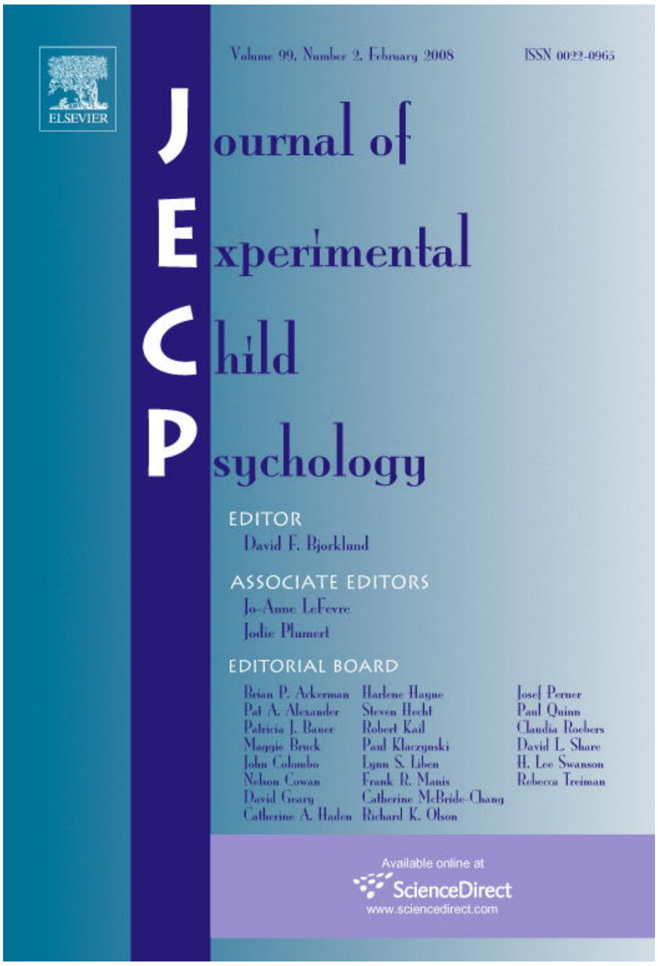
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Rumor mongering and remembering: How rumors originating in children's inferences can affect memory

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Abstract

This study examined how rumors originating in 3- to 6-year-olds' causal inferences can affect their own and their peers' memories for a personally experienced event. This was accomplished by exposing some members of classrooms to contextual clues that were designed to induce inferences about the causes of two unresolved components of the event. After a 1-week delay, a substantial number of children who were exposed to the clues misremembered their inferences as actual experiences. Causal inferential memory errors were most pronounced among 5- and 6-year-olds. Also, many of the children whose classmates were exposed to the clues mistakenly incorporated their classmates' causal inferences into their own accounts, with 3- and 4-year-olds being most likely to make this error.

Keywords: Memory; Suggestibility; Rumor; Inference; Children; Eyewitness testimony

Introduction

Over the past several decades, researchers have focused increased attention on children's memory and suggestibility for their experiences. This attention has been motivated by both an unprecedented involvement of young witnesses in the legal system and a shift in developmental psychology away from assessments of memory in laboratory settings toward a focus on remembering under more naturalistic conditions. This substantial literature has revealed that even though children as young as 3 years of age can provide

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accurate and detailed reports of the past, various suggestive interviewing practices, such as misleading questions (Cassel, Roebers, & Bjorklund, 1996), stereotype induction (Leichtman & Ceci, 1995), and visualization (Ceci, Huffman, Smith, & Loftus, 1994), can lead to serious errors in recall. Notwithstanding the importance of research on suggestive questioning for the effective interviewing of young witnesses (see, e.g., Memon & Bull, 1999; Poole & Lamb, 1998), investigators have directed relatively little attention toward exploring opportunities for memory contamination outside of the formal interview context. Thus, very little is known about the ways in which children's memories can be transformed by suggestions that are encountered during their everyday experiences.

In everyday life, one common way to encounter suggestions is through rumor. Rumors often are generated and transmitted during times of uncertainty or anxiety due to their capacity to explain or relieve ambiguities (Allport & Postman, 1947; Rosnow, 1991). Because rumors have no definite factual basis but are passed along as if they are fact, the potential to encounter false suggestions from rumors is considerable. To explore the effects of rumors on memory, Principe, Kanaya, Ceci, and Singh (2006) had some 3- to 5-year-olds within the same classrooms overhear a conversation in which an adult alleged a fictitious rumor that a certain event had occurred. The remaining children within each classroom did not overhear the adult conversation but had opportunities to interact freely with their classmates who had been exposed to the rumor. A third group of children, who did not have any contact with the first two groups, actually experienced the event suggested by the rumor. When interviewed a week later, nearly all of the children in the first two groups reported experiencing the rumored event. In fact, these children were as likely to report experiencing the rumored event as were those who actually experienced it. These findings show not only that children will spread overheard rumors naturally but also that the circulation of such information can intrude into the memories of children and their peers. Further demonstrating the potency of rumor, the majority of false reports of the rumored event appeared in the children's free recall and nearly all of the children provided a considerable degree of novel embellishment consistent with the theme of the fictitious rumor. In a related investigation, Principe, Tinguely, and Dobkowski (2007) found that the interfering effects of rumor were less powerful among 5- and 6-year-olds, but not 3- and 4-year-olds, when the overheard information conflicted with the past than when it helped to explain an earlier ambiguous event.

Despite the basic and applied relevance of these studies, both center on the effects of rumors planted by adults. The extant literature does not address the influence of rumors generated by children themselves. The purpose of the current investigation, therefore, was to extend the rumor literature by examining whether rumors originating in children's own cognitive processes, rather than those originated by adults, also can contaminate memory. This question was of interest because of a growing attention in the memory literature to "autosuggestibility" (Brainerd & Reyna, 1995), that is, errors in memory that emanate from internal constructive processes in which children's own beliefs, expectations, goals, and so on distort their recollections. It has become clear that there are various types of memory errors that can arise from children's own cognitive activity.

One class of autosuggestion errors that has been widely researched originates from the spread of activation in semantic memory. These errors occur when children wrongly remember being exposed to new material that is consistent with semantic relationships expressed in the original material. For example, after hearing semantically integrated sentences (e.g., "The bird is inside the cage. The cage is under the table."), many children falsely recognized nonpresented sentences that were semantically consistent with the sentences presented (e.g., "The bird is under the table.") (Paris & Carter, 1973; Paris & Lindauer, 1976). Similarly, in the Deese–Roediger–McDermott (DRM) task, in which lists of semantically related words (e.g., *bed*, *rest*, *awake*, *tired*, *dream*) are read aloud, many children later claimed to have heard nonpresented words that are strong semantic associates of the presented words (e.g., *sleep*) (Brainerd, Reyna, & Forrest, 2002; Sugrue & Hayne, 2006).

