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To cite this article: Anna E. Goswick , Hillary G. Mullet & Elizabeth J. Marsh (2013) Suggestibility From Stories: Can Production Difficulties and Source Monitoring Explain a Developmental Reversal?, Journal of Cognition and Development, 14:4, 607-616, DOI: [10.1080/15248372.2012.710864](https://doi.org/10.1080/15248372.2012.710864)

To link to this article: <https://doi.org/10.1080/15248372.2012.710864>



Accepted author version posted online: 01 Aug 2012.
Published online: 18 Oct 2013.



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ARTICLE

Suggestibility From Stories: Can Production Difficulties and Source Monitoring Explain a Developmental Reversal?

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Children's memories improve throughout childhood, and this improvement is often accompanied by a reduction in suggestibility. In this context, it is surprising that older children learn and reproduce more factual errors from stories than do younger children (Fazio & Marsh, 2008). The present study examined whether this developmental reversal is limited to production tests, or whether younger children are still less suggestible when the final test (multiple-choice) asks them to recognize the answer. A second goal was to explore the role of source monitoring in children's suggestibility by examining children's awareness of learning within, versus before, the experiment. Five-year-olds and 7-year-olds listened to stories containing correct, neutral, and misleading references and later took either a multiple-choice or short-answer general knowledge test. In addition, they judged whether each answer had appeared in the stories and whether they had known it before the experiment. Critically, a developmental reversal in suggestibility was observed on both tests; younger children were less suggestible even when faced with the story errors at test. Although older children showed superior source discriminability for whether their answers had appeared in the stories, they showed an illusion of prior knowledge, believing they had known their misinformation answers all along. To this effect, older children's increased suggestibility may be due not only to their superior memory capacity for specific story errors, but also to their ability and tendency to integrate story information into their knowledge base.

Episodic memory, or the ability to form and retrieve memories of the details and context of events, improves throughout childhood (Ghetti & Lee, 2011). As this ability develops, children become less likely to commit memory errors and falsely remember events. For example, the suggestibility of child eyewitnesses decreases with age, with older children being less likely to accept misleading suggestions about earlier events (Ceci & Bruck, 1993). Similarly, older children are less likely to accept and develop false memories for entire events, like riding in

a hot-air balloon (Ceci, Huffman, Smith, & Loftus, 1994). Consistent with source-monitoring theory (Johnson, Hashtroudi, & Lindsay, 1993), children become less suggestible as they become better able to accurately identify the sources of their memories (Giles, Gopnik, & Heyman, 2002).

Given the extensive literature showing age-related declines in suggestibility, of particular interest are developmental reversals, with suggestibility *increasing* with age (Brainerd, Reyna, & Ceci, 2008). Many of these demonstrations involve the Deese-Roediger-McDermott (DRM) paradigm for creating false memories (Deese, 1959; Roediger & McDermott, 1995). Children hear lists of related words such as *bed, pillow, dream, covers, night, tired, nap, sheets*, and of interest is whether they later falsely recall (or recognize) a critical nonpresented word like *sleep*. Surprisingly, younger children are less likely than older children to falsely remember *sleep*. Such demonstrations are difficult to fit with source-monitoring theory, because source monitoring typically improves across childhood (e.g., Lindsay, Johnson, & Kwon, 1991). Instead, susceptibility to the DRM illusion has been linked to age-related improvements in extracting meaning from the list. Theoretically, these results have been interpreted within fuzzy trace theory (Brainerd et al., 2008). The argument is that children store two different memory representations: A gist trace captures meaning across events (e.g., list theme), and verbatim traces capture the surface-level details of individual events (e.g., individual words). Children's ability to identify themes and extract meaning across words (gist memory) improves with age, meaning older children are more susceptible to false memories in the DRM paradigm.

