a score of 1 for each violation page they chose. Neither the 3-year-olds’ nor the 4-year-olds’ responses differed among the three physical violation choices or the three biological violation choices, all Cochran’s $Q(2, N = 32)$ values < 3.72, all ps > .15, so we summed their scores for the three physical and three biological violation choices together. Preliminary analyses also revealed no effect of gender on responses to these questions for either age group, both Mann-Whitney $U > 456.00$, absolute value of both z-scores < 0.77, both ps > .44. As a result, the rest of our analyses collapse the data across these conditions.

We next tested for differences between the distributions of responses of the two age groups (see Figure 2). Overall, 4-year-olds made fewer violation choices than did 3-year-olds, Mann-Whitney $U = 171.00$, $z = -4.69$, $p < .01$. To consider the effect size of this difference, we report mean ranks for this and similar subsequent analyses (following Green & Salkind, 2008). Three-year-olds had a mean rank of 43.16, while 4-year-olds had a mean rank of 21.84. This age difference held independently for the physical violation questions (Mann-Whitney $U = 277.00$, $z = -3.29$, $p < .01$, mean ranks of 39.84 vs. 25.16) and the biological violation questions (Mann-Whitney $U = 141.50$, $z = -5.26$, $p < .01$, mean ranks of 44.08 vs. 20.92).

We also compared responses to the physical and biological violations. Three-year-olds’ choices did not differ between the physical and biological domains, Wilcoxon Signed Rank Test, $z = -0.21$, $p = .83$. But 4-year-olds were more likely to choose a violation picture when the violation involved an aspect of physical causality than when it involved an aspect of biological causality, Wilcoxon Signed Rank Test, $z = -2.35$, $p = .019$, mean ranks of 6.70 vs. 5.50.

Although there was no overall difference among responses to the three physical or three biological picture pairs, it is possible that the fixed order of the picture pairs influenced responses.
To consider this, we examined whether there was a difference the first time children saw a switch between domains and the last time they saw a switch between domains. Because the first case occurs early in the story, children might not have decided what kind of story world they are constructing. We found no significant differences for either age group, both McNemar $\chi^2(1, N = 32) < 0.57$, both $ns$. In contrast, because the last switch occurred late in the story, after children had potentially decided what kind of story world they were constructing, if children made systematic responses based on their causal knowledge, then we would expect more causal violations of the physical pair than the biological one. This was found for the 4-year-olds, McNemar $\chi^2(1, N = 32) = 4.00, p = .04$, but not the 3-year-olds, McNemar $\chi^2(1, N = 32) = 1.06, ns$.

Chi-squared goodness-of-fit tests were used to compare the distribution of children’s choices of violation pictures in each domain to what would be expected by chance. Three-year-olds’ distribution of responses for the three physical choices and the three biological choices was no different from chance, $\chi^2(3, N = 32) = 1.33$ and 3.17, respectively, both $ps > .36$. Four-year-olds’ distribution of responses differed from chance for both the physical and biological items, $\chi^2(3, N = 32) = 56.33$ and 68.67, respectively, both $ps < .01$. In both cases, the 4-year-olds were more likely to choose normal pictures than violation pictures, binomial tests, both $ps < .05$.

Finally, we analyzed the coherence within an individual child’s story. We measured coherence in three ways. First, we examined whether children differed in their commitment to a fictional world that consistently obeyed or consistently violated real-world physical and biological causality. To do so, we summed the number of children in each age group who made all normal choices or all violation choices within the physical and biological domains. These data are shown in Table 1. Overall, 4-year-olds were more likely to make all violation or all normal choices than were 3-year-olds for both the physical and biological items, $\chi^2(1, N = 64) = 7.57$ and 15.27, respectively, both $ps < .01$. The frequency with which 3-year-olds chose consistently was no different from chance for both domains, both binomial tests $p > .14$, while the frequency with which 4-year-olds chose consistently was greater than chance expectations, both binomial tests, $p < .01$.
Second, we considered children’s stories in terms of how often they made any violation choice (i.e., generated a story that contained only normal choices). Three-year-olds never generated this response pattern, which is not different from chance (1/2^5 or 1.56%), binomial test, \( p = .61 \). Four-year-olds did so 50% of the time, significantly more often than chance levels, binomial test, \( p < .01 \).

Third, we analyzed the frequency with which children switched from a violation choice to a normal choice, or vice versa, throughout the entire story. We considered how children responded to the first picture pair as a basis and then counted the number of times they alternated between this initial choice and the other alternative. Because there were 5 subsequent picture choices, there were 5 possible switch opportunities. Three-year-olds averaged 2.38 switches, while 4-year-olds averaged only 1.16 switches, a significantly different distribution, Mann-Whitney \( U = 227.00, z = -3.90, p < .01 \), mean ranks of 41.34 vs. 23.66. Moreover, chi-squared goodness-of-fit tests revealed that the distribution of switches made by 3-year-olds was no different from that of chance \( \chi^2(5, N = 32) = 4.60, p = .47 \), while the distribution generated by 4-year-olds was significantly different from chance, \( \chi^2(5, N = 32) = 237.52, p < .01 \). In general, these three analyses suggest that 4-year-olds were not only consistent in their choices within a domain, but across the entire story.