Another variety of autosuggestion errors takes place when children's schemas (Brewer & Nakamura, 1984) intrude into their recollections of objects, people, and events. These errors occur when children's experiences differ from their existing schemas. For instance, when exposed to actors performing actions that are incongruous with typical gender role schemas (e.g., a man holding a purse), many children later reported the expected genders of the actors rather than the observed ones (Martin & Halverson, 1983). Likewise, when asked to recall the details of a physical examination that excluded some scripted medical procedures (e.g., listening to the heart with a stethoscope), many children subsequently reported expected but omitted procedures (Ornstein et al., 1998).

Although errors arising from the activation of semantic memory and schemas have been studied extensively in children, other types of autosuggestibility that have received little research attention are possible. A few studies in the adult literature show that autosuggestion errors can arise when people make causal inferences as they experience an event and later mistake their inferences for memories of the actual event. For instance, after viewing slide sequences of familiar events (e.g., going grocery shopping) that depicted effects (e.g., oranges on the supermarket floor) but not their causes, many adults wrongly reported seeing slides that showed the most probable causes of the observed effects (e.g., a woman pulling an orange from the bottom of the stack) (Hannigan & Reinitz, 2001). Hannigan and Reinitz (2001) used Johnson and colleagues' (e.g., Johnson, Hashtroudi, & Lindsay, 1993) reality monitoring framework to account for their findings claiming that their participants misattributed the results of their internally generated inferences as arising from the externally experienced slides. This theoretical framework implies that errors arising from causal inferences are due to underlying processes different from those based on semantic memory and schemas. The latter results from the application of existing knowledge, whereas the former arises from the construction of new information during inferential reasoning about an experience. To illustrate, if a person sees oranges scattered on the grocery store floor, he or she might infer that someone took an orange from an unstable area in the pile. The person's script for food shopping would not lead to this inference because this event is atypical for a trip to the supermarket and so would not be contained in the script.

If children commonly engage in causal reasoning as they experience events, then they, like adults, may be vulnerable to causal inference errors. The traditional view of young children assumes that they have little knowledge of causality, largely shaped by Piaget's (1930) characterization of preschoolers as "precausal." However, contemporary investigators working in two different research traditions, one focused on causal knowledge about the world and the other centered on causal inferences in stories and picture sequences, have shown an early understanding of cause and effect in a wide range of contexts. Studies of causal knowledge have found that children as young as 3 and 4 years of age can make important inferences about how physical objects cause each other to move (Gopnik & Sobel, 2000; Nazzi & Gopnik, 2000); how biological entities cause growth, inheritance, and illness (Gelman & Wellman, 1991; Inagaki & Hatano, 1993; Kalish, 1996); and how emotions, desires, and beliefs cause human actions (Flavell, Green, & Flavell, 1995; Gopnik & Wellman, 1994; Perner, 1991). In each of these domains, children in this age range can use formal inductive principles based on their experience to make *new* causal inferences (Gopnik, Sobel, Schulz, & Glymour, 2001; Schulz & Gopnik, 2004). Similarly, investigations of inference making in stories and picture sequences have shown that 3- and 4-year-olds can derive appropriate causal inferences about observed effects, particularly when demands on their memory or verbal skills are minimized or when they are reasoning in familiar domains (Kun, 1978; Schmidt & Paris, 1978). Despite this evidence of young children's understanding of causality, no research to date has examined their ability to make causal inferences about personally experienced events.

One reason for the growing attention toward autosuggestibility is that older children are more prone than younger children to make knowledge-driven errors on a variety of tasks. For instance, false recognition of sentences and pictures that are semantically consistent with previously presented material increases with age (Paris & Carter, 1973; Prawat & Cancelli, 1976; Schmidt, Schmidt, & Tomalis, 1984). Likewise, in the DRM task, mistaken reports of nonpresented but semantically related words rise developmentally (Brainerd, Holliday, & Reyna, 2004; Brainerd et al., 2002; Dewhurst & Robinson, 2004; Howe, Cicchetti, Toth, & Cerrito, 2004). Even in traditional misinformation paradigms, older children are more likely than younger children to falsely recognize semantically related distractors whenever the distance between a critical item and its distractor is more closely represented in semantic space by older children than by younger children (Ceci, Papierno, & Kulkofsky, 2007). Script-based intrusions also increase developmentally. In Ornstein and colleagues' (1998) study described above, 6-year-olds were more likely than 4-year-olds to wrongly recall expected but nonexperienced medical procedures. A reverse age trend also has been observed on tasks that involve the scripting of new events. Connolly and Price (2006) found that after experiencing four similar versions of a novel event, 6- and 7-year-olds were more likely than 4- and 5-year-olds to erroneously report suggestions that were semantically consistent with details that varied with each instantiation of the event.

Admittedly, a developmental increase in autosuggestion errors might seem counterintuitive because dozens of studies in the suggestibility literature that have shown that younger children generally are more prone than older children to make false reports following exposure to misleading information (for reviews, see Bruck & Ceci, 1999; Holliday, Reyna, & Hayes, 2002). However, given the richer knowledge representations of older children relative to younger children in most, if not all, domains (Bjorklund, 1987; Fivush, 1997), a reverse development trend in interference from knowledge should be expected on empirical grounds. For instance, because older children have more extensive semantic networks than do younger children, the DRM items should induce greater activation of semantically related words, thereby increasing the chance that semantic associates become confused with original words. Similarly, because scripts become more complex and quickly established with age, older children should show more intrusions of anticipated but nonexperienced components of a familiar event.