It should not be assumed that the same mechanism underlies all developmental reversals. Consider the *learning from fiction* paradigm, in which children hear stories containing both correct and incorrect facts and then take a general knowledge test (Fazio & Marsh, 2008). Of interest is how hearing errors embedded in stories (e.g., "*Mount Washington, the tallest mountain in the world*") influences children's ability to answer later general knowledge questions (e.g., "*What is the tallest mountain in the world?*"). Although both older (7-year-olds) and younger children (5- and 6-year-olds) benefit from story exposure to correct answers, only older children use the story errors to answer later short-answer questions. This developmental reversal in suggestibility was not due to a deficiency in source memory, as older children showed superior memory for whether their answers had appeared in the stories. However, the developmental reversal was also unlikely to be due to age-related differences in gist extraction, because the story errors were unrelated, with no common gist to extract (i.e., "*A tadpole will grow up to be a fish*" is unrelated to "*Mount Washington is the tallest mountain*"). Instead, a different mechanism was implicated: Suggestibility likely depended upon memory for the individual pieces of information (verbatim traces), meaning that older children were more suggestible because they had better memory for specific story errors. Although these results suggest a mechanism involving verbatim memory for misinformation, one major concern is that the use of a short-answer test may have driven these results. That is, the final test required children to produce answers from memory instead of recognizing them, and younger children often cannot recall information that they can recognize (Schneider & Pressley, 1997). In other words, the concern is that younger children were at floor for false memories because they could not produce them, not because they had not learned them.

To test this possibility, we examined whether the relationship between age and suggestibility would change on a final multiple-choice test where younger children no longer had to produce their answers. Suggestibility on the multiple-choice test would mean choosing

the misinformation when faced with both the correct answer and the misleading lure. In addition to negating concerns that young children were simply suffering from a production deficit, obtaining the developmental reversal on the multiple-choice test would be impressive because recognition tests are generally less sensitive to age differences compared with free recall (Ackerman, 1985).

A second goal involved more closely examining the contribution of source memory to suggestibility. Undergraduates show an illusion of prior knowledge when reproducing errors from stories (Marsh, Meade, & Roediger, 2003). Students report knowing misinformation before the experiment even though it was first encountered in the stories, indicating it has been integrated with related knowledge. Although Fazio and Marsh (2008) found older children had superior memory for whether their answers had appeared in the stories, there was no measure of children's perception of prior knowledge (what they claimed to know *before* listening to stories). Therefore, of interest was whether older children would exhibit an illusion of prior knowledge, because it would suggest that they had integrated the story information into their knowledge base.

To preview, 5- and 7-year-olds listened to stories that contained factual inaccuracies and later took either a short-answer or multiple-choice general knowledge test. Critically, the multiple-choice test always paired the correct answer with the story error, as well as with two other plausible lures, meaning that suggestibility on this test would mean accepting the error even when the correct answer was displayed. Regardless of test type, children made two source judgments about each answer, indicating whether each answer had appeared in the stories and whether they knew each answer before coming to the experiment. Of interest was whether a developmental reversal in suggestibility would hold for both tests and whether all children would show similar patterns of source memory for the stories and prior knowledge.

METHOD

Participants

Forty-eight children participated: twenty-four 5-year-olds ($M = 5.5$; $SD = 3.84$ months; 8 males) and twenty-four 7-year-olds ($M = 7.4$; $SD = 3.24$ months; 9 males).

Design

The design was a 2 (age: 5-year-olds, 7-year-olds) \times 2 (test type: multiple-choice, short-answer) \times 3 (fact framing: correct, neutral, misleading) mixed design. Age and test type were between-subjects variables, and fact framing was manipulated within subjects. Within each age group, participants were randomly assigned to the different testing conditions.

Materials

Two children's stories (one about the Eiffel Tower and the other about farm animals; Angelou, 2004; Harrison, 1986) were modified for use in the experiment (similar to those used in Fazio &

Marsh, 2008). Stories were presented on the computer and consisted of pictures paired with recordings from a female speaker (no words appeared to minimize age-related differences in reading ability). On average, each story lasted 4.6 minutes.

