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False Memory in Children: Data, Theory, and Legal Implications

Valerie F. Reyna
Britain Mills
Steven Estrada
Charles J. Brainerd
Cornell University

False memory is an area of intense research interest for both theoretical and practical reasons. From a theoretical perspective, false memories have been the subject of hot debates about the nature of human memory and a focal point for old and new memory theories. From a practical perspective, false memories are a threat to the validity of eyewitness testimony, a misleading source of autobiographical information in psychotherapy, and a biased representation of lessons taught in educational settings. True memories represent events as they really happened, whereas false memories shade, distort, or entirely misrepresent what really happened. False memories may sometimes seem to be only subtly different from strictly accurate reports of experienced events, as when witnesses misremember true inferences about events as though the inferences were directly experienced. Such false memories, which are often confidently reported as directly witnessed, are ubiquitous in everyday life. However, the distinction between inference and experience is crucial in many real-world contexts, especially in legal settings (Reyna & Brainerd, 1998). Eyewitnesses are not called upon to report their theories of events, but, rather, what they actually remember experiencing. Although some inferences turn out to be consistent with the facts, others are based on prejudice, ignorance, and unfounded suppositions (Nisbett & Ross, 1980). Thus, justice requires that we minimize the influence of false memories in legal proceedings at every stage in which children are interviewed, from the crime scene to the courtroom

In this chapter we review evidence concerning false memories of multiple types in children, whose perceived competence as witnesses has shifted dramatically in the last 20 years. The general question that concerns us is whether children's memory is essentially accurate (and under what conditions), and whether their memory is more or less accurate compared with that of adults. To these ends, we have divided the published literature on children's false memory into three sections: spontaneous false memory for meaningful materials (e.g., sentences, pictures, numbers, or stories), false memory in the Deese-Roediger-McDermott word-list paradigm, and resistance to and rejection of false memories in a variety of paradigms. Within each section, we review the major findings, discuss explanations for those findings (including schema, activation, source-monitoring, and fuzzy-trace theories), and, in a final section, draw out their social and legal policy implications.

As an advance organizer, it is useful to describe the content and approach of this chapter. We review the latest research concerning children's false memory, mainly focusing on laboratory tasks because those tasks cleanly test hypotheses about which factors produce and reduce false memories. For those readers who are most interested in practical applications, the last section provides an overview of social and legal implications of false-memory research. However, understanding the evidentiary basis for recommended practice, discussed in the initial sections of this chapter, is essential in court. Ironically, basic research using laboratory tasks is often more applicable to real-life legal cases than research that mimics the complexities of real life (see Brainerd & Reyna, in
[AQ1] press; Brainerd, Reyna, & Poole, 2000; Reyna, Holliday, & Marche, 2002, for details). The reason for this difference in trustworthiness is that well-designed laboratory tasks isolate causes for human behavior (rather than jumbling up multiple possible causes and effects, as happens in real life). Results of sound scientific studies, especially those that have been replicated, provide evidence for general causal principles that predict behavior in real life.

For example, asking child witnesses to generate inferences about what might have happened in order to draw them out is likely to produce not only false testimony but also false memories—confident beliefs that whatever was produced actually happened. In this chapter we explain how experiments conducted under controlled conditions show that repeatedly encouraging inferences (with the use of a variety of methods) leads to later confident assertions that those inferences were experienced. Thus, readers who are interested primarily in practical applications of research should think about laboratory experiments as analogous to events in real life and try to extract the general principles or rules of thumb that experiments have demonstrated to be true about human behavior. Specifically, they should think of the words, sentences, pictures, and other presented material in experiments as though they were experienced events in the real world and think of memory tests as analogous to investigative interviews. Are there examples of failure of laboratory tasks to generalize to the real world? Indeed, there are such examples, but they are fewer than literal thinkers would have us believe, and, more generally, no single experiment or real-life event for that matter is completely analogous in every respect to another event. Professionals need to think carefully about the underlying causal mechanisms for behavior and about whether those mechanisms apply to the real-life situation, in order to judge whether the analogy holds.

Assumptions about what can and cannot be generalized from laboratory tasks ultimately depend on one's theory of a phenomenon—in this case, of false memory. In that connection, readers should evaluate the following theoretical explanations for false memories in light of the evidence presented below: Are false memories caused by constructing, or making up, memories based on prior knowledge and inference; by activating past associations between the experienced event and related events; by confusing the sources of memories (i.e., whether they were thought up or experienced); or by using mechanisms such as semantic activation and inference to store gist memories of experienced events in parallel with and independent of verbatim memories for the same events? Although these theories of false memory all seem plausible and perhaps indistinguishable, as we discuss, they make strikingly different predictions that have been tested, and the theories have not been uniformly supported by the results of those tests.

SPONTANEOUS FALSE MEMORY FOR MEANINGFUL MATERIALS

In classic sentence memory experiments, Bransford and Franks (1971) showed that adults would falsely recognize sentences that were semantically consistent with presented sentences (and that integrated ideas presented in separate sentences), often with high confidence that those sentences had been presented. For example, given the sentences *The ants ate the sweet jelly* and *The sweet jelly was on the table* (mixed with other sentences of varying lengths), subjects would confidently assert that they had been presented with the sentence *The ants ate the sweet jelly that was on the table*. Confidence was highest for test sentences that combined four ideas that had been expressed separately during the earlier study phase and was significantly higher compared with sentences that, in fact, had been previously presented. In line with earlier findings of schematic memory in adults (Bartlett, 1932), this finding was thought to support the conclusion that human memory is interpretive rather than strictly accurate. Numerous investigators set out to determine whether this dramatic demonstration of false recognition of sentences could be replicated in children.

In one of the earliest demonstrations, Paris and Carter (1973) presented children with sentences expressing spatial relationships much like those that had been given to adults. For example, a child might be told that *The bird is in the cage* and *The cage is under the table*, and given a filler sentence to complete a short narrative. Like adults, children also falsely recognized true inferences, such as *The bird is under the table*, as having been presented earlier. Other studies (e.g., Johnson & Scholnick, 1979; Liben & Posnansky, 1977; Paris & Mahoney, 1974; Prawatt & Cancelli, 1976; Small & Butterworth, 1981) produced similar findings: test sentences that had not been previously presented during the study phase, but which preserved the meaning of presented sentences, were misrecognized more often than sentences that did not preserve meaning. Meaningfully related pictures (Brainerd & Reyna, 1993; Paris & Mahoney, 1974) and numbers (Brainerd & Gordon, 1994) also elicited false recognition of nonpresented materials that were consistent with the patterns of presented materials. For example, given stories that contained numerical information and relationships, such as Farmer Brown has 10 cows, 7 horses, 4 pigs, 3 sheep, and 2 chickens (some stories contained relational statements such as

Farmer Smith has more ducks than turkeys), children falsely recognized the statement that Farmer Brown has more cows than horses as having been presented. Brown, Smiley, Day, Townsend, and Lawton (1977) obtained analogous effects for children's recall, namely, intrusions of thematic ideas in children's retention of stories. The traditional explanation for these kinds of false recognition and recall findings has been that memory is schematic or constructive, which implies that it is difficult to discriminate what has actually been experienced from what has been constructed in the mind based on knowledge, inference, and interpretation.

A developmental corollary of the general notion that memory is constructive is the idea that false recognition and recall should increase with development. Predictions about development usually highlight increasing accuracy and improved performance with increasing age. However, if, as Piaget and Inhelder (1973, p. 382) and many of their cognitive developmental descendants claimed, "the schemata used by the memory are borrowed from the intelligence," then certain kinds of memory errors that are consistent with inferential reasoning should become more common with age. In other words, younger children would be less likely to misrecognize true inferences as having been presented, because they are less likely to make those inferences in the first place.

This prediction of schema theory or constructivism was not borne out by the evidence, however. The evidence for the developmental prediction of greater false recognition of inferences with age or developmental level is mixed. For example, Paris and Carter (1973) and Liben and Posnansky (1977) did not find developmental differences according to age or developmental level, respectively, in types of false recognition. (In some experiments, younger children misrecognized true inferences *more* often than older children, but they also misrecognized other nonpresented sentences as well.) However, Johnson and Scholnick (1979) and Prawatt and Cancelli (1976) did find such differences (increases in false recognition of inferences) associated with cognitive level. In other studies, the opposite developmental trend was observed: developmental decreases in spontaneous false memories for inferences (Ackerman, 1992, 1994; Reyna & Kiernan, 1994, 1995) and for nonexperienced events that are broadly consistent with actually experienced events (Pipe, Gee, Wilson, & Egerton, 1999; Poole & White, 1991). Finally, some investigators reported different developmental trends in different conditions (Brown et al., 1977; Paris & Mahoney, 1974).

Several investigators (Liben & Posnansky, 1977; Paris & Mahoney, 1974; Small and Butterworth, 1981) have pointed out that the conclusion that memory is schematic or constructive is subject to an important methodological confound. In most studies of verbal materials, true test sentences—presented sentences and true inferences—contain words that were presented, whereas false sentences contain new words that had not been presented. Thus, simple familiarity rather than consistency with meaning or inferences is sufficient to account for false recognition of true sentences. Reyna and Kiernan (1994) showed that when familiar wording and truth value of sentences are unconfounded (i.e., true sentences sometimes contain familiar words and other times contain new words, and similarly for false sentences), older children are less likely than younger ones to misrecognize true inferences, regardless of the familiarity of their wording. Older children demonstrated much better verbatim recognition of presented true sentences compared with true inferences or true paraphrases; 9-year olds were 50% more likely to say "old" to presented verbatim sentences versus their nearest true competitors (i.e., the most often misrecognized true nonpresented sentences), whereas 6-year-olds were only 24% more likely to say "old" to the presented sentences versus true nonpresented sentences. The differences between true inferences and false sentences were about the same across age. These results contrast with predictions of schema theory or constructivism, which suggest that memory errors that preserve meaning or inferential gist should be more prevalent among older children; instead, meaning-preserving false recognitions were less likely among older children (see also Reyna & Kiernan, 1995, for another study in which familiarity and meaning consistency were unconfounded, with similar results).

Another prediction of schema theory and constructivism is that recognition judgments of presented sentences and of nonpresented inferences ought to be related. Memory judgments about presented sentences and inferences should both be affected either by common schemata (Piaget & Inhelder, 1973) or by their consistency with a semantic representation of presented information (Paris & Carter, 1973). For example, Paris and Carter argue explicitly that false recognition of inferences should be more likely when presented sentences (that support the inferences) are remembered. This prediction of positive dependency—that the tendency to say "old" to true inferences is positively related to the tendency to say "old" to presented sentences that support those specific inferences—was disconfirmed for both children (Reyna & Kiernan, 1994) and for adults (Lim, 1993) with the use of identical materials. Although recognition judgments of presented sentences were independent of judgments of meaning-preserving paraphrases and inferences, judgments of meaning-preserving paraphrases and inferences (i.e., nonpresented true sentences) were positively dependent on one another. Semantic integration occurred for nonpresented true sentences but was independent of memory for verbatim sentences. Similar false recognition and independence effects were found for metaphors and corresponding nonpresented sentences that expressed their interpretations (Reyna & Kiernan, 1995).

Activation theories often apply to recognition of presented and semantically related words (Roediger, Watson, McDermott, & Gallo, 2001) because words are readily represented as fixed items in a mental lexicon (or dictionary), but activation theories of sentences (Anderson, Budiu, & Reder, 2001) have also been developed. Activation theories generally account for false recognition by assuming ancillary activation of semantic neighborhoods or semantically (or associatively) related links in a mental network. For example, if someone hears the word *apple*, it is as if the node for *apple* lights up in the brain, and some activation spreads to related words, such as *banana*. Because activation is shared along a network linking presented items with related nonpresented items, recognition judgments of presented and nonpresented items should clearly be dependent—but, as we have seen, they have been found to be independent. Activation theories would also be hard pressed to account for higher recognition rates for nonpresented related items than presented items (as has been found by Brainerd & Reyna, 1998), because activation dissipates from presented items to related nodes. Thus, it is difficult for activation to be higher for related items than for items that were actually presented, all other factors being equal (Reyna & Lloyd, 1997). If one assumes that activation from related nodes is summated in order to accommodate this effect, it then becomes difficult to account for the fact that people do not routinely mistake concepts related to experienced events as having been directly experienced. Why is remembering that you heard *banana* when you actually heard *apple* not the norm? The significance of this point is that any adequate theory has to simultaneously explain true and false memories.

Source-monitoring theory makes a prediction about dependency that is similar to that made by activation theory (Johnson, Hashtroudi, & Lindsay, 1993). According to this theory, source judgments depend on qualities of the memory for the experienced event (e.g., the event of witnessing a crime or the event of hearing a list of sentences). Source-monitoring theory predicts positive dependency between presented and semantically related items (contrary to data) because both are related to memory for the experienced event. People decide that true inferences were externally presented rather than internally generated, according to this theory, because inferences share features with memory for the experienced event (i.e., shared semantic features), and people do not necessarily retrieve cues from their memory that would distinguish the source of the inference (e.g., evidence of internal cognitive operations, such as remembering thinking of the inference). Source-monitoring theorists have consistently predicted (based on developmental improvements in memory judgments and source discrimination) and often found source monitoring differences between children and adults (and between younger children and older children; for a review, see Roberts [2002]). As Reyna and Lloyd (1997) review in some detail, source-monitoring theory describes many false memory effects in children and adults, but has difficulty accounting for inconsistent developmental patterns (discussed earlier), findings of verbatim-gist independence, as well as other false-memory effects. Source-monitoring theory continues to be an excellent framework for characterization of situations in which memories for information from multiple sources remain intact, even though the sources of the memories are confused. The source-monitoring framework has also generated a special task (in which people judge the specific source of recognized items) that reduces false memories attributable to source confusions. A range of mechanisms from divergent theories, however, may be [AQ2] used to explain these source-confusion errors (see Brainerd & Reyna, ~~in press~~).

The most recent developmental theory of false memory is fuzzy-trace theory, which was designed to build on findings from earlier theories as well as generate new predictions (e.g., Reyna & Brainerd, 1995, 1998; Reyna, Holliday, & Marche, 2002). According to fuzzy-trace theory, children extract separate verbatim and gist representations of experience (i.e., these representations are not semantically integrated) that become inaccessible at different rates over time. With development, older children become better able to acquire and retain verbatim information, compared with when they were younger. They also become better able to understand and spontaneously connect the semantic gist or meaning of related events. The experiments of Reyna and Kiernan (1994, 1995) were generated to test predictions of fuzzy-trace theory, and results were found to be supportive of the theory. Reyna and Brainerd (1995) outline a number of factors that predictably affect the accessibility of verbatim versus gist memories and, thus, the tendency to falsely recognize and recall gist-consistent materials, including words, sentences, pictures, and numbers. These factors include delay (verbatim memory becomes inaccessible more rapidly over time than memory for gist), age (verbatim and gist memory develop with age), materials (pictures and metaphors, for example, support more enduring verbatim memories compared with words and literal sentences, respectively), and instructions (instructions to use verbatim memory, as opposed to meaning instructions, reliably affect recognition and recall judgments). These assumptions account for the results we have reviewed thus far, as well as other findings, for instance, that judgments of presented sentences and true inferences become positively dependent after a retention interval (e.g., an interval of a week or more between presentation of sentences and memory testing). According to this theory, once verbatim memories for presented sentences are no longer accessible after a delay, judgments of both presented and true related sentences are made on the basis of semantic gist.

Additional false-memory phenomena generated by fuzzy-trace theory (and demonstrated in children) include mere-memory testing (prior nonsuggestive memory tests of semantically related material increase false recognition for that material), false memory persistence (gist-based false memories are more persistent over time than initially verbatim-based true memories), repeated cuing of gist (gist repetition, especially unopposed by verbatim repetition, produces vivid false recognition), and false-recognition reversal (semantically related items can be misrecognized less often than unrelated items under conditions of high verbatim priming or accessibility; see Brainerd & Reyna, 2002, ~~in press~~; Reyna & Brainerd, 1995; and Reyna & Lloyd, 1997 for discussions). There is some [AQ3] debate over whether fuzzy-trace theory uniquely predicts these effects or whether source-monitoring theory could be extended to cover these findings (Lindsay & Johnson, 2000; Reyna, 2000). The bottom line of these variants on standard false-memory effects is that they demonstrate the ease with which natural properties of human memory conspire to create false memories in everyday life and that conditions that strengthen or cue gist memories are likely to increase spontaneous false memories in children. As Reyna and Lloyd (1997) discuss, internally generated inferences and semantic gist can be made more accessible through externally provided cues that work in synergy with a prepared mind

FALSE MEMORY IN THE DEESE-ROEDIGER-McDERMOTT WORD-LIST PARADIGM

In tasks involving spontaneous false memory in which memory is tested shortly after materials are presented, the typical pattern of findings for elementary school-aged children and for adults is that presented items are recognized more readily than semantically related false items are misreported as “recognized.” (Younger preschool-aged children are more variable in their responses and have less accurate verbatim memories.) The extent to which children and adults discriminate between presented items and semantically related items hinges on the nature of instructions. Reyna and Kiernan (1994) determined that it was essential to explicitly present true nonpresented sentences and explain that they should be rejected; otherwise, children and many adults assumed that instructions to affirm only sentences that were the “same” as those that were presented

meant that they should affirm sentences that were the *same in meaning*, not in surface form. Verbatim identity instructions are unnatural in everyday life and, thus, require special procedures (e.g., concrete examples), although they mimic the constraints of legal testimony. Investigations subsequent to those of Bransford and Franks (1971), in which familiarity of elements and other methodological confounds are better controlled, have shown that their dramatic false recognition effects are difficult to replicate when instructions to reject meaning-consistent items are clear (for a review, see Brainerd &
[AQ4] Reyna, in press).

However, dramatic false recognition and recall effects have been reliably obtained in adults with the use of the Deese-Roediger-McDermott (DRM) paradigm. The DRM paradigm is a procedure originally devised by Deese (1959) and recently rediscovered by Roediger and McDermott (1995) and Read (1996). The task involves presenting a list of 12–15 words that are semantic associates of a word that is not presented (the critical lure), for example, *nurse, sick, health, hospital, ill* . . . (critical lure: *doctor*); or, *bed, rest, tired, awake* . . . (critical lure: *sleep*). For both recognition and recall, the typical finding is that intrusions of the critical lure occur with a probability that is only about 10% lower than recall of studied items, and false recognition of the critical lure occurs with a probability that is comparable to that of correct recognition of studied items. In addition, subjects report high degrees of confidence in these judgments and often claim to remember experiencing the lure at study when asked whether they "remember" or just "know" that the item was presented.

Although it might seem at first blush that false memories for words from semantically related lists have little to do with forensically relevant memories for real-life events, at a deeper level, the DRM task illustrates many of the common features of forensically relevant memories, and the findings derived from this task appear to apply broadly to memory for complex events. For example, in real life, child victims of crimes often experience repeated, related events (e.g., of abuse). Experiencing subsequent events is likely to cue memories for earlier events that are substantively similar, especially if victims realize that the events are not exact repetitions but are related. If victims connect similar events over time, despite accurate memory for actual details of separate instances, they may nevertheless become confused about whether events that are consistent with the theme of repeated events occurred. In addition, investigative interviews and sworn testimony are likely to take place days, weeks, months, or even years after crimes occurred, making meaning-based memory distortions more likely. Furthermore, the form of memory questions in legal contexts can vary from highly specific, if not leading, questions to open-ended free recall, another factor investigated in DRM studies (see Reyna, 1998, and Reyna, Holliday, & Marche, 2002, for other forensically relevant examples).

Before we proceed to a review of the published research on children's propensity to exhibit false memories in the DRM paradigm (and what this means for the accuracy of their memory reports), it is important to outline some of the major explanations for this dramatic effect. Understanding the nature of the effect in adults provides a context in which effects with children can be interpreted. Deese originally characterized the probability of lure intrusion as a function of the mean associative strength of the list items, defined as the average probability that list words (targets), all of which are associates of the lure, also elicit the lure *as an associate of themselves* (e.g., the average probability that words such as *bed* and *rest*, which are associates of *sleep*, also elicit *sleep* as an associate of themselves). However, Robinson and Roediger (1997) manipulated the number of associates on the studied list by adding lower (i.e., more weakly related) associates or by holding the list length constant and replacing associates with unrelated items. Inasmuch as the mean associative strength of the lists decreases in either situation, Deese's account implies that the probability of falsely recalling the critical lure should decrease under both conditions. In the first condition, Robinson and Roediger found that the probability of falsely recalling the critical item increased with the number of associates on the list; in the second manipulation (holding the list length constant), adding unrelated words had no effect on the probability of lure intrusion. Taken together, these observations suggest that it is the summed backward associative strength—rather than the mean—that determines the probability of lure intrusion. Children's associative networks for words are known to be well established as of the preschool years, and therefore their patterns of activation from that point onward ought to be similar to those of adults (Bjorklund, 1987). Thus, if summed associative strength were the source of DRM effects, then children ought to display those effects. As we discuss in greater detail below, children do not display such effects, which is evidence against the summed activation account.

Variants of Underwood's (1965) notion of an implicit associative response (IAR) have been incorporated into many explanations of the DRM effect. In its original version, the high association between studied items and the lure results in the conscious activation of the lure during study. The lure thus behaves as if it were actually presented in the original list, and the high proportion of "remember" responses given to lures supports this idea. However, this explanation is refuted by the finding by Robinson and Roediger that increasing the number of studied words has opposite effects on the recall of presented words versus critical lures. "Highly associated non-presented items, implicitly activated during study, should reveal the same patterns of recall as do studied words. Clearly, veridical recall drops as a function of the number of studied associated items, whereas false recall increases" (p. 236). Robinson and Roediger entertain a modified activation hypothesis in which the critical lure is activated multiple times, which might explain the increase in the probability of its recall with more opportunities for repetition (although, as discussed below, this account does not explain why critical lures generated in tandem with the study list are not forgotten much the way studied words are).

According to Robinson and Roediger (1997), extant findings are consistent with both a modified activation account (with associative strength equivalent to activation) and a fuzzy-trace theory account based on repeated cuing of gist (each word repeatedly cues the gist theme of the list—and the critical lure is an excellent cue for that gist—although none of the targets are repeated verbatim; e.g., Reyna & Lloyd, 1997). Repeated cuing of the same gist produces vivid false memories that behave, paradoxically, like gist memories in terms of resistance to forgetting and dependence on meaning, but they acquire an illusory intensity that we have called phantom recollection (Brainerd, Wright, Reyna, & Mojardin, 2001). Crucially, for repeated cuing of the same gist to be effective, people must connect the gist from one instance to another. Otherwise, different gists are each cued once, instead of repeated cuing and strengthening of the same gist theme across items. As Holliday, Reyna, and Hayes (2002) and Reyna and Brainerd (1998) discuss, it is important to separate phenomenological experiences (vivid recollection versus vague familiarity) associated with memory representations from the nature of memory representations themselves (precise verbatim memories versus fuzzy gist memories). Although the norm is that vivid recollective phenomenology accompanies retrieval of verbatim memories (and vague familiarity is generally associated with gist memories), when gist is repeatedly cued as in the DRM paradigm whereas each verbatim word is presented only once, gist memories become associated with vivid (but illusory) recollective phenomenology (Brainerd et al., 2001; Brainerd, Payne, Wright, & Reyna, 2003). This fuzzy-trace theory account of the effect of repeated cuing of gist on conscious experience (or phenomenology) of memories was originally applied to memories for inferences (Reyna, 1995; Reyna & Brainerd, 1995; Titcomb & Reyna, 1995) and subsequently applied to the DRM paradigm, without modification.

Source-monitoring theory is sometimes taken to imply, in combination with activation theories, that the critical lure is implicitly activated at study (or at test) but not successfully monitored or gated out at test (Roediger, Watson, McDermott, & Gallo, 2001). However, both the modified activation account and the latter source-monitoring account fail to explain why memory for critical lures endures over time (consistent with memory for gist) rather than following a forgetting process, similar to that of targets, that is initiated at study (e.g., Brainerd et al., 2001, 2003; McDermott, 1996; Payne et al., 1996; Toglia, Neuschatz, & Goodwin, 1999). Source monitoring also encompasses shifts in response criteria or thresholds (Johnson, Hashtroudi, & Lindsay, 1993), that is, that people sometimes adopt looser or stricter criteria for judging a memory as true or experienced (in addition to basing source judgments on perceptual and semantic similarity). However, the DRM effect is unlikely to be influenced by social demand factors or caused exclusively by strategic criterion shifts (compare Miller & Wolford, 1999, with Roediger & McDermott, 1999). The structure of the DRM task minimizes the contribution of demand influences, and this effect is routinely elicited in computerized versions of the task with no experimenter immediately present. According to the criterion shift account, meta-knowledge concerning the gist of studied items makes subjects more likely to respond "old" if the test item is consistent with that gist. However, Gallo, McDermott, Percer, and Roediger (2001) showed that providing detailed instructions about the nature of the DRM task to subjects after study had no effect on false recognition when subjects have studied multiple lists that may or may not have included the critical lure. These considerations illustrate that demand factors or conscious strategizing is not critical to this false memory phenomenon. The failure to find a large role for demand effects or conscious strategies would imply robust false-memory effects in children because conscious strategizing is a late-developing skill. Hence, the DRM false-memory effect does not require metacognitive skills that children lack.

As this review of explanatory mechanisms in the DRM paradigm suggests, traditional developmental predictions vary from early demonstrations of false memory effects (i.e., in younger elementary school-aged children, if not younger) followed by little developmental change, which would seem to fall out of activation theories, to developmental declines in false memory effects as clearly predicted by source-monitoring theory. Fuzzy-trace theory's dual process assumptions lead to predictions of divergent developmental trends under specific conditions (Brainerd & Reyna, ~~in press~~). According to fuzzy-trace [AQ5] theory, children store separate representations of both the exact surface form of their experiences (called *verbatim* traces, although they apply equally to pictures, numbers, events, and other meaningful stimuli in addition to verbal stimuli) and of their interpretation of the meaning of those experiences (called *gist* traces, which capture relations, patterns, inferences, and other elaborations of experience filtered through children's understanding). Both verbatim and gist memory develop; in particular, the ability to use verbatim memories to reject gist-consistent false memories improves during childhood as does the ability to spontaneously notice conceptual (or gist) relations that hold across a series of instances. We discuss the former verbatim developmental trend in the section that follows.

With respect to the latter (connecting-the-gist limitations), ample evidence can be found in studies of free recall of semantically related word lists. When studied word lists can be organized into categorically related subgroups, adults typically cluster those subgroups of words together when they recall the list. When young children recall the same types of lists, they do not cluster words into related subgroups (e.g., Bjorklund, 1987). A series of studies has shown that the lack of clustering is not related to retrieval difficulties, but instead reflects more fundamental differences in noticing and storing meaningful relations that hold across *items*. Children also fