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Children's Use of Memory Editing Strategies to Reject Source Misinformation

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This is the first reported study of children's use of two metacognitive strategies, recollection rejection and diagnostic monitoring, to reject misinformation. Recollection rejection involves the retrieval of details that disqualify an event, whereas diagnostic monitoring involves the failure to retrieve expected details. First (n = 56, age 7 years) and third graders (n = 52, age 9 years) witnessed a staged classroom interaction involving common and bizarre accidents, were presented with misinformation about the source of these events, and took a memory test. Both age groups used recollection rejection, but third graders were more effective. There was little evidence that diagnostic monitoring influenced responses for bizarre events, potentially because these events were not sufficiently bizarre in the context of the stereotype induction.

Research has examined how children use memory editing or metacognitive strategies to prevent spontaneous false memories (Brainerd, Reyna, & Kneer, 1995; Ghetti, 2003, 2008). Some of this research has found that children, as young as 5 years old, are capable of using metacognitive strategies to some extent to prevent spontaneous false memories (Brainerd et al., 1995; Ghetti, Qin, & Goodman, 2002). Less research has examined how children use these strategies to prevent suggested false memories. Children are especially prone to suggested false memories (Cohen & Harnick, 1980; for a review, see Ceci & Bruck, 1993) but are less prone to spontaneous false memories for related lures than adults (Brainerd, Reyna, & Ceci, 2008). The purpose of this study was to examine how children use metacognitive strategies to reject suggested false memories in a context representing psycholegal settings (e.g., when a child is an eyewitness). Due to the fact that children are vulnerable to be victims of and witnesses to crimes, it is important to understand children's reliability as witnesses. Recollection and metamemory, abilities that influence the use of metacognitive strategies, develop throughout childhood. Therefore, children of different ages may differ in their ability to engage in these strategies.

Over the past 20 years researchers have examined different types of metacognitive strategies that prevent false memories (Gallo, Bell, Beier, & Schacter, 2006; Ghetti, 2003, 2008; Howe, Toth, & Cicchetti, 2011; Lampinen & Odegard, 2006). This research allows us to understand how people use recall to reject information that was not encountered (e.g., Brainerd & Reyna, 2002; Jacoby, 1991; Johnson, Hashtroudi, & Lindsay, 1993; Rotello & Heit, 2000). Recollection rejection and diagnostic monitoring are two of these metacognitive strategies.

Recollection Rejection

Recollection rejection involves searching memory for recollections that can logically disconfirm the prior presentation of a questionable event (Brainerd, Reyna, Wright, & Mojardin, 2003; Gallo, 2004). Recollection rejection is a particularly useful strategy when information is mutually exclusive. For example, if a person recalls seeing the word "large" on a list of studied words they may be able to reject the word "big" if they are able to assume that synonyms were never presented.

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Recollection rejection has been found to influence episodic memory decisions such as source-based exclusion processes (e.g., Jacoby, Jones, & Dolan, 1998) and recall-to-reject processes that have been documented in a variety of false recognition tasks (e.g., Brainerd et al., 2003; Gallo, 2004; Hintzman & Curran, 1994; Lampinen & Arnal, 2009; Lampinen, Odegard, & Neuschatz, 2004; Leding & Lampinen, 2009; Odegard, Lampinen, & Toglia, 2005; Rotello & Heit, 2000). In cases where memory decisions can be influenced by recollection rejection, the person remembers some information that leads to the rejection of an event as having occurred.

Diagnostic Monitoring

Diagnostic monitoring occurs when people reject false memories on the basis of not recalling the expected information about that event or item (Gallo, 2004). Diagnostic monitoring involves developing retrieval expectations based on recalled information for what details should be recalled about studied items or events. When trying to determine if an event occurred, people search their memory for details that confirm or deny its occurrence. If the recalled details do not match retrieval expectations, then the event is rejected.

Diagnostic monitoring is used by adults on many types of episodic memory decisions, such as decisions made on source memory tests (e.g., Johnson, Raye, Foley, & Foley, 1981; Marsh & Hicks, 1998) as well as decisions made on recognition memory tests (e.g., Dodson, Koutstaal, & Schacter, 2000; Ghetti, 2003; Leding, Lampinen, Edwards, & Odegard, 2007).

Memory Editing in Childhood

Given that recollection abilities (Anooshian, 1999; Brainerd, Holliday, & Reyna, 2004; Ghetti & Angelini, 2008) and metamemorial abilities (Flavell, 1979; Geurten, Catale, & Meulemans, 2015; Howe, 1990; O'Sullivan, 1996; Schneider, 1985, 1986, 1999; Schneider & Sodian, 1988) have been found to improve with age, children's ability to use metacognitive strategies should also improve with age. Research has examined this in the context of spontaneous false memories. Brainerd et al. (1995) had children, 5 years and older, study lists of words for a recognition memory test. On the test, some related distracters were primed with the target items that corresponded to them. For instance, the distracter *dog* may have appeared on the test shortly after the target *puppy*. When the related distracter was presented immediately or shortly after the studied target, participants rejected related distracters (e.g., dog) at higher rates than they rejected unrelated distracters (e.g., table). This finding suggests that children used recollection rejection to reject corresponding related distracters (e.g., dog). Third graders exhibited a larger false recognition reversal effect than kindergartners, suggesting that older children may be better able to use recollection rejection than younger children.

In terms of diagnostic monitoring, Ghetti et al. (2002) examined spontaneous false memories in 5- and 7-year-olds and adults using the Deese-Roediger-McDermott paradigm. Lists of words were said aloud or were said with an accompanying picture. False recognition was reduced for all age groups when words were presented with a picture. Ghetti et al. (2002) argued that this is because retrieval expectations are stronger for pictures because they are more distinctive than words. Relatedly, Geurten, Willems, and Meulemans (2015) found that children as young as 4 years old had fewer false recognitions for items studied as pictures than for items studied as words.

Additionally, a series of studies has examined how children use diagnostic monitoring, also known as memorability-based strategy, to reject suggested false memories (Ghetti & Alexander, 2004; Ghetti & Castelli, 2006; Ghetti, Papini, & Angelini, 2006). Research found that 9-year-olds and adults, but not 5- or 7-year-olds, consistently rejected high-memorability false autobiographical events in comparison to low-memorability events (Ghetti & Alexander, 2004; Ghetti & Castelli, 2006). Ghetti et al. (2006) found that 9- to 10-year-olds who received strategy training were more likely to reject experiencing bizarre events than common events.