### DISCUSSION

In this study, 3- and 4-year-olds constructed a story world. They were introduced to a human or alien character and were asked to choose whether possible or impossible events belonged in a story about this character. The impossible events violated either real-world physical or biological knowledge. Three-year-olds generally responded at chance and showed no systematic performance in the construction of their stories. Four-year-olds, in contrast, showed evidence of systematic performance. They rarely constructed stories with many impossible events and often generated stories that contained no violations of real-world causal knowledge. Moreover, 4-year-olds tended to pick violations of physical causality more often than violations of biological causality. Surprisingly, however, the nature of the story’s protagonist—whether he was a human being or an alien—had no effect on their responses.

This last result is interesting, particularly because several researchers have demonstrated that introducing a fantasy context can help preschoolers’ reasoning (e.g., Dias & Harris, 1988, 1990;
Lillard & Sobel, 1999; Richert et al., 2009). These prior findings, however, demonstrated that children’s reasoning is affected by the presence or absence of a fantasy context. In contrast, our manipulation attempted to ascertain whether children recognized that stories could be in different genres—specifically, whether one story could violate more real-world events than another. While adults recognize this difference (e.g., Weisberg & Goodstein, 2009), 4-year-olds might not be able to construct different fictional worlds based solely on the nature of the protagonist. This is consistent with results showing that 4-year-olds rely on contexts as opposed to characters to make decisions as to whether novel objects mentioned in stories are real (Riskind & Woolley, 2008).

Turning to our findings about domain differences, it is tempting to conclude that there is a significant difference between 3- and 4-year-olds’ understanding of stories. The younger children appeared to respond completely at random, while the older children responded in relatively structured ways. It is certainly possible that between the ages of 3 and 4, children’s understanding of narratives becomes more coherent or that they come to understand more about story genre or canonical story structure (consistent with findings on the development of narrative skill; e.g., Benson, 1993; Hudson & Shapiro, 1991; Nicolopoulou, 2008; Stein, 1988). However, there are many possible reasons why 3-year-olds might have exhibited chance performance, including, most basically, a failure to understand the nature of the task. As a result, we will concentrate on interpreting the data from only the older children.

One conclusion that emerges from these data is that 4-year-olds appear not to believe that “anything goes” in fiction. They seemed resistant to generating stories that contained violations of real-world causal knowledge. This is consistent with previous research, which revealed that children generally do not include rule-violating events in fictional contexts (Weisberg, Sobel, Goodstein, & Bloom, in press). But when the 4-year-olds did include events that violated causal knowledge, they were consistent in what domain of knowledge they choose to violate: They preferred to choose impossible physical events over biological ones. This finding is consistent with previous work suggesting that 4-year-olds differentiate between physical and biological domains of knowledge in making judgments about fictional entities (Cook & Sobel, 2011; Sharon & Woolley, 2004).

There are several alternate explanations for this domain difference. One possibility is that this result emanated from our using a fixed order for the picture pairs. We find this unlikely, as the present results are consistent with previous findings that show similar differences between the biological and physical domain and that did not present items in a fixed order (Cook & Sobel, 2011; Sharon & Woolley, 2004). A different possibility is that this domain difference reflected children’s greater familiarity with physical rather than biological causal violations. Although all of these events are impossible (and thus the base rates of their appearing in the world are presumably equally low), physical violations might be more familiar to children because they appear more often in cartoons or other media. Given this familiarity, children might have been more inclined to put them in stories. We again find this possibility unlikely. If it were true, then we would expect a comparison of any biological/physical pair to show this effect. Although responses to the three physical and three biological pairs did not differ from each other, the first time 4-year-olds saw a physical and biological pair, they did not differ in their responses. Only later in the story do these individual item differences emerge. Further, if familiarity alone drove these effects, then both 3- and 4-year-olds should have shown this difference—even though 4-year-olds have more overall experience with the world than younger children, both age groups
would have been exposed to the same disparity in observed causal violations. Finally, Weisberg et al. (in press) showed that 4-year-olds do not have a preference for violations to physical or biological causality as opposed to their realistic analogues (using similar contrasts presented here) outside of a story context. All of these considerations suggest that familiarity does not drive our results.

We favor the interpretation that although 4-year-olds do not fully understand the concept of story genre, they may possess the roots of such an understanding. They do not yet recognize the role of a story’s protagonist in implying the existence of a realistic or fantastical story world, as illustrated by our failure to find a difference in how children responded in the realistic and fantastical conditions (see also Riskind & Woolley, 2008). But they do recognize, to some degree, that stories should be internally coherent and follow a consistent set of laws. It may have been this recognition that led them to tend to include only either biological or physical violation events in their stories. This behavior potentially reflects 4-year-olds’ more mature understanding of physical rather than biological causality. Indeed, given this difference in understanding, it is possible that these children were less likely to register that the biological violations were impossible compared with the physical ones.