Developmental work in the inference literature suggests that causal inferential errors also might exhibit a reverse age trend. Although most studies of causal inference have focused on children in the 5- to 11-year age range, the limited literature on younger children suggests an important developmental shift in causal reasoning between 3 and 5 years of age. For instance, when asked to judge the cause of novel events, 5-year-olds can make use of the abstract causal reasoning principle of temporal priority (i.e., that causes precede their effects), whereas 3-year-olds simply apply their knowledge of similar past events (Sophian & Huber, 1984). Similarly, 5-year-olds, but not 3-year-olds, are able to articulate their use of temporal priority as a basis for their inferences about cause and effect (Bullock & Gelman, 1979). Age differences between 3- and 4-year-olds and older children also are apparent on tasks assessing the use of other important causal reasoning principles such as covariation (i.e., causes and their effects covary) (Shultz & Mendelson, 1975) and contiguity (i.e., causes and their effects might be contiguous in place and time) (Mendelson & Shultz, 1976). When directed to make inferences, 5-year-olds, but not 4-year-olds, readily infer the causes of events depicted in simple pictorial sequences (Schmidt & Paris, 1978). When 4-year-olds do make causal inferences about event sequences, their inferences tend to be less relevant to the story line than do those made by older children (Thompson & Myers, 1985). Likewise, when asked to recall pictorial sequences that include causally related scenes, 6-year-olds are much more likely than 4-year-olds to spontaneously report probable causes of observed effects (Poulsen, Kintsch, Kintsch, & Premack, 1979). Schmidt and Paris (1978) and others (e.g., Brown & French, 1976) have attributed these age effects to an inability among children age 4 years or younger to reverse causal sequences and run through them backward to infer causes from earlier observed effects. Furthermore, there is some evidence that children age 4 years or younger generally are less aware than older children of even *observed* causal relations within an event. When asked to recall televised sequences, 6-year-olds were much more likely than 4-year-olds to recall components that contributed to the causal structure of the observed sequences (van den Broek, Lorch, & Thurlow, 1996). Thus, because causal inference errors depend on the ready generation of relevant cause and effect inferences, the observed age trends in these various strands of research would suggest a developmental increase in causal inference errors at around 5 or 6 years of age.

In addition to exploring how children's inferences can become confused with and intrude into their own memories of a personal experience, of interest in the current study is whether children's inferences also can make their way into their peers' reports when children are given opportunities to interact naturally. This question extends Principe and colleagues' (2006) demonstration that children's reports can be degraded when exposed to peers who overheard a false rumor from an adult by exploring whether children's accounts will be contaminated similarly when exposed to peers who have generated their own rumors. This is an important extension of Principe and colleagues' data because although much is known about how adults can induce errors in children's recollections, little is understood about how children themselves can affect other children's recall.

The current study

With these issues in mind, there were four major purposes in the current study. The first was to demonstrate a new type of autosuggestibility among 3- to 6-year-olds based on their causal inferences about an experienced event. The children were induced to make inferences by exposing them to clues that suggested probable causes for previously experienced effects within a complex and naturalistic event. Causal inference errors were examined by asking children to recall the event, and of interest was the extent to which they would make false reports in line with the probable causes suggested by the clues. The second purpose was to explore whether those children who derived causal inferences from the clues might share this information with their peers naturally and whether this transmission of information might leak into peers' reports. Given children's well-established tendency to mistake self-generated (e.g., imagined) memories as real more readily than they mistake other-generated memories as real (Foley, Santini, & Sopasakis, 1989; Lindsay, Johnson, & Kwon, 1991), the children who saw the clues were expected to make more reports of nonexperienced events implied by the clues than were their peers. The third purpose was to explore the quantity and quality of the narratives provided by the children who mistakenly reported experiencing occurrences suggested by the clues. Several studies have shown that false reports induced by external sources, such as misleading interviews (Bruck, Ceci, & Hembrooke, 2002) or overheard rumors (Principe et al., 2006), can be surprisingly detailed. Unknown is whether internal autosuggestive sources, such as causal inference, also might lead to elaborate false accounts. Despite the expectation of some degree of narrative elaboration among those who make causal inference errors, the false reports of these children's peers were expected to be more elaborate given that their explanations for the experienced effects would originate in freely varying rumors, whereas the explanations of those making causal inference errors would originate in controlled experimenter-provided clues. The final purpose was to explore age differences. Based on developmental improvements in causal inferencing, age differences in causal inference errors were predicted. Age differences in children's narratives also were expected given the well-established finding that narratives about experienced events generally become increasingly voluminous with age (e.g., Fivush, Haden, & Adam, 1995; McCabe & Peterson, 1991). Although it is unknown whether false narratives also become more elaborate with age, when children believe their false reports to be true (as would be the case with causal inference errors), there is every reason to suspect that older children would produce longer narratives than would younger children. Furthermore, given that children generally become increasingly resistant to the suggestions of others with age (for reviews, see Bruck & Ceci, 1999; Holliday et al., 2002), younger children who were exposed to the clues only via their peers' inferences were expected to make more false reports than were older children.

Method

Participants

Participants were 114 children divided into two age groups: younger children (3- and 4-year-olds) and older children (5- and 6-year-olds). There were 56 younger children (30 girls and 26 boys, mean age = 50 months, range = 40–59) and 48 older children (26 girls and 22 boys, mean age = 74 months, range = 60–83). The children were recruited from suburban preschools and summer day camps in southeastern Pennsylvania. Reflecting the population of these programs, 95% of the children were European American. Written consent and verbal assent were obtained from all participating parents and children, respectively.

Experimental design

Within each age group, the children were assigned to one of three rumor groups: Clue, Classmate, or Control. The six groups formed by the combination of age and rumor group ranged in size from 20 to 24, and the number of females in each group ranged from 13 to 16. Each school ($N = 10$) was randomly assigned to rumor condition (i.e., Clue vs. Control or Classmate vs. Control), and the children within each experimental school were randomly assigned to either the Clue or Classmate condition. Of the 10 participating schools, 6 were assigned to the Clue or Classmate condition and 4 were assigned to the Control condition.

Procedure

The children were seen during two sessions, each of which took place in a room other than their regular classrooms at their schools. The sessions were separated by an interval of approximately 1 week (mean = 7 days, range = 5–9), and 95% of the children were interviewed exactly 7 days after the magic show. The interviews were videotaped.

The to-be-remembered event

Following Principe and colleagues' (2006) procedure, each classroom was visited by a magician, named Magic Mumfry, who performed a scripted magic show. During the show, Mumfry failed at two tricks: pulling a live rabbit out of his top hat and producing a baked cake from a mixture of real ingredients put into a cake pan. For the rabbit trick, Mumfry reached into his hat several different times, using various "magic" words (e.g., *presto*, *abracadabra*), but gave up after three failed attempts. For the cake trick, after placing real eggs, sugar, milk, and flour into a cake pan, Mumfry put a lid on top of the pan and promised a fully baked cake. However, when Mumfry opened the lid, the cake pan was empty.