Each story contained 15 critical items based on facts from Brain Quest: Grade 1 (Feder, 2006); samples include the number of eggs in a dozen and the color of a polar bear's fur. Within each story, 5 items were presented in a correct format (e.g., "*autumn, that's another word for fall*"), 5 were presented in a misleading format (e.g., "*autumn, that's another word for spring*"), and 5 were presented in a neutral format (e.g., the word "*autumn*" was presented without information relevant to the corresponding test question). Neutral items served as controls to estimate what children knew prior to the experiment. Each child was exposed to only one version of each item; assignment of items to correct, neutral, and misleading formats was counterbalanced across children.

The final general knowledge test contained 30 questions corresponding to the 30 critical items (a single random order was used). Half of the children answered multiple-choice questions and half answered short-answer questions. In both conditions, children were warned against guessing and were allowed to answer, "*I don't know.*" The multiple-choice options always included the correct answer, the target misinformation, two additional plausible lures, and "*I don't know.*" For example, the child would be asked, "*What is another word for autumn: fall, spring, summer, winter, or I don't know?*" The short-answer questions were exactly the same, except that they were open-ended and no possible options were suggested to the children (e.g., "*What is another word for autumn?*"). No restrictions were placed on children's responses to short-answer questions.

The source test required children to identify where they had learned each of their answers to the general knowledge questions ("*I don't know*" responses were excluded). Children answered two questions: 1) whether the answer had been presented in the stories, and 2) whether they had known the answer before hearing the stories. Source judgments were always collected after all general knowledge questions had been answered, because cueing children to source earlier may have changed how they answered the general knowledge questions (e.g., by encouraging them to explicitly think back to the story source; Bright-Paul, Jarrold, & Wright, 2005).

Procedure

After researchers obtained oral assent from the child and written consent from his/her guardian, the child was seated at a laptop for the story phase. The child was told to listen carefully and to press the spacebar to turn each virtual page when a chime sounded. A 1-minute filler followed the story phase, involving paper-and-pencil mazes.

The child then took the general knowledge test, in either multiple-choice or short-answer form. The experimenter explained that some of the questions would be difficult and that the child should respond, "*I don't know*" if she did not know the answer, rather than guess. Critically, the "*I don't know*" instruction was given for both test types to ensure that reproductions of story misinformation were not driven by guessing.

The experimenter then introduced the source test, explaining that the child would be asked where she learned each answer provided earlier. First, the child was asked if she heard the answer in one of the stories and then whether she knew the answer before coming into the

experiment. The experimenter used a familiar fact that had not been presented in the stories (“A triangle has three sides”) to test the child’s understanding of the two source questions. First, the experimenter asked the child, “Did you hear that in one of the stories?” and was then asked, “Did you know this before hearing the stories today?” All of the children answered these practice questions correctly and then completed the source test.

Upon completion, the experimenter explained that sometimes stories contain information that is not true and corrected any misinformation learned from the stories.

RESULTS

Coding

Two trained undergraduates scored each short-answer response as *correct*, *story misinformation*, *another wrong answer*, or *I don’t know*. They agreed on 99.31% of items, and the first author resolved all discrepancies.

Benefits of Story Reading

To examine whether hearing correct answers in the stories helped children to correctly answer questions on the general knowledge test, we performed a 2 (age: 5-year-olds, 7-year-olds) \times 2 (test type: multiple-choice, short-answer) \times 2 (fact-framing: correct, neutral) analysis of variance (ANOVA) on the proportion of questions answered correctly. The misleading frame was not included in this analysis because hearing misinformation should not benefit later performance. As expected, older children correctly answered more questions ($M = 0.63$) than did younger children ($M = 0.38$), $F(1, 44) = 31.07$, $MSE = .05$, $\eta_p^2 = .41$, $p < .001$. Replicating Fazio and Marsh (2008), there was also a main effect of fact framing: Children answered more questions correctly after hearing the correct answer in the story ($M = 0.56$) as compared with the neutral baseline ($M = 0.45$), $F(1, 44) = 13.96$, $MSE = .02$, $\eta_p^2 = .24$, $p = .001$. Also consistent with prior work, the interaction between age group and fact framing was not significant, $F(1, 44) = 1.32$, $MSE = .02$, $p = .26$. In other words, younger and older children benefited similarly from hearing correct answers in the stories.