Previous research examined the use of diagnostic monitoring to prevent suggested false memories for events. In the present research, we examine the use of diagnostic monitoring to reject suggested false memories for who caused an event to occur. There are many contexts in which the primary concern is not whether the event occurred but who is responsible for the event occurring. The present research asks the novel question of whether this sort of false memory is influenced by the distinctiveness of the event itself. One possibility is that events and the agents who caused the events are so closely linked that highly distinctive events, compared to low distinctive events, are relatively immune from suggestions as to who caused the events. Alternatively, it is possible that highly distinctive events are

dissociated from the agents who caused the events (Brainerd, Gomes, & Moran, 2014; Starns, Hicks, Brown, & Martin, 2008). When a suggestion is made as to who caused the event, the events are likely to be retrieved and the suggested source might be more prone to being accepted.

In adults, recollection-based rejection strategies have been studied in eyewitness suggestibility paradigms (Loftus, 1979; Moore & Lampinen, 2016; Pezdek, Finger, & Hodge, 1997; Tousignant, Hall, & Loftus, 1986). For instance, Moore and Lampinen (2016) found that adults use recollection rejection to reject misinformation. These findings suggest the possibility that children may also use these strategies to reject suggested information about a witnessed event. However, there are also reasons to question whether children will be able to utilize recollection rejection for suggested information. First, most developmental recollection rejection studies have been highly scaffolded (Brainerd et al., 1995). In a typical misinformation paradigm this does not occur, which raises the question of whether children can spontaneously make use of recollection to reject suggested false memories. Some research suggests that children may have difficulties spontaneously producing skills that they could perform under other conditions (Flavell, 1970). Additionally, young children are less likely to question the veracity of an adult authority figure than are older children or adults (Ceci, Ross, & Toglia, 1987; Lampinen & Smith, 1995). Utilizing recollection rejection in this context requires not only using recollection of inconsistent information to override plausible but incorrect information but also requires that children trust their own memory of the details of the event more than the adult authority figure's description of the event. If established, this would constitute an impressive demonstration of metacognitive skills on the part of young children that has not previously been demonstrated in this context. Whether children use metacognitive strategies to reject suggested false memories is an important question for the legal system as it may help to inform about a child's reliability as an eyewitness. In the context of eyewitness memory, memory editing strategies, when used effectively, could prevent the occurrence of false memories about a crime.

The Misinformation Effect

The misinformation paradigm is used to create suggested false memories (Loftus, 1975, 1979). The misinformation paradigm involves watching an event, encountering misinformation (via questions or a summary), and taking a test. The misinformation effect occurs when misinformation is accepted at higher rates than nonsuggested false details on the test. For example, Loftus, Miller, and Burns (1978) showed participants slides of a car accident. One slide showed a car at a stop sign. Some participants were asked a question that presupposed the car was at a yield sign. Participants who received misinformation were more likely to recall the yield sign on a later test than participants who did not.

Types of Misinformation

There are two types of misinformation. Contradictory misinformation is false information that contradicts information from the original event. For example, participants read that a car passed a stop sign when in reality they saw it pass a yield sign (Loftus et al., 1978). Additive misinformation is extraneous false information. One example of additive misinformation is telling participants that a car passed a barn when in reality no barn was present in the event (Loftus, 1975). In the present study, we used additive and contradictory source misinformation and compared them to estimate recollection rejection. Contradictory misinformation allows for recollection rejection because one can compare the original event detail to the misinformation.

Children and the Misinformation Effect

Children have been found to be susceptible to the misinformation effect (Ackil & Zaragoza, 1995; Akehurst, Burden, & Buckle, 2009; Cassel, Roebers, & Bjorklund, 1996; for review, see Holliday, Reyna, & Hayes, 2002). In fact, research has found that children are more prone to accepting misinformation than adults (Ceci & Bruck, 1993). Misinformation acceptance tends to decrease with age across most of childhood. For instance, Ceci et al. (1987) presented stories to 3- and 12-year-olds and presented misinformation 24 hr later. The 3-year-old children accepted more misinformation than 12-year-old children did.

Source Monitoring

Source monitoring errors can lead to the acceptance of misinformation when a person misattributes misinformation as having occurred during the original event (Lindsay & Johnson, 1987, 1989; McCloskey & Zaragoza, 1985). Research in both children and adults has found that source monitoring reduces suggestibility (Giles, Gopnik, &

Heyman, 2002; Zaragoza & Lane, 1994). Source monitoring develops throughout childhood (Ackil & Zaragoza, 1995; Johnson et al., 1993; Markham, Howie, & Hlavacek, 1999). For instance, Principe, Kanaya, Ceci, and Singh (2006) found that preschool-aged children who heard a rumor about an event said they experienced the event at the same rate as children who actually experienced the event, 5- and 6-year-olds were less prone to making these errors (Principe, Haines, Adkins, & Guiliano, 2010).

Recollection rejection and diagnostic monitoring can influence source-based memory decisions. For instance, when a person attributes details to their respective sources, they can reject misinformation as having occurred (i.e., recollection rejection). Diagnostic monitoring can influence source monitoring when sources differ in the richness of the details, leading to different retrieval expectations. If a person sets a high-memory criterion, they may reject details that are less distinctive in memory. Israel and Schacter (1997) found participants recognized fewer critical lures when words were paired with a corresponding picture in comparison to participants who studied only words. This led to the proposal that participants use a distinctiveness heuristic, making retrieval decisions on the expected distinctiveness of memories (Schacter, Israel, & Racine, 1999; see Schacter & Wiseman, 2006 for review). Diagnostic monitoring drives the distinctiveness heuristic making distinctiveness manipulations one way to estimate diagnostic monitoring processes (i.e., people adopt a more conservative retrieval criteria for distinctive sources; also see Gallo, Weiss, & Schacter, 2004; McDonough & Gallo, 2008).

Source monitoring errors can occur for the source of a crime. Eyewitness misidentifications have been widely regarded as the leading cause of wrongful convictions (Conners, Lundregan, Miller, & McEwen, 1996; Garrett, 2008; Innocence Project, 2012). Due to the critical nature of source monitoring, we chose to use source attributions as our critical information (i.e., information participants received misinformation about) in the current study.