To generate the rumors, the children in the Clue condition were exposed to two sets of clues: carrot ends with "teeth marks" and a plate with cake crumbs and a dirty fork. It was expected that the carrot and cake clues would induce two inferences (hereafter referred to as target activities): one about the cause of the failed hat trick (i.e., the rabbit got loose in the school) and one about the cause of the vanished cake (i.e., someone ate the cake). To investigate whether these children would propagate their inferences about the escaped rabbit and the eaten cake to peers naturally, the children in the Classmate condition were the classmates of those in the Clue group but were not exposed to the clues. This was accomplished by having all of the children form a line to pick out a sticker, with the Clue children being ahead of the Classmate children. As the Clue children received their stickers, they individually walked back to their classrooms. During the magic show and out of sight of the children, the two sets of clues were placed in prominent locations on the route that the children took back to their classrooms. Exposure to the clues was ensured by a confederate who surreptitiously watched the children return to their classrooms and noted that all of the children reacted verbally or behaviorally to both the carrot ends and the crumbs on the plate. Once all of the Clue children returned to their classrooms, the confederate closed the classroom door and removed the clues, thereby preventing the Classmate children from directly observing the clues during their walk back to their classrooms. The remaining children in the Control condition, who were drawn from schools different from those of the Clue and Classmate children, did not have any opportunities to interact with those who saw the clues, nor did they see the clues themselves. Consistent with Principe and colleagues' (2006) procedures, teachers and parents were instructed to refrain from discussing or answering any questions about the magic show and the clues.

Memory interview

After a 1-week delay, a condition-unaware interviewer (the second or third author or one of three trained advanced undergraduate assistants) questioned all of the children about the magic show. The interview was structured hierarchically and involved five levels of questions: (a) open-ended, (b) specific, (c) witness, (d) countersuggestion, and (e) peer conformity. The children were told to report ''only about things that you remember happening to you—things that you really did or remember seeing with your own eyes.'' The interview began with an open-ended question: ''I'd like you to tell me everything that you remember about the day that Magic Mumfry visited your school. I wasn't there that day, so I don't know what happened. Don't guess or make anything up. Just tell me what you did or saw the time that Magic Mumfry came to your school. Start with the first thing that happened and tell me everything that you can, even things that you don't think are very important.'' Additional open-ended prompts were asked (e.g., ''What else happened?'') until the children's free recall was exhausted. Next, target activities that were not reported at the open-ended level were queried with specific probes: ''Did anything happen to Mumfry's rabbit [Mumfry's cake]?'' General prompts (e.g., ''tell me more'') were used to encourage the children to elaborate on each target activity mentioned in response to an open-ended or specific question.

For each target activity nominated at the open-ended or specific level, the children were asked whether they saw that activity with their own eyes. These questions, referred to as the witness questions, asked, ''Did you see [activity vis-à-vis the loose rabbit or the eaten cake as noted by the child, e.g., *your teacher eat the cake*] with your own eyes?'' Then, for each target activity that the children reported seeing, a countersuggestion that insinuated they had *not* actually witnessed the target activity was posed: ''You really didn't see [action vis-à-vis the loose rabbit or the eaten cake as noted by the child, e.g., *the rabbit running around in your school*], did you?''

For each target activity *not* nominated at the open-ended or specific level, the children were asked a question that suggested some of their classmates already had reported a loose rabbit or an eaten cake. These probes, referred to as the peer conformity questions, asked, ''Some of your friends told me that Mumfry couldn't pull the rabbit out of his hat because the rabbit got loose in your school [Mumfry couldn't find his cake in the pan because someone had eaten the cake]. Now it's your turn to tell. Did that happen?'' Two comparable interview protocols that differed in the order in which the children were asked questions about the rabbit or the cake were used.

Coding of the interviews

The interviews were transcribed verbatim from the videotapes. First, the interviews were coded to specify the target activities reported (i.e., a loose rabbit in the school and someone eating the cake) and the specificity of questioning necessary to elicit the information (i.e., open-ended, specific, or peer conformity). Next, when asked, the children's responses to the witness questions and countersuggestions were scored. Then, the children's narrative responses to both open-ended and specific questions about the target activities were broken down into propositions for coding. Propositions were not coded separately for each target activity because many of the children blended their descriptions of the two target activities in their narrative responses, for example, recounting that Mumfry's rabbit ate the missing cake. Following Fivush and colleagues' (1995) definition, a proposition was defined as a clause containing a subject and a verb, either explicit or implied, that had not been mentioned previously by either the interviewer or the child. Examples of propositions included "the bunny rabbit it was sleeping," "the bunny laid all the carrots down," and "he [the rabbit] bite my finger."

Then, propositions regarding the target activities were parsed into one of three categories: Inferences, Inventions, or Inconsistencies. Propositions were coded as Inferences if they involved inferences that could be derived logically from the clues that were witnessed by the children in the Clue condition, for example, "the bunny was munching on carrots" and "somebody ate the whole cake." Inventions were statements that were consistent with the notions of a loose rabbit or someone eating the missing cake but that went beyond inferences that could be derived from the clues, for example, "the bunny hid under the slide" and "I saw Mrs. Ross eating the cake." Inconsistencies were descriptions of events that were inconsistent with the clues or that could not have happened in reality, for example, "the bunny drove his family to my house" and "Sponge Bob took it [the cake] home."

Of the 114 interviews coded, 20% ($n = 24$) were coded independently by two condition-unaware judges and checked for interrater reliability. Interrater agreement as measured by kappa was excellent, ranging from .93 to 1 for all codes. The few coding discrepancies were mainly oversights that were resolved through discussion.

Results

Preliminary analyses

Preliminary analyses indicated no effects in the dependent variables discussed below as a function of the particular confederate who played the role of Mumfry, the order of questioning during the interview, the individual who served as interviewer, the delay interval between the magic show and the interview, gender, or ethnicity. In addition, within each of the three groups, there were no effects of school. Furthermore, there were no differences in delay interval, gender, ethnicity, or age in months as a function of school.