The novel question was whether the effects of hearing the stories would be similar on the two different tests. There was a main effect of test type, $F(1, 44) = 5.14$, $MSE = .05$, $\eta_p^2 = .11$, $p = .03$, which was driven by the fact that children answered more multiple-choice questions correctly ($M = 0.55$) as compared with short-answer questions ($M = 0.45$). Although not surprising that performance would be lower on the production test (short-answer), the direct comparison between the two tests must be made with caution because it involves two different dependent measures. What matters is whether age and fact framing had the same effects on the two tests. As shown in Table 1, the patterns were the same on the two tests; neither the interaction between test type and fact framing ($F < 1$) nor the interaction between test type and age group reached significance ($F < 1$). Furthermore, the three-way interaction was not significant, $F(1, 44) = 1.67$, $MSE = .02$, $p = .20$. Regardless of test type, both younger and older children were more likely to correctly answer general knowledge questions after hearing the correct answers in the stories.

TABLE 1
 Proportion of General Knowledge Questions Answered Correctly (Top Panel) Versus With Story Misinformation (Bottom Panel), as a Function of Age, Fact Framing, and Test Type

Age	Multiple-choice test		Short-answer test	
	Correct	Neutral	Correct	Neutral
	<i>Correct Answers</i>			
5-year-olds	.45 (.24)	.43 (.17)	.38 (.16)	.25 (.15)
7-year-olds	.74 (.17)	.58 (.12)	.65 (.24)	.53 (.18)
<i>M</i>	.60 (.04)	.51 (.03)	.52 (.04)	.39 (.03)

Age	Multiple-choice test		Short-answer test	
	Neutral	Misleading	Neutral	Misleading
	<i>Misinformation Answers</i>			
5-year-olds	.11 (.11)	.16 (.16)	.02 (.04)	.07 (.09)
7-year-olds	.07 (.08)	.23 (.18)	.02 (.04)	.18 (.17)
<i>M</i>	.09 (.02)	.19 (.04)	.02 (.01)	.13 (.03)

Note. Standard deviations are shown in parentheses.

Costs of Story Reading

To explore children's suggestibility, we examined whether hearing story errors increased the proportion of general knowledge questions answered with those specific errors (as compared with the neutral baseline). We performed a 2 (age: 5-year-olds, 7-year-olds) \times 2 (test type: multiple-choice, short-answer) \times 2 (fact framing: neutral, misleading) ANOVA on the proportion of questions answered with misinformation from the stories. The correct frame was not included in this analysis because hearing correct answers should not increase later production of misinformation. As expected, children answered more questions with target misinformation ($M = 0.16$) after hearing misinformation in the stories, as opposed to neutral references ($M = 0.05$), $F(1, 44) = 17.65$, $MSE = .02$, $\eta_p^2 = .29$, $p < .001$.

Critically, a developmental reversal in suggestibility was observed: Older children were more suggestible than were younger children, as reflected in the significant interaction between age group and fact framing, $F(1, 44) = 4.77$, $MSE = .02$, $\eta_p^2 = .10$, $p = .03$. After hearing misleading references in the stories, older children showed robust suggestibility, producing significantly more misinformation ($M = 0.20$) than after hearing neutral references ($M = 0.04$), $t(23) = 4.06$, $SEM = .04$, $p < .001$. In contrast, this suggestibility effect failed to reach significance in the younger children, even though they answered slightly more questions with misinformation after hearing it in the stories ($M = 0.11$) as compared with their neutral baseline ($M = 0.06$), $t(23) = 1.73$, $SEM = .03$, $p = .10$.