The Current Study

The purpose of this experiment was to examine the use of recollection rejection and diagnostic monitoring in naturalistic psycholegal settings by investigating metacognitive strategies in the context of suggestion. Specifically, we used a misinformation paradigm to examine how first and third graders use metacognitive strategies to reject misinformation about source memory. We used a stereotype induction to emulate the situation that children may experience when asked to identify someone from a lineup. We used a classroom, a familiar context for most children, as the setting for our event. We created a female version of the character Sam Stone named Samantha Stone (Leichtman & Ceci, 1995).

We hypothesized that recollection rejection would be used when the suggested source contradicted the actual source of the event to the extent that children could recollect the actual source of the event and disqualify the suggested source. We hypothesized that children would have lower rates of false memories for bizarre events compared to events that were not bizarre. Although recollection rejection relies on the rejection of a verbatim detail, diagnostic monitoring relies on an awareness of the gist of an event (Gomes & Brainerd, 2013). Given that verbatim memory develops earlier than gist memory, we expected that the onset of recollection rejection might occur earlier than the onset of diagnostic monitoring. By disentangling these two kinds of monitoring processes on memory accuracy, this study allowed us to determine whether these processes followed different developmental trajectories.

Method

Participants

In this study, 56 first and 52 third graders were recruited from Northwest Arkansas after school programs, the University of Arkansas newswire, and flyers placed around Northwest Arkansas. Children participated in the study from February to July 2015. Each child who participated was neurotypical. The mean age of the first graders was 7.25 years (SD = .43) and the mean age of the third graders was 9.11 years (SD = .34). The sample consisted of 62 boys and 46 girls. The sample consisted of 81% Caucasian, 3.7% Hispanic, 8.3% mixed or other race, and 2.7% Asian participants. Parents gave informed consent for their child(ren) to participate and children provided informed assent. Children received a $20 gift card for their participation.

Design

The study employed a 2 (age group: first, third) × 3 (source: Samantha Stone, Mrs. Mitchell, unknown) × 2 (suggestion: provided or not) × 2 (bizarreness: bizarre or not) mixed factors design. Age group was a between-subjects factor. The

within-subjects variables were crossed such that there were 12 experimental cells. The dependent variables were whether: (a) the child remembered the event, (b) the child said Samantha Stone caused the accident, (c and d) the child rejected (or accepted) Samantha Stone as the cause of the accident at the highest confidence level, and (e) we determined that the child used metacognitive strategies via their self-report response. These dependent variables allowed us to test for general memory, the misinformation effect, diagnostic monitoring, phantom recollection, and recollection rejection.

Materials

Stereotype Induction

The stereotype induction script included the following:

> Samantha Stone is a very clumsy person. She's probably the clumsiest person in the whole world! I've never seen anyone as clumsy as Samantha Stone. She's always causing accidents and making messes she's sooooo clumsy. But don't worry Samantha Stone is also really nice!

Misinformation Task

A video was constructed consisting of two adult women and five children. The video was filmed in a classroom. One of the adults portrayed a teacher named Mrs. Mitchell. The children in the video portrayed Mrs. Mitchell's students. The other adult portrayed a friend of Mrs. Mitchell's named Samantha Stone. The video consisted of Samantha Stone visiting Mrs. Mitchell's class. After Samantha Stone's arrival a series of accidents occurred. These accidents were caused by Samantha Stone, Mrs. Mitchell, or an unknown source (i.e., the source of the accident was not shown). Twelve accidents, one for each cell in our design, occurred in the video. We filmed three versions of each accident such that we had clips of each accident being caused by each source. Three versions of the video were constructed, each consisting of one version of each accident, in order to counterbalance the sources of each accident. Each video included four accidents caused by each of the three sources. Six of the accidents were bizarre in nature (e.g., a comb falling into a toilet), and six of the accidents were not bizarre (e.g., spilling crayons) (see Appendix). The video ends with everyone cleaning up and playing musical chairs. We obtained estimates of bizarreness for each of the accidents from adult participants to ensure that the bizarre accidents were considered bizarre and vice versa.

An interview was constructed consisting of 12 open-ended questions one about each of the accidents in the video. Two versions of the interview were constructed. In each version, 6 of the 12 questions suggested that Samantha Stone caused the accident (e.g., "Did Samantha Stone get another soda after she spilled hers?"), and 6 of the questions were nonsuggestive (e.g., "Did anyone eat the hot dog that fell out of a backpack?"). We crossed suggestion with the actual source of the accident such that participants received a suggestion that Samantha Stone caused the accident for two of the four accidents caused by each source. Crossing suggestion and source led to our three item types. Contradictory misinformation occurred when Mrs. Mitchell actually caused the accident, but it was suggested that Samantha Stone caused the accident. Additive misinformation occurred when an unknown source caused the accident, but it was suggested that Samantha Stone caused the accident. Unrelated items occurred when an unknown source caused an accident and no suggestion about source was provided.

Final Memory Test

A final memory test consisted of questions about 24 different events from the video including the 12 accidents that occurred in the video. There was one question on the test for each of the 12 accidents. We refer to these questions and accidents as critical events and questions. For the critical questions, participants were asked if the accident in question occurred (yes/no recognition); if the child said yes, a follow-up source memory question asked if Samantha Stone caused the accident. These 12 questions were critical because they were the subject of our independent variables, including suggestion, although each child only received suggestions for six of the questions. As described in the Results section, our analyses of the critical questions allowed us to determine the extent that children used metacognitive strategies.

In addition to the 12 critical questions, 12 filler questions were included on the test. Eight were true (i.e., targets) and four were false (i.e., foils). We divided the correct answers (i.e., yes or no) to the filler questions to balance out the number of correct "yes" and "no" responses to questions with respect to the Samantha Stone question for the 12 critical

events (i.e., although all 12 of the critical events happened, 4 were perpetrated by Samantha, whereas 8 were not). Bizarreness was not manipulated in the filler questions. Two of the 12 filler questions asked whether certain events occurred and if so, if Mrs. Mitchell was the person who caused the event. We used these two-part filler questions to prevent any patterns from being noticed with the two-part critical questions and to have filler questions analogous to our critical questions. One of the two teacher questions was a target (i.e., the event occurred), and the source of the event was the teacher. The second of the two teacher questions was a foil (i.e., the event did not occur). The other 10 filler questions consisted of single questions about whether or not various events occurred in the video. Seven of the single question fillers were targets and three were foils.