Reporting the target activities

Total recall

The proportions of target activities (i.e., that the rabbit was loose in the school and that someone ate the cake) reported by the children are shown in Table 1 as a function of age, rumor condition, and level of recall: open-ended, specific, or total (i.e., open-ended plus specific). A 2 (Age: 3- and 4-year-olds vs. 5- and 6-year-olds) × 3 (Rumor Condition: Clue vs. Classmate vs. Control) analysis of variance (ANOVA) run on total recall of target activities indicated a main effect of rumor condition on the children's total recall of the target activities, $F(2, 103) = 27.36$, $p < .0001$, $\phi = .22$. Preplanned contrasts indicated that the children in the Clue condition ($M = .69$, $SD = .36$) reported a higher proportion of target activities than did those in the Classmate condition ($M = .43$, $SD = .38$), who in

Table 1
Mean proportions of target activities reported as a function of age, rumor condition, and level of recall

	n	Open-ended	Specific	Total
3- and 4-year-olds				
Clue	17	.24 (.31)	.38 (.35)	.62 (.33)
Classmate	20	.33 (.37)	.15 (.26)	.48 (.39)
Control	19	.03 (.11)	.09 (.24)	.11 (.27)
5- and 6-year-olds				
Clue	14	.54 (.41)	.25 (.38)	.79 (.38)
Classmate	16	.19 (.25)	.19 (.25)	.38 (.34)
Control	18	.03 (.12)	.09 (.19)	.11 (.21)

Note. Standard deviations are in parentheses.

turn reported more target activities than did those in the Control condition ($M = .11$, $SD = .24$), Fs(1, 103) $\geqslant$11.58, ps < .001, ϕs $\geqslant$ .11. There were no age differences in total recall.

Open-ended recall

A common assumption in the literature on event memory is that children's open-ended recall is highly accurate in the absence of exposure to suggestive questioning (e.g., Fivush, 2002). As such, it was of interest to explore the extent to which the clue manipulation led to errors in the children's open-ended accounts. As seen in Table 1, there was a main effect of rumor condition, $F(2, 103) = 14.12$, $p < .001$, $\phi = .13$, that was qualified by a significant Age × Rumor Condition interaction, $F(2, 103) = 5.09$, $p < .01$, $\phi = .05$. To explore this interaction, the effect of rumor condition was examined separately for younger and older children. Among the younger children, differences by rumor condition emerged, $F(2, 55) = 5.42$, $p < .01$, $\phi = .09$. Contrasts indicated that the younger children in the Clue and Classmate conditions, who did not differ from one another, reported a higher proportion of target activities following open-ended questions than did those in the Control condition, Fs(1, 55) $\geqslant$ 4.68, ps < .05, ϕs $\geqslant$ .08. Follow-up tests among the older children indicated an effect of rumor condition, $F(2, 47) = 13.70$, $p < .001$, $\phi = .23$, such that those in the Clue group reported proportionately more target activities than did those in the Classmate and Control groups, Fs(1, 47) $\geqslant$ 11.96, ps $\leqslant$ .01, ϕs $\geqslant$ .21, who did not differ significantly from one another. Given expected age differences in causal inference errors, the effect of age was analyzed separately for each rumor condition. Older Clue children reported a higher proportion of target activities in response to open-ended questions than did younger Clue children, $F(1, 30) = 5.30$, $p < .05$, $\phi = .15$. There were no age differences among the children in the Classmate and Control conditions.

Seeing the target activities

Table 2 shows the proportions of target activities reported at the open-ended and specific levels of questioning that the children recalled as actually witnessed with their own eyes in response to the witness questions and the proportions of witnessed target activities

Table 2
Mean proportions of target activities reported as actually witnessed following the witness questions and countersuggestions as a function of age and rumor condition

	n	Witness questions	Countersuggestions
3- and 4-year-olds			
Clue	17	.32 (.39)	.12 (.22)
Classmate	20	.35 (.37)	.25 (.34)
Control	19	.08 (.19)	.03 (.11)
5- and 6-year-olds			
Clue	14	.46 (.41)	.32 (.37)
Classmate	16	.13 (.22)	.09 (.20)
Control	18	.03 (.12)	.03 (.12)

Note. Standard deviations are in parentheses.

that continued to be reported as witnessed following countersuggestions. Analyses of the witness questions, displayed in the first column, indicated that the main effect of rumor condition, $F(2, 103) = 10.86$, $p < .0001$, $\phi = .10$, was qualified by a significant Age × Rumor Condition interaction, $F(2, 103) = 3.04$, $p < .05$, $\phi = .03$. The effect of rumor condition was examined separately for younger and older children. There was an effect of rumor condition for the younger children, $F(2, 55) = 3.98$, $p < .05$, $\phi = .07$, such that those in the Clue and Classmate conditions, who did not differ from one another, were more likely to report witnessing the target activities than were those in the Control condition, Fs(1, 55) = 5.37, ps < .05, ϕs ⩾ .09. Rumor condition differences also were found among the older children, $F(2, 47) = 11.15$, $p < .0001$, $\phi = .20$, with contrasts indicating that those in the Clue group were more likely to recall witnessing the target activities than were those in the Classmate and Control groups, Fs(2, 47) = 12.02, ps ⩽ .001, ϕs ⩾ .21, who did not differ from one another. Given expected age differences, again, the effect of age was analyzed separately for each rumor condition. Younger Classmate children reported witnessing a higher proportion of target activities than did older Classmate children, $F(1, 35) = 4.64$, $p < .05$, $\phi = .12$. Older and younger Clue and Control children did not differ from one another.

Analysis of the children's responses to the countersuggestions, shown in the second column of Table 2, indicated a main effect of rumor condition, $F(2, 103) = 5.80$, $p < .01$, $\phi = .06$, qualified by a significant Age × Rumor Condition interaction, $F(2, 103) = 4.44$, $p < .05$, $\phi = .04$. Rumor condition differences emerged among the younger children, $F(2, 55) = 4.03$, $p < .05$, $\phi = .07$, with contrasts indicating that those in the Classmate condition were more likely to maintain that they had witnessed target activities following countersuggestions than were those in the Control condition, $F(1, 55) = 7.95$, $p < .01$, $\phi = .13$. The younger Clue children did not differ from those in either the Classmate or Control group. Follow-up tests revealed an effect of rumor condition for the older children, $F(2, 47) = 6.12$, $p < .01$, $\phi = .12$, such that those in the Clue group were more likely to persist in their reports of witnessing target activities in response to countersuggestions than were those in the Classmate and Control groups, Fs(2, 47) = 6.57, ps ⩽ .01, ϕs ⩾ .13, who did not differ from one another. Although the younger Classmate children approached significance relative to the older Classmate children, $F(2, 35) = 3.13$, $p = .09$, $\phi = .08$, there were no significant age differences within the Clue and Control groups.