Most importantly, this developmental reversal in suggestibility occurred on both types of tests. Overall, misinformation was selected at a higher rate on the multiple-choice test ($M = 0.14$) than it was produced on the short-answer test ($M = 0.07$), $F(1, 44) = 8.53$, $MSE = .01$, $\eta_p^2 = .16$, $p < .01$, but what is more important is that age group and fact framing had

similar effects on both tests. As shown in Table 1, neither the interaction between test type and age group nor the interaction between test type and fact framing reached significance (both F s < 1). Similarly, the three-way interaction was not significant ($F < 1$). On both the multiple-choice and short-answer tests, after hearing misinformation, older children answered more questions with the misinformation than did the younger children. In other words, after exposure to misinformation, 7-year-olds were more likely to answer later general knowledge questions with misinformation than were 5-year-olds, regardless of test format.

Source Memory

We examined children's knowledge of whether their answers had appeared in the stories. A story attribution was defined as a child's claim that she had heard the answer in one of the stories. A prior knowledge attribution was defined as a child's assertion that she had known the answer *before* listening to the stories. Critically, these attributions were independent measures; children were able to attribute any given answer to both the stories and prior knowledge.

Accuracy of story attributions. To examine the accuracy of children's story attributions, we computed a 2 (age: 5-year-olds, 7-year-olds) \times 2 (story status: presented, not presented) ANOVA on the proportion of general knowledge answers that children claimed to have heard in the stories. An answer was categorized as having been presented "in the story," as long as the child had actually heard that particular answer during the story phase (regardless of whether the answer had been presented in a correct or misleading frame). The main effect of age group was not significant ($F < 1$), but there was a significant main effect of story status, $F(1, 46) = 47.77$, $MSE = .03$, $\eta_p^2 = .51$, $p < .001$. Both younger and older children were more likely to correctly claim to have heard answers that had actually been presented in the stories ($M = 0.55$) than they were to incorrectly claim to have heard answers that, in fact, had not been presented ($M = 0.31$). Critically, the interaction between age group and story status was also significant, $F(1, 46) = 6.33$, $MSE = .03$, $\eta_p^2 = .12$, $p = .02$. Older children showed better source discriminability; that is, the difference between the proportion of answers correctly sourced to the stories and the proportion of answers incorrectly sourced to the stories was greater for older children ($M = 0.32$) than it was for younger children ($M = 0.15$), $t(46) = 2.52$, $p = .02$.

Illusions of prior knowledge. Of particular interest was whether children showed illusions of prior knowledge, meaning that they believed they had known their misinformation answers before the experiment. This analysis was limited to misinformation answers because the children likely knew many of the correct answers before hearing them in the stories, but it was unlikely that they actually believed their misinformation answers before the experiment (this assumption was supported by the low rates of misinformation production after hearing neutral-framed facts). Figure 1 shows misinformation production after hearing neutral or misleading references, broken down by whether answers were attributed to prior knowledge (bottom portion of the bars) or not (top portion). Overall, children attributed 63.3% of misinformation answers to prior knowledge, and this percentage was similar regardless of age

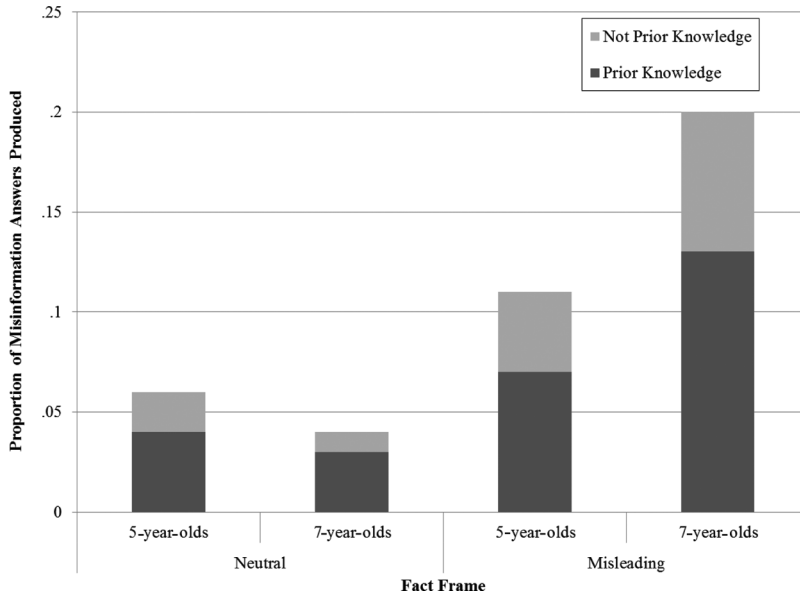


FIGURE 1 Proportion of general knowledge questions answered with misinformation and attributed to prior knowledge (bottom portions of the bars) or not (top portions) as a function of fact framing and age.