Each of the 24 questions was followed by a confidence question, "How sure are you that your answer is correct?", and a three-point confidence scale ("very sure," "neither sure or unsure," "very unsure"). For the two-part questions (i.e., event and source), the confidence question followed the source question. A child friendly confidence scale with smiley faces adapted from Roebers (2002) was used. Three practice questions were placed before the memory test in order to ensure that children knew how to use the confidence scale. An open-ended question followed the confidence question, "Why did you choose the answer that you did?"

Procedure

Participants were tested in the laboratory or an empty classroom. Figure 1 shows the order of events. The experimenter verbally administered all written parts of the procedure and recorded participant's responses. First, the experimenter read the stereotype induction. Next, experimenters showed a version of the video, randomly assigned, to the participant. The experimenter then played tic-tac-toe with the participant for 3 min (i.e., filler task). After this, the experimenter administered the interview that contained misinformation. The experimenter may have been aware that the test probes were veridical or false because they watched the video with the participants. However, experimenters were trained not to provide verbal or nonverbal cues to participants about their performance. Another 3-min filler task took place (i.e., tic-tac-toe). After this, the experimenter administered the final test. For the one-part questions (i.e., fillers) children were asked whether they saw something or if an event occurred in the video. One example of a filler question was, "Did the kids sit on the floor for story time?" A yes/no response was recorded. For the two-part questions, children were first asked if an event occurred in the video. If the child responded affirmatively, the experimenter followed up with a source question. For example, for the juice box item, the event question was "Did you see a juice box get spilled?" and the source question was "Was it Samantha Stone who spilled the juice box?" The two-part filler questions about Mrs. Mitchell were in the same format except the source question was "Was it Mrs. Mitchell . . . ?" After the event question (i.e., one-part questions) or after the source question (i.e., two-part questions), participants rated their confidence and provided a reason why they chose the answer that they did.

Results

Our results are organized by our dependent variables (i.e., event recognition, source memory, high-confidence rejections, high-confidence acceptances, and self-report). First, we will discuss overall event recognition, and then we will turn to the source data to investigate the metacognitive strategies (as elaborated in that section). For each section following the event recognition section we did two sets of analyses. First, we analyzed the raw data. That is, if the participant said "no" to the event question, we coded all of the following dependent variables as a 0 indicating that these things did not occur. Second, we analyzed the data conditional upon the participant saying "yes" to the event question. That is, if the participant responded "no" to the event question, we counted the participant as not having responded to the source memory, high-confidence rejection and acceptances, or the self-report. This allowed us to examine false memory and

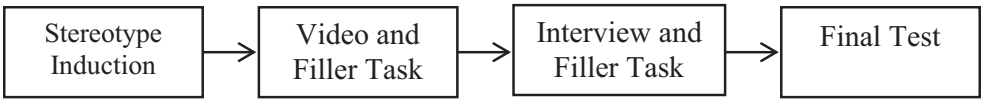

Figure 1. Procedure.

recollection rejection rates for children who remembered the critical event. In many cases, the conditional analyses did not differ or only differed slightly from the raw analyses. Therefore, we only report the conditional results that differ from the raw analyses.

Data Analysis

We used logistic multilevel modeling (MLM) because the dependent variables were dichotomous and some predictors were within-subjects factors. The MLM allowed us to account for nonindependence of errors due to the within-subjects factors. The logistic MLMs were performed using software package R and the "lme4" package for generalized multilevel models (Bates & Maechler, 2009; R Development Core Team, 2008). Participant was a random effect in the model. The predictors were deviation coded to maintain their interpretability as main effects when interactions were included in the model. The main predictors were bizarreness, source, suggestion, age, and their interactions. The predictors were entered as fixed effects. We used an unstructured covariance matrix. The model was estimated using maximum likelihood estimation.

Critical Items: Overall Event Recognition

Overall event recognition of the 12 critical events was operationalized as the mean percentage of "yes" responses to the event question (Part 1). These data can be seen in the left column of Table 1. Children's overall recognition memory for the events was quite high ranging from 82% to 100% accuracy. We hypothesized that children would remember distinctive items better and that older children would have better recognition memory than younger children. We examined the base model, which included event recognition and participant, the random effect, to determine if our data were a good candidate for MLM. We calculated the intraclass correlation coefficient (ICC), here after referred to as ICC, using the following equation: $\rho = \sigma^2_{u0}/\sigma^2_{u0} + \pi^{2/3}$. The ICC was .257. The ICC was above .01 indicating that our data were a good candidate for MLM.

We fit a model including participant, age, bizarreness, and an Age × Bizarreness interaction. We found effects of age and bizarreness. As hypothesized, children were more likely to remember bizarre accidents ($M = .96$, $SE = .01$) than nonbizarre accidents ($M = .90$, $SE = .01$), $b = -.61$, $SE = .14$, $p < .001$. Third graders memory for the accidents was better ($M = .96$, $SE = .01$) than first graders ($M = .91$, $SE = .01$), $b = .47$, $SE = .18$, $p = .01$.

Note that our primary analysis was on average number of "yes" responses to studied events and did not take into account baseline "yes" responses to nonstudied event fillers (e.g., false alarms). In general, false alarms were very low and did not vary across our age groups, so the same age effect was obtained regardless of whether these false alarms were taken into account. We collapsed the one-part and two-part fillers into target (i.e., correct