A point for further discussion is whether these results persist across other domains of knowledge. For instance, in addition to looking at physical versus biological knowledge, Sharon and Woolley (2004) showed that children’s understanding of whether fictional characters had human-like social and mental properties differed with age. We investigated the difference between physical and biological events because there are clear differences in when children’s causal knowledge develops between these domains. Within the psychological domain, for instance, there are some causal relations involving mental events that 4-year-olds should understand (like that someone would be happy when given a desirable object; e.g., Wellman & Woolley, 1990) but others that might not be comprehended (such as that a knowledgeable person would not be surprised by an outcome; e.g., Hadwin & Perner, 1991). In short, we suspect that children’s existing causal knowledge about the particular causal relations within a domain would underlie their motivation to include violations of that knowledge in fictional worlds. In this way, age is a proxy for this causal knowledge. For instance, we suspect that if we tested a sample of 6-year-olds, who have more biological knowledge, we would not see any difference between their responses to the physical and biological events (consistent with Cook & Sobel, 2011; Sharon & Woolley, 2004).

Finally, in considering the implications of these findings, we would argue that young children might use fictional worlds as a way of experimenting with their knowledge, much in the way Lillard (2001) suggests that children’s pretense might act as a thought experiment (akin to the concept of “twin earth” in philosophy; see also Buchsbaum, Bridgers, Weisberg, & Gopnik, 2012). When children do place violations to causal structure into stories, they construct a fictional world with different ontological commitments than the real world. Constructing such fictional worlds might help the child to understand and reason about the ontological structure of the real world.

In this vein, some have argued that children’s causal knowledge emanates from their ability to reason counterfactually (e.g., Harris, German, & Mills, 1996; following Mackie, 1974). Although we would not suggest that children’s causal knowledge develops only from their understanding of possible worlds, constructing such possible worlds might aid children’s developing ontological knowledge. When children pretend, they often test the limits of the causal,
functional, or deontic relations that they understand (e.g., Gopnik, 2009). Certainly, children’s narrative abilities reflect their understanding of causal structure (e.g., Stein & Glenn, 1979). It would not be surprising if providing children with a story context affords them the ability to conceptualize new pieces of causal knowledge. The present data suggest that this may be a fruitful tool for 4-year-olds. Future research should consider how fictional modalities interact with the mechanisms by which these children learn about the ontological structure of the world and whether younger children have similar learning abilities.

ACKNOWLEDGMENTS

We would like to thank Emily Blumenthal, Sheridan Brett, Cesalie Stepney, and Lea Travers for assistance with stimulus design, participant recruitment, and data analysis. We would like to thank Sarah Beck, Christoph Hoerl, Teresa McCormack, and particularly Paul Bloom for helpful discussion regarding this research.

FUNDING

This work was supported by the National Science Foundation (DLS-0518161).

REFERENCES


APPENDIX

Script of Stories and Choice Pictures

First Picture

Realistic condition: This is Moe and he’s from the planet Earth.
Fantastical condition: This is Zoltron and he’s from the planet Zolnar.

Second Picture

Let’s follow Moe/Zoltron around during the day and see what he does.

First Choice

Normal: Moe/Zoltron lives with his mommy and daddy. He also lives with his brother and sister. He has one brother and one sister.
Violation: Moe/Zoltron lives with his 32 mommies and daddies. He also lives with his brothers and sisters. He has 64 brothers and 53 sisters.

Second Choice

Normal: Moe/Zoltron goes to school each morning. Mommy drives him in the car to get to school.
Violation: Moe/Zoltron goes to school each morning. He flies to get to school.

Third Choice

Normal: After school is over, Moe/Zoltron goes outside to play. To get outside, he goes through the door in the back of the classroom.
Violation: After school is over, Moe/Zoltron goes outside to play. To get outside, he passes through the wall in the back of the classroom.

Fourth Choice

Normal: Moe/Zoltron and his friends play with a ball. They play a game of catch. They pick up the ball and throw it to one another.
Violation: Moe/Zoltron and his friends play with a ball. They play a game of catch. They think about the ball and the ball moves from one of them to another.

Fifth Choice

Normal: Moe/Zoltron is going to grow up one day and be a grown-up just like his mommy and daddy.
Violation: Moe/Zoltron is never going to grow older. He is going to stay the same age forever.

Sixth Choice

Normal: Now it’s nighttime. Moe/Zoltron has to go to sleep. He gets pretty tired. He tries to stay awake, but he can’t. So, he and his brother and sister fall asleep.
Violation: Now it’s nighttime. Moe/Zoltron does not have to sleep. He never gets tired. He always stays awake. He stays up all night playing games with his family.

Final Picture

Wow, what a long day. And who knows what will happen tomorrow. The End.