($F < 1$) and fact framing ($F < 1$). It is not particularly surprising that younger children claimed prior knowledge for their answers, because story reading did not significantly increase their misinformation production. It is more surprising, however, that older children—who *did* show a significant tendency to learn misinformation from the stories—were equally likely to claim prior knowledge for misinformation answers produced after hearing neutral and misleading references. In other words, older children showed an illusion of prior knowledge: They were just as likely to claim prior knowledge for misinformation answers regardless of whether they had heard them in the stories or not, even though story exposure clearly increased misinformation production.

DISCUSSION

Younger and older children benefited equally from story exposure to correct facts, but older children were more likely to learn and reproduce the misinformation that they heard in the stories. Critically, this developmental reversal in suggestibility occurred regardless of whether the final general knowledge test contained short-answer or multiple-choice questions. That is, older children, not younger children, answered more general knowledge questions with misinformation after hearing the misinformation in the stories, as compared with hearing the neutral references. This result held on the multiple-choice test as well, even though this test always re-presented the correct answer to children and should have been less sensitive to age differences (Ackerman, 1985).

The observed developmental reversal was not due to amnesia for the story source, as predicted by source-monitoring theory. Older children showed superior source discriminability as compared with younger children: they were better able to distinguish between answers that had been presented in the stories and those that had not. However, older children fell prey to a different source error, reproducing story misinformation and attributing that misinformation to prior knowledge (even though the neutral baseline suggests children were unlikely to believe target misinformation prior to the experiment). This illusion of prior knowledge may have contributed to older children's increased suggestibility, in that they were more likely to integrate story information into their knowledge base and in turn accept it as true. This is consistent with recent work showing that older children are better able to integrate across events to create new knowledge (Bauer & San Souci, 2010).

The observed developmental reversal in suggestibility is consistent with fuzzy trace theory (Brainerd & Reyna, 1998), although we believe it is driven by verbatim representations rather than gist (as there was no related meaning to be extracted across critical items). Multiple-choice tests are thought to be especially sensitive to verbatim traces (Brainerd et al., 2008), but in this case, the multiple-choice test pitted verbatim memories for correct information against verbatim memories for story errors. Children did not rely on their verbatim memories for the correct answers to reject the misleading suggestions (Brainerd & Reyna, 2002), as suggestibility was equally robust across the two tests. This result suggests that encountering misleading information can have more powerful effects than simply blocking retrieval of the correct answer on a later production test; rather, children might actually incorporate the misinformation into their knowledge base such that they become more likely to endorse the misleading suggestion even in the presence of the correct answer.

These results have implications for the use of fictional materials in the classroom. Although older children may benefit from story reading, they are also more likely to retain and integrate misinformation from stories into their knowledge base, leading them to reproduce or recognize it on later tests. Therefore, effective use of stories in the classroom should incorporate feedback regarding the accuracy of story information (Butler, Zaromb, Lyle, & Roediger, 2009). In this way, story-reading benefits will be maximized and costs will be reduced.

ACKNOWLEDGMENTS

This research was supported by a collaborative activity award from the James S. McDonnell Foundation to E. J. M. The opinions expressed are those of the authors and do not represent the views of the foundation.

We thank Justina Wong, Andrea Green, Stephani Zakatansky, and Louis Bonacorsi for their help with subject recruitment and data coding, and Amanda Gill for her help with recording sound files. We are grateful to Lisa Fazio for her valuable comments throughout the research process.

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