Table 1
Mean Responses to the 12 Critical Questions (and SE*)*

			Mean "yes" to event (part 1 of question)		Mean "yes" to Samantha (part two of question)		Conditional mean "yes" to Samantha (part 2 of question)	
Actual source	Event type	Interview suggestion	First	Third	First	Third	First	Third
Outcome	Nonbizarre	No suggestion	0.86 (.04)	0.94 (.03)	0.58 (.06)	0.61 (.06)	0.65 (.07)	0.62 (.07)
		Suggestion	0.88 (.04)	0.90 (.04)	0.73 (.05)	0.73 (.05)	0.81 (.06)	0.78 (.06)
	Bizarre	No suggestion	0.95 (.03)	1.0 (.00)	0.62 (.06)	0.76 (.05)	0.64 (.07)	0.74 (.06)
		Suggestion	0.96 (.03)	0.98 (.02)	0.75 (.05)	0.73 (.05)	0.76 (.06)	0.73 (.06)
Teacher	Nonbizarre	No suggestion	0.82 (.05)	0.96 (.02)	0.50 (.06)	0.41 (.06)	0.59 (.07)	0.42 (.07)
		Suggestion	0.93 (.03)	0.85 (.04)	0.71 (.05)	0.39 (.06)	0.74 (.06)	0.47 (.07)
	Bizarre	No suggestion	0.93 (.03)	0.94 (.03)	0.71 (.05)	0.55 (.06)	0.71 (.05)	0.55 (.06)
		Suggestion	0.96 (.02)	0.98 (.02)	0.75 (.05)	0.61 (.06)	0.75 (.05)	0.61 (.06)
Sam Stone	Nonbizarre	No suggestion	0.86 (.04)	0.96 (.02)	0.79 (.05)	0.86 (.04)	0.87 (.05)	0.88 (.04)
		Suggestion	0.88 (.04)	0.98 (.02)	0.83 (.05)	0.96 (.02)	0.89 (.04)	0.98 (.02)
	Bizarre	No suggestion	0.93 (.03)	0.98 (.02)	0.77 (.05)	0.88 (.04)	0.82 (.05)	0.88 (.04)
		Suggestion	0.95 (.03)	1.0 (.00)	0.83 (.05)	0.90 (.04)	0.84 (.05)	0.90 (.04)

answer was "yes" to event question) and foil items (i.e., correct answer was "no" to event question) in Table 2.

Critical Items: Source Memory

In each of the following sections, we tested for recollection rejection by comparing teacher items to unknown items and diagnostic monitoring by examining the effect of bizarreness on unknown items. We examined unknown items because the rejection of unknown items could not be caused by recollection rejection. We did not find effects of bizarreness on the unknown items for source memory or high-confidence rejections/acceptances, *p*s < .05 (details of analysis available from the authors). We also tested for effects of misinformation and age.

Source memory for the 12 critical events (accidents) was operationalized as the mean percentage of "yes" responses to the Samantha Stone judgment (part two). These data can be seen in the right column of Table 1. A "yes" response to the Samantha Stone question was inaccurate when the source was the teacher or unknown but was accurate when the source was Samantha Stone. Children's overall tendency to say "yes" to the Samantha Stone question was quite high even when we did not suggest that Samantha Stone caused the accident, likely reflecting our portrayal of Samantha Stone as a clumsy, accident-prone person (e.g., the stereotype induction).

Of critical interest to our memory monitoring hypotheses were the false attributions of actions to Samantha Stone when, in fact, she had not committed the original accident. These source memory errors are presented in Figures 2 and 3. In these and all following analyses the four accidents that Samantha Stone actually committed were excluded because we were interested in examining the rejection of misinformation (i.e., rejecting Samantha Stone as the source of an accident that was actually caused by another source). The ICC of the base model was .278.

We fit a model including all main effects and interactions because any of our variables could have entered into meaningful interactions. We found main effects of suggestion, source, and bizarreness. Children were more likely to attribute accidents that were not caused by Samantha Stone to Samantha Stone when they received suggestions that Samantha Stone caused the accident (M = .68, SE = .03) than when they did not receive suggestions (M = .59, SE = .03), $b = -.26$, SE = .08, p = .002. Children were more likely to attribute bizarre accidents (M = .69, SE = .03) to Samantha Stone than nonbizarre accidents (M = .58, SE = .03), $b = -.29$, SE = .08, $p < .001$. We expected that children would be better able to remember bizarre accidents and therefore more likely to make accurate source attributions about bizarre accidents. The opposite of this was true; this may be because of the stereotype induction we used. Children may have been especially likely to think Samantha Stone caused the bizarre accidents because she was described as being very clumsy and causing accidents.

Table 2
Accuracy by Filler Items and Age

Grade	Target	Foil
First	.87 (.13)	.96 (.09)
Third	.92 (.09)	.98 (.07)

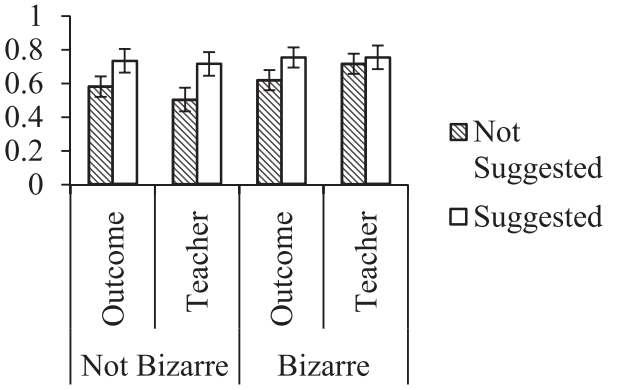

Figure 2. First graders false memories of Samantha Stone causing accidents.

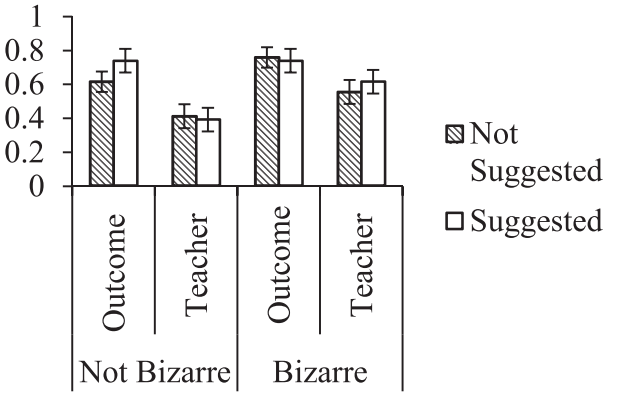

Figure 3. Third graders false memories of Samantha Stone causing accidents.

Next, we turn to the effect of source in order to understand children's use of recollection rejection. Children were more likely to attribute accidents caused by an unknown source (M = .69, SE = .03) to Samantha Stone than accidents caused by the teacher, Mrs. Mitchell (M = .58, SE = .03), b = .28, SE = .08, p < .001. This indicates that children may have used recollection rejection to reject Samantha Stone as the cause of accidents that were caused by Mrs. Mitchell.

We found a significant interaction between age and source, b = .28, SE = .08, p = .001. First graders false memories for Samantha Stone causing an accident that was actually caused by an unknown source (M = .67, SE = .05) or Mrs. Mitchell (M = .67, SE = .04) did not differ. In comparison, third graders had higher rates of false memories of Samantha Stone causing an accident for accidents caused by an unknown source (M = .71, SE = .05) than Mrs. Mitchell (M = .49, SE = .04). This finding suggests that third graders were able to take advantage of the exclusive source detail (i.e., Mrs. Mitchell) to reject Samantha Stone as the source.

In order to examine whether false memories differed based on item type, we conducted McNemar's tests. McNemar's test is the within-subjects equivalent of chi-square. We broke up the analyses by bizarreness because children were much more likely to falsely report that Samantha Stone was the source of bizarre accidents. There were no significant differences between the percentage of false memories for nonbizarre contradictory and unrelated items p = .76. This may be because children used recollection rejection to reject contradictory misinformation. More false memories were reported for nonbizarre additive items than unrelated items p = .02. More false memories were reported for nonbizarre additive items than contradictory items p = .02. This finding supports the idea that children used recollection rejection to reject contradictory source information. We found no significant differences between the bizarre item types. This may be because children were especially likely to endorse Samantha Stone as the source when the accident was bizarre.

Conditional Source Memory

The conditional source memory errors are presented in Figures 4 and 5. In comparison to the unconditional data, we found an effect of age. First graders (M = .72, SE = .02) were more likely to attribute accidents caused by another source to Samantha Stone than third graders (M = .62, SE = .03), b = −.37, SE = .18, p = .04.

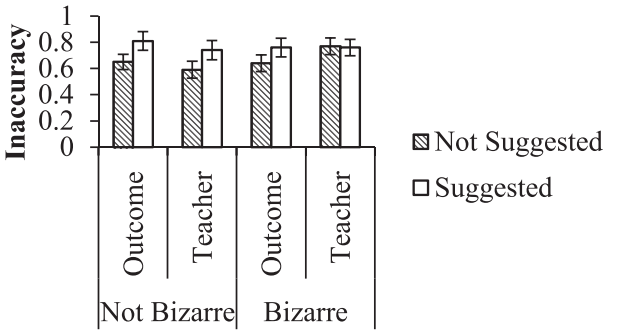

Figure 4. First graders false memories of Samantha Stone causing accidents conditional upon an affirmative response to event question.

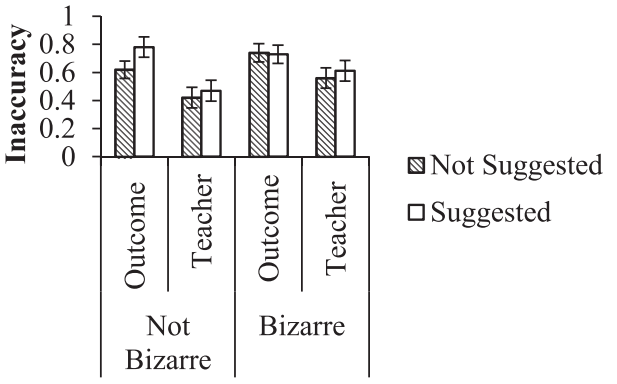

Figure 5. Third graders false memories of Samantha Stone causing accidents conditional upon an affirmative response to event question.

High-Confidence Rejections

We examined high-confidence rejections of Samantha Stone as the source of accidents that she did not cause to determine how or if children were using recollection rejection. Recollection rejection generally occurs under high levels of confidence. Therefore, we would expect that high-confidence rejections would occur more frequently for items in which recollection rejection is used. The ICC for the base model was .341.

We found effects of source and bizarreness. High-confidence rejections occurred at higher rates when the source was the teacher, Mrs. Mitchell (M = .30, SE = .03), than when the source was unknown (M = .17, SE = .03), b = −.46, SE = .10, p < .001. This indicates that children used recollection rejection to reject Samantha Stone as the source of accidents caused by Mrs. Mitchell. High-confidence rejections

occurred at higher rates for nonbizarre accidents (M = .27, SE = .03) than for bizarre accidents (M = .20, SE = .03), b = .24, SE = .10, p = .02.

We found an Age × Source interaction, b = −.38, SE = .10, p < .001. First graders were equally likely to report a high-confidence rejection when accidents were caused by an unknown source (M = .20, SE = .04) and Mrs. Mitchell (M = .22, SE = .04), but third graders were more likely to report a high-confidence rejection for accidents caused by Mrs. Mitchell (M = .38, SE = .04) than an unknown source (M = .15, SE = .04). This finding suggests that third graders used recollection rejection to reject Samantha Stone as the source of accidents caused by Mrs. Mitchell.

Conditional High-Confidence Rejections

In comparison to the unconditional data, there was a marginally significant effect of bizarreness, b = .19, SE = .11, p = .09, and a Suggestion × Bizarreness interaction, b = .22, SE = .11, p = .05. When events were not suggested, there were more high-confidence rejections for nonbizarre (M = .30, SE = .02) than bizarre items (M = .19, SE = .01). When events were suggested, there was no difference in high-confidence rejections for nonbizarre (M = .20, SE = .01) and bizarre items (M = .19, SE = .01).

Diagnostic Monitoring

When we examined high-confidence rejections for the unknown items, we found a Suggestion × Bizarreness interaction, b = .49, SE = .24, p = .04. When no suggestion occurred, there were more high-confidence rejections for nonbizarre (M = .23, SE = .02) than bizarre items (M = .14, SE = .02). When a suggestion occurred, there was no difference in high-confidence rejections for nonbizarre (M = .10, SE = .02) and bizarre items (M = .14 SE = .02).

High-Confidence Acceptances

We examined high-confidence acceptances of Samantha Stone as the source of accidents to measure phantom recollection. Phantom recollections are vivid false memories. High-confidence acceptances are erroneous, and so we expected opposite results as compared to high-confidence rejections. The ICC for the base model was .339.

We found effects of source, bizarreness, and suggestion. Children were more likely to highly confidently accept Samantha Stone as the source of the accident when the source was unknown (M = .53, SE = .04) than when the source was the teacher, Mrs. Mitchell (M = .46, SE = .04), b = .21, SE = .08, p = .013. High-confidence acceptances occurred at higher rates for bizarre accidents (M = .55, SE = .04) than nonbizarre accidents (M = .44, SE = .03), b = −.27, SE = .08, p = .001. High-confidence acceptances occurred at higher rates when a suggestion was present (M = .53, SE = .03) than when it was not (M = .46, SE = .04), b = −.32, SE = .08, p < .001.

We found a significant Age × Source interaction, b = .18, SE = .08, p = .03. First graders were equally likely to report high-confidence acceptances when accidents were caused by an unknown source (M = .56, SE = .05) and Mrs. Mitchell (M = .54, SE = .05). Third graders were more likely to report high-confidence acceptances for accidents caused by an unknown source (M = .52, SE = .05) than Mrs. Mitchell (M = .38, SE = .05).

Self-Report Responses

Two independent coders coded self-report of recollection rejection. The interrater reliability was κ = .79 (p < .001), 95% CI [.70, .87], indicating substantial agreement. An example of recollection rejection for an unknown source was "it just showed the hand," and when Mrs. Mitchell was the source was "Mrs. Mitchell did it, I saw her clothes." Our primary variable of interest was correct recollection rejection. The ICC for the base model was .265.

There were effects of source and age. Recollection rejection occurred at higher rates when the source was the teacher (M = .20, SE = .03) than when the source was unknown (M = .11, SE = .02), b = −.40, SE = .13, p = .002. First graders (M = .09, SE = .03) reported less recollection rejection than third graders (M = .21, SE = .03), b = .61, SE = .18, p < .001. There was also an Age × Source interaction. First graders had equal reports of recollection rejection when the actual source was unknown (M = .08, SE = .03) or Mrs. Mitchell (M = .11, SE = .04), but third graders were more likely to report recollection rejection for accidents caused by Mrs. Mitchell (M = .30, SE = .04) than an unknown source (M = .13, SE = .03), b = −2.04, SE = .65, p = .002.

The interaction between bizarreness and source was significant, b = −.37, SE = .13, p = .004. When the source was unknown, there was no difference in self-reported recollection rejection for nonbizarre (M = .09, SE = .01) or bizarre items (M = .12,

SE = .01). In comparison, when the source was the teacher, there were more self-reports of recollection rejection for nonbizarre (*M* = .26, *SE* = .02) than bizarre items (*M* = .14, *SE* = .01).

There was a significant interaction between age, suggestion, and source, *b* = −.34, *SE* = .13, *p* = .007 (see Figure 6). When the source was unknown, third graders reported more recollection rejection when they received a suggestion (*M* = .16, *SE* = .03) than when they did not (*M* = .11, *SE* = .03). In comparison, first graders reported more recollection rejection when they did not receive a suggestion (*M* = .11, *SE* = .05) than when they did (*M* = .06, *SE* = .03). When the source was Mrs. Mitchell, the teacher, third graders reported more recollection rejection when they did not receive a suggestion (*M* = .33, *SE* = .04) than when they did (*M* = .27, *SE* = .04). In comparison, first graders used more recollection rejection when they received a suggestion (*M* = .13, *SE* = .04) than when they did not (*M* = .08, *SE* = .03).

There was a significant interaction between suggestion, bizarreness, and source, *b* = .27, *SE* = .13, *p* = .04 (see Figure 7). When the source was unknown and no suggestion was given, recollection rejection occurred more for nonbizarre items (*M* = .13, *SE* = .03) than for bizarre items (*M* = .08, *SE* = .03). When the source was unknown and a suggestion was given, recollection rejection occurred more for bizarre items (*M* = .16, *SE* = .03) than nonbizarre items (*M* = .06, *SE* = .02). When the source was Mrs. Mitchell, the teacher, and no suggestion was given, recollection rejection occurred more for nonbizarre items (*M* = .25, *SE* = .04) than for bizarre items (*M* = .16, *SE* = .03). When the source was Mrs. Mitchell, the teacher, and a suggestion was given, recollection rejection occurred more for nonbizarre items (*M* = .27, *SE* = .04) than for bizarre items (*M* = .12, *SE* = .03).

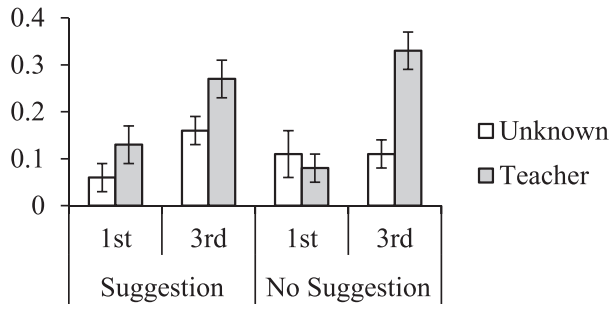

Figure 6. Three-way interaction between age, suggestion, and source for self-reported recollection rejection.

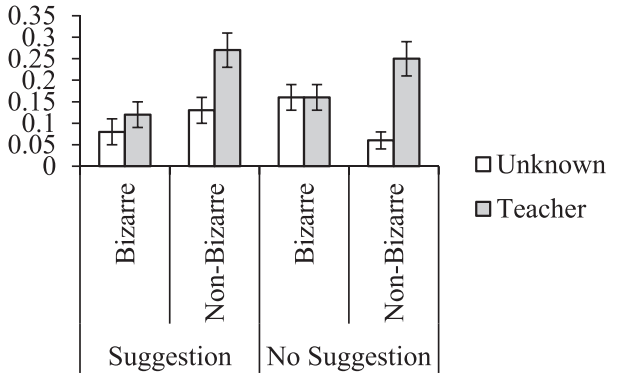

Figure 7. Three-way interaction between bizarreness, suggestion, and source for self-reported recollection rejection.

Discussion

The purpose of this study was to determine if children use metacognitive strategies to reject false memories in a scenario that simulated the eyewitness experience. First and third graders completed a misinformation paradigm. We used three measures to estimate children's use of recollection rejection: misinformation acceptance, high-confidence rejections, and self-reports of recollection rejection. We also analyzed children's high-confidence acceptances. We measured diagnostic monitoring by comparing children's memory for bizarre accidents to their memory for nonbizarre accidents on items in which recollection rejection could not be used. This study presents novel contributions in the form of examining children's use of recollection rejection to reject suggested false memories, examining whether distinctiveness effects and diagnostic monitoring extrapolate from event to the source of the event, and examining children's use of recollection rejection and diagnostic monitoring in the same paradigm.

Third graders remembered the events occurring at higher rates than first graders. In addition, children remembered the bizarre accidents better than the nonbizarre accidents. Across all measures, we found that third graders used recollection rejection to reject Samantha Stone as the source, when in actuality Mrs. Mitchell caused the accident, at higher rates than when the source was unknown. In comparison, first graders were not able to use this extra information (i.e., source) to reject Samantha Stone as the source of the Mrs. Mitchell accidents at higher rates than when the source of the accident was unknown. This finding suggests that third graders have some ability beyond first graders that allowed them to use recollection rejection.

Ghetti and Angelini (2008) found that 6- and 8-year-olds had similar recollection abilities but had worse recollection abilities than 10-year-olds. The children in our study were on average 7 and 9 years old. Although Ghetti and Angelini (2008) did not study 9-year-olds, it is possible these children have developed better recollection abilities, similar to 10-year-olds than younger children. Increased recollection abilities could account the differences in first and third graders use of recollection rejection.

High-confidence acceptances occurred at higher rates for accidents caused by an unknown source than for accidents caused by Mrs. Mitchell. High-confidence acceptances provide an estimate of phantom recollection. Previous research has suggested that when recollection rejection is used it suppresses rates of phantom recollection (Brainerd, Wright, Reyna, & Mojardin, 2001). We call this phenomena "verbatim precedence" because the recall of the verbatim detail (i.e., Mrs. Mitchell) takes precedence over the false detail (i.e., Samantha Stone). This corroborates the finding that children used source information to inform their memory decisions. This finding was moderated by an Age × Source interaction such that first graders high-confidence acceptances did not vary by source, but third graders had higher rates of high-confidence acceptances for accidents caused by unknown sources than for accidents caused by Mrs. Mitchell. High-confidence acceptances occurred at higher rates for bizarre accidents than for nonbizarre accidents. High-confidence acceptances occurred at higher rates for accidents in which children received a suggestion than for accidents in which no suggestion was given.

Some children did not appear to consider all of the confidence options, despite thorough training, and instead seemed to rely on choosing the highest confidence option throughout the test. Given that the conclusions drawn from these observations are true, it is possible that the proportion of high-confidence acceptances and rejections were inflated. Previous studies have successfully used the confidence scale, with similar training exercises, that was used in the current study with children as young as the participants in our study, Roebers (2002). Therefore, it is unclear why some of the children in our study appeared to struggle with this scale.

Our findings demonstrate that first and third graders used recollection rejection to some extent. However, only third graders were able to take advantage of the mutually exclusive source detail leading to higher rates of recollection rejection and lower rates of false memories. Children used recollection rejection to reject misinformation without instructions. Although the first graders in our study used recollection rejection at lower rates than the third graders, we found that children in both first and third grades were able to spontaneously induce this strategy. In addition, children in both first and third grade self-reported using recollection rejection accurately.

Yonelinas (2001) has argued that three converging measures control, confidence, and consciousness form the core of what is meant by the construct conscious recollection. Control was measured through false memory rates, which represented children's ability to recall the correct source detail (i.e., Mrs. Mitchell) to reject Samantha Stone as the source of an accident. Next, we obtained confidence ratings from children for these responses. Finally, we estimated consciousness through asking children why they chose the answer they did and coding for recollection rejection. The findings from each of these measures converged. Our converging findings indicate that all of our measures are estimating children's use of recollection rejection.

Children were more likely to have false memories for bizarre accidents than nonbizarre accidents. We expected that bizarre accidents would be more memorable, and thus children would be more likely to reject Samantha Stone as the source of bizarre accidents. Children were more likely to recall that bizarre events occurred than nonbizarre events, but this knowledge did not help them in rejecting false suggestions about the source of the event. This may be because children could not overcome the idea that Samantha Stone was clumsy, as suggested by the stereotype induction, in order to make accurate source attributions. Alternatively, although distinctive events are more memorable, this may not have extrapolated to the other details of the event (i.e., the source of the event). Indeed, recent research has found that item memory and source memory are independent abilities (Brainerd et al., 2014; Starns et al., 2008).

We can also consider the relative onset of recollection rejection and diagnostic monitoring. We found no evidence for children's use of diagnostic monitoring to reject false source memories, but previous studies have found that children as young as 9 years old can spontaneously use diagnostic monitoring to reject suggested false information (Ghetti & Alexander, 2004; Ghetti & Castelli, 2006). In addition, we found no relation between diagnostic monitoring and recollection rejection. Our findings suggest that the onset of the spontaneous use of

recollection rejection may occur earlier, as young as 7 years of age, than the onset of the spontaneous use of diagnostic monitoring to reject suggested information. This makes sense in terms of fuzzy-trace theory's consideration of recollection rejection and diagnostic monitoring (Reyna & Brainerd, 1995). Recollection rejection may be used when false information matches the gist (e.g., Samantha Stone caused clumsy accidents) but violates the verbatim (e.g., Samantha Stone did not cause *that* clumsy accident). Children are skilled at verbatim memory. In comparison, diagnostic monitoring requires recognition that the event in question violates the gist of the experience. Gist memory develops throughout childhood, this is the reason children are less prone to related spontaneously false memories than adults (Gomes & Brainerd, 2013), therefore the ability to spontaneously use diagnostic monitoring to reject suggested false memories might develop later than the ability to use recollection rejection in the same way. Alternatively, children may be able to use diagnostic monitoring at a younger age when the suggested events are not connected to the character of the source of the event. Future research should examine how children use diagnostic monitoring in these contexts.

Conclusions

Our study examined developmental trends in the use of metacognitive strategies in the misinformation paradigm. All participants used recollection rejection. Third graders were able to take advantage of mutually exclusive details to reject false information, an ability that first graders did not demonstrate. In contrast, we did not find evidence that bizarre events increased diagnostic monitoring, potentially because the distinctiveness of bizarre events were offset by expectations set in the stereotype induction. Metacognitive strategies can be useful tools for rejecting false memories, which are problematic for eyewitness. However, the use of metacognitive strategies extends beyond this to daily life and learning in school. Future research should further examine the onset of these strategies and their use in real-world contexts.

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Appendix

Nonbizarre

Spilling crayons
Spilling juice
Spilling a soda
Knocking a board game off a table
Breaking chalk
Spilling the contents of a backpack

Bizarre

Putting flowers in a vase upside down
A hot dog falling out of a bag
A comb falling in the toilet
Dropping ice cream on a hamburger
Dropping a toy bowling ball in a pie
Putting whipped cream on a teddy bear