Responses to peer pressure questions

To explore the extent to which the children who did not report one or both of the target activities in response to open-ended or specific questions (i.e., initial denials) later acquiesced when confronted with peer pressure questions, the rate of change from initial denials of target activities (i.e., the number of target activities not reported in response to open-ended or specific questions) to subsequent assents (i.e., the number of *yes* responses) following peer conformity questions was calculated for each of the three rumor conditions and two age groups and subjected to ANOVAs. Note that these ANOVAs included only those children who had not already reported one or both of the target activities in response to open-ended or specific probes. Table 3 lists the numbers of children's responses that were initial denials, the numbers of subsequent assents in response to peer pressure questions, and the rates of change from initial denials to assents following peer conformity questions (number of subsequent assents divided by number of initial denials). Thus, the maximum value for the first column ranged from 62 to 74 (number of children in each rumor condition times two target activities). As can be inferred from the data presented in the far right column, there was a main effect of condition in children's rates of change from initial denials of target activities to subsequent assents in response to peer conformity questions, $F(2, 124) = 8.94$, $p < .001$, $\phi = .07$. Specifically, the rates of change for children in the Clue condition ($M = .94$, $SD = .24$) and Classmate condition ($M = .73$, $SD = .45$), who did not differ from one another, were significantly higher than those for children in the Control condition ($M = .48$, $SD = .50$), Fs$(1, 124) \geqslant 7.79$, ps $\leqslant .01$, ϕs $\geqslant .06$. Also, younger Control children had higher rates of change than did older Control children, $F(1, 65) = 5.91$, $p < .05$, $\phi = .05$.

Narratives describing the target activities

The proposition coding scheme described earlier was used to characterize the children's narrative accounts of the target activities. Narratives were coded for the subset of children who reported at least one target activity at the open-ended or specific level of questioning. Table 4 shows the average numbers of propositions coded as Inferences, Inventions, and Inconsistencies by age and rumor condition, accompanied by the *n*s on which the means are based. As can be seen in the last column, the Clue and Classmate children provided a

Table 3
Total numbers of initial denials of target activities, total numbers of assents to peer conformity questions, and rates of change from initial denials to assents as a function of age and rumor condition

	Initial denials	Assents	Rates of change
3- and 4-year-olds			
Clue	12	11	.91 (.29)
Classmate	21	17	.81 (.40)
Control	34	21	.62 (.49)
5- and 6-year-olds			
Clue	6	6	1.00 (.00)
Classmate	20	13	.65 (.49)
Control	32	11	.34 (.48)

Note. Standard deviations are in parentheses.

Table 4
Mean numbers of propositions reported about the target activity as a function of age and rumor condition

	n	Inferences	Inventions	Inconsistencies	Total
3- and 4-year-olds					
Clue	14	1.14 (1.10)	3.21 (2.26)	1.21 (1.89)	5.57 (3.63)
Classmate	13	0.23 (0.44)	5.77 (4.34)	3.62 (3.28)	9.62 (5.77)
Control	3	0.00 (0.00)	0.67 (1.54)	1.33 (1.53)	2.00 (1.00)
5- and 6-year-olds					
Clue	12	2.00 (1.54)	8.83 (3.71)	1.00 (2.89)	11.83 (5.94)
Classmate	10	0.80 (0.91)	14.30 (7.83)	0.70 (1.50)	15.80 (8.14)
Control	4	0.00 (0.00)	1.50 (0.57)	2.00 (2.45)	3.50 (2.38)

Note. Standard deviations are in parentheses.

considerable amount of narrative detail about the target activities. To illustrate, consider the following excerpts: "I saw him [the rabbit] bounce and bouncing. He goed away from me because he doesn't like strange creatures."; and "I heared somebody going near her [the person who ate the cake], and then he [the rabbit] snuck up on her and took all the cake and then went to his house and ate it all up. Actually, then I knew I looked at all the trails and I make it to his house and saw him eating it, then I attacked him."

To evaluate group and age differences statistically, a 2 (Age: younger vs. older) × 2 (Rumor Condition: Clue vs. Classmate) ANOVA was carried out on the total number of propositions for the subset of children who reported one or both of the target activities. The Control children were dropped from this analysis because of the small numbers of children in this condition who reported a target activity at the open-ended or specific level of questioning. There was a main effect of age on the total number of propositions, $F(1, 48) = 13.53$, $p < .001$, $\phi = .23$, with the older children ($M = 12.08$, $SD = 7.57$) providing more voluminous narratives about the target activities than the younger children ($M = 6.97$, $SD = 5.13$). There was also a main effect of rumor condition, $F(1, 48) = 5.60$, $p < .05$, $\phi = .11$, indicating that the Classmate children ($M = 12.30$, $SD = 7.42$) provided more detailed narratives than did the Clue children ($M = 8.46$, $SD = 5.70$).

However, the rumor condition effect disappeared when only the subset of children in the Clue and Classmate conditions who reported that they actually saw at least one of the target activities were considered ($n = 18$, $M = 10.22$, $SD = 5.81$, and $n = 17$, $M = 13.11$, $SD = 8.30$, respectively), indicating that the driving force behind narrative length was not the source of the rumor (i.e., self vs. other) but rather whether or not the children actually believed that they had witnessed the loose rabbit with their own eyes. Supporting this interpretation is the finding that those Clue and Classmate children who recalled actually seeing at least one of the target activities ($n = 35$, $M = 11.63$, $SD = 7.17$) produced more elaborate narratives than did those who reported not seeing either target activity ($n = 14$, $M = 6.86$, $SD = 4.19$). A 2 (Age: younger vs. older) × 2 (Group: reported seeing at least one target activity vs. reported not seeing either target activity) ANOVA confirmed a main effect of group, $F(1, 48) = 7.07$, $p = .01$, $\phi = .14$. The effect of age remained significant within this subset of children (younger: $n = 27$, $M = 7.52$, $SD = 5.12$; older: $n = 22$, $M = 13.64$, $SD = 7.14$), $F(1, 48) = 14.08$, $p < .01$, $\phi = .13$.

To explore the content of children's narratives in more depth, separate analyses were conducted on the mean numbers of Inferences, Inventions, and Inconsistencies among the Clue and Classmate children. For Inferences, there was a main effect of age, $F(1, 48) = 5.35$, $p < .05$, $\phi = .11$, with the older children ($M = 1.23$, $SD = 1.39$) reporting more Inferences than the younger children ($M = 0.63$, $SD = 0.93$). There was also a main effect of group, $F(1, 48) = 11.75$, $p < .01$, $\phi = .21$, with the Clue children ($M = 1.54$, $SD = 1.36$) providing more Inferences than the Classmate children ($M = 0.48$, $SD = 0.73$). The analysis of Inventions revealed a similar pattern for age, $F(1, 48) = 27.59$, $p < .0001$, $\phi = .38$, such that the older children ($M = 9.81$, $SD = 6.91$) provided more Inventions than did the younger children ($M = 4.07$, $SD = 3.55$). In contrast to the findings with Inferences, the Classmate children ($M = 9.48$, $SD = 7.32$) were more likely to generate Inventions than were the Clue children ($M = 5.81$, $SD = 4.11$), $F(1, 48) = 8.87$, $p < .01$, $\phi = .17$. Finally, for Inconsistencies, a main effect of age, $F(1, 48) = 4.12$, $p < .05$, $\phi = .09$, indicated that the younger children ($M = 2.27$, $SD = 2.77$) provided more Inconsistencies than did the older children ($M = 1.04$, $SD = 2.32$). However, there was no group effect for Inconsistencies, indicating that age, rather than group, was the driving force behind Inconsistencies.

Discussion

The results of the current study demonstrate that children engage in causal reasoning when they experience events and that the results of these reasoning processes can be mistaken for their previous experiences. Previous work found that the activation of semantic knowledge and the application of schemas can lead to autosuggestion errors in children (e.g., Ornstein et al., 1998; Poulsen et al., 1979). The current research shows that autosuggestion errors also can result from causal inferential reasoning. After viewing contextual cues that implied the cause of an earlier observed event, children as young as 3 and 4 years of age were able to derive plausible inferences, and many later mistook their inferences as memories for the observed event. Causal inference errors, however, were more pronounced among the 5- and 6-year-olds, who exhibited more intrusions of inferences during free recall and recounted nonexperienced but inferred events with more extensive narrative detail than did the younger children. Furthermore, children who made causal inferences propagated this information to their peers naturally. The spread of inferred information was particularly potent among the 3- and 4-year-olds, who were more likely than the older children to report actually seeing events that their peers merely inferred. These data extend work by Principe and colleagues (2006) by demonstrating that rumors originating in children's own reasoning processes, rather than those planted by adults, can contaminate both their own and their peers' memory for a past event.

Effects of inferences on memory

Admittedly, it is not surprising that the Clue children generated appropriate inferences because the clues were designed to impose previously lacking and reasonable causes for the magician's failed tricks. These findings replicate previous studies that showed that children as young 3 years of age can make inferences about the causes of observed events (e.g., Bullock & Gelman, 1979; Sophian & Huber, 1984). The extant literature, however, is limited to situations in which children are asked to make causal judgments in the service of a laboratory task, for example, deciding whether a toy engine or a caboose made a certain train car move or whether a child in a story got to school by bus or by car. The current study extends this literature to a different, more naturalistic context by showing that children derive causal inferences about their everyday experiences naturally even when they are not explicitly instructed to do so. Furthermore, the Clue group's errors are the first demonstration that causal inferences can give rise to memory errors in children. As alluded to above, this type of autosuggestibility is not due to the activation of knowledge structures as are both semantic memory- and schema-based errors. In fact, knowledge representing typical events might not even play a role in causal inference errors in event memory. Even though most children presumably have a magic show script, a loose rabbit and an eaten cake would not be contained in the script because both are atypical for a magic show. Thus, the Clue children's reports of a loose rabbit and an eaten cake could not have been due to the activation of existing magic show knowledge but rather occurred because the children inferred probable causes (e.g., the rabbit got loose in the school and someone ate the cake) from observed effects (e.g., eaten carrot tops and cake crumbs and a dirty fork left on a plate) and subsequently misremembered the results of their inferential processes as experienced previously. Furthermore, although causal inference errors have been observed in adults (Hannigan & Reinitz, 2001, 2003), these demonstrations have been limited to false recognition of "cause" slides that represented the most likely cause for a pictorially depicted event and have not yet been shown in event recall. Thus, the current findings extend the autosuggestibility literature by revealing that causal inference errors are not restricted to laboratory materials and recognition procedures but rather can occur in free recall of actually experienced events.

Consistent with the reverse developmental trend frequently observed in other types of autosuggestion errors (Brainerd et al., 2002; Ornstein et al., 1998), the older children were particularly affected by their own inferences. They were more likely than the younger children to mistakenly report their inferences during free recall, and they provided nearly double the elaborative detail (i.e., the total number of propositions) in their descriptions of the target activities. Despite the strong contextual support that the clues provided for the generation of relevant inferences, findings in the inferencing literature that children under 5 years of age often cannot infer the causes of observed events (Poulsen et al., 1979; Schmidt & Paris, 1978) would suggest that the younger children had difficulty in using the clues to infer causes for the failed tricks. In contrast, assuming that the older children made appropriate inferences more readily, they likely had created for themselves more opportunities to make causal inference errors. In support of the older children's more advanced inferential skills as the source of the observed age differences is the breakdown of the content of the children's accounts. Compared with the younger children, the older children imported more logical inferences based on the clues and more often elaborated on their inferences in a rational and logical manner. Thus, not only did the older children provide a greater amount of elaboration than the younger children, but also their boost in elaboration was not due to an increase in unrelated or idiosyncratic detail; rather, it was due to the fact that they constructed a greater number of logical inferences. In contrast, and consistent with prior work (Paris & Upton, 1976; Schmidt & Paris, 1983), the younger children were more likely than the older children to recount irrelevant, illogical, or even impossible details about the target activities. Given that finders of fact seem to view detail as diagnostic of accuracy (Lamb, Sternberg, Esplin, Hershkowitz, & Orbach, 1997; Leichtman & Ceci, 1995), these findings have some applied relevance in that they suggest that when conditions are ripe for causal inferences, older children may be more prone to construct false reports that are more compelling or believable than those produced by younger children.

A related factor that likely led to the boost in false reports of target activities among the older Clue children was their more detailed memories of their inferences relative to those of the younger Clue children. According to the reality monitoring framework (Johnson et al., 1993), individuals use the quality of their memories to make decisions about source. Memories rich in detail tend to be attributed to actual experiences, whereas memories lacking in detail often are judged as internally generated (Johnson, Foley, Suengas, & Raye, 1988). Assuming that verbal reports reflect the underlying representation, the older Clue children's more detailed memories of the target activities likely made them more prone than the younger children to mistake these inferences for actual experiences. Furthermore, the finding that the subset of children who reported actually seeing at least one target activity generated more voluminous accounts than did those who denied seeing either of the target activities is consistent with the notion that a highly detailed representation of the target activities was associated with increased causal inference errors. Thus, when memories for inferred events contain much elaborative detail, children may be at heightened risk for mistaking them for real experiences.

Effects of peers on memory

In line with Principe and colleagues' (2006) findings, the current results provide evidence that rumors spread among peers can intrude into children's recollections. However, whereas Principe and colleagues focused on the effects of rumors planted by adults, the current research centered on the influence of rumors originated by children themselves without any exposure to suggestions from adults. Notably, the children in the current study were not instructed to share their inferences with their peers; rather, they spread their inferences naturally in such a manner that affected the subsequent memory reports of their peers. Within both age groups, exposure to peers inflated the children's total recall of target activities relative to the Control group. This increase, however, was not as great as that observed in the Clue group, suggesting that the children generally were more influenced by their own conclusions about the failed tricks than by those of their peers. Indeed, this rationale is consistent with findings in the source monitoring literature that internally generated events are more easily confused with one's own personal experiences than are externally suggested events (e.g., Lindsay et al., 1991).

Further evidencing the potency of peers, despite the lower levels of reports of target activities in the Classmate group relative to the Clue group, children at both ages evidenced a boost in elaborative detail in the Classmate group relative to the Clue group. This finding is consistent with Principe and colleagues (2006) and provides additional evidence that children may be especially likely to embellish information picked up from peers. A breakdown of the content of children's narratives shows that the boost in elaboration for the Classmate children was not due to an increase in fantastic or idiosyncratic embellishments; rather, it was due mainly to an increase in propositions that were consistent with the notions of a loose rabbit or someone eating the missing cake but went beyond inferences that could be derived directly from the clues. Perhaps because the Classmate children did not see the clues themselves but rather based their reports on their peers' stories about the causes of the failed tricks, they were less limited than the Clue children to describing the simple inferences implied by the clues.

Despite some influence of peers among both age groups, the effects of peer-generated misinformation were especially strong among the younger children. Compared with the Control children, only the younger Classmate children made more errors during open-ended recall and showed an increase in reports of actually witnessing the target activities. It is noteworthy that the higher rates of open-ended causal inference errors among the older Clue children compared with the younger Clue children did not translate into a similar age pattern for these two measures, particularly because both of these errors reflect a strong degree of conviction that the target activities actually occurred. Nonetheless, the heightened levels of open-ended errors and claims of personally witnessing the target activities among the younger children are consistent with the usual trend in the suggestibility literature that false reports following exposure to external misinformation decrease with age. Given that the source of erroneous reports among the Classmate children was external (i.e., classmates), the observed age trend would be expected on empirical grounds. Thus, in line with both the autosuggestibility and suggestibility literatures, internally generated inferences were particularly damaging to older children, whereas externally suggested inferences were especially harmful to younger children.

Further demonstrating the impact of peers is the finding that the majority of children in the Clue and Classmate conditions who failed to recall a loose rabbit or an eaten cake acquiesced to these activities when told that their friends already had reported these activities. Principe and Ceci (2002) showed that these sorts of cues can elicit false reports of events witnessed by children's peers. The current findings extend this work by demonstrating that peer pressure can increase false reports of events that never were witnessed but merely were inferred by children or their peers.

Implications and conclusions

The findings of this study reveal two very different but powerful sources of memory errors, namely, children's own causal inferences and natural discussions with peers. The relevance of these errors to legal settings is that neither type would be reduced by techniques currently used (e.g., exclusive nonsuggestive questioning, videotaping interviews) to elicit testimony from children. The reverse developmental trend observed in causal inference errors has considerable significance in the forensic realm because it suggests that, at least among 5- and 6-year-olds, internally generated misinformation (in the form of inferences) could be as powerful as, or even more powerful than, externally presented misinformation. Moreover, these findings contribute to an understanding of children's everyday cognition by extending the usual laboratory-based study of causal inference generation to a naturalistic context. Furthermore, these results underscore the importance of continuing an examination of the influence of peers on children's memory. Only recently has the concept of peer influence been applied to empirical investigations of suggestibility (e.g., Principe & Ceci, 2002; Principe et al., 2006). This is perhaps somewhat attributable to the usual conceptualization of memory as the product of the encoding, storage, and retrieval of an event (or nonevent) on the part of each child. However, the current findings underscore the notion that memory is not always solely the child's creation; rather, sometimes it is the result of natural collaborations with others.

In evaluating the forensic implications of this investigation, however, it is important to consider the differences between the tasks in which the study participants were engaged and children's experiences in actual legal cases; for example, in the current study, the event was enjoyable, the rumors were innocuous, and the delay interval was relatively short. Nonetheless, witnesses must be able to identify whether they know something because they saw it occur or whether they simply inferred it. Because inferences can be wrong, misremembering inferences as experienced could have grave consequences. Despite the potent effects of inference, an important next step is to explore whether inferences tend to be bound to a specific context or whether inferences migrate readily across contexts. The latter possibility is worrisome to the extent that benign causal inferences made in one context (e.g., a child who sees an empty wine bottle infers that her parents must have drunk the wine) might later engender erroneous and incriminating inferences in another context (e.g., the child later misremembers seeing the empty wine bottle during the evening that her teenage cousin was babysitting her).

Furthermore, because witnesses to a crime are likely to discuss their experiences with one another, the current results suggest that if one witness makes an erroneous inference about a past event, it could very well have a negative influence on other witnesses' memories as well. This possibility has much legal relevance because misattributing another's inferences as one's actual experiences would derail the nonadmissibility requirement for nonevidential testimony (i.e., statements that witnesses derive from hearsay must be excluded from consideration by fact finders). One way to reduce such errors would be for police investigators to record independent statements from each witness as early as possible. Moreover, the current results document a situation that can lead to agreement among peers even when none of the children is providing an accurate account. Because judges and juries are known to take agreement among witnesses as a marker of accurate testimony (Duggan, Aubrey, Doherty, Isquith, & Levine, 1989), the results of this study and other recent work (Principe & Ceci, 2002; Principe et al., 2006) demonstrate that fact finders should be cautious in using corroboration among witnesses as a criterion for gauging accuracy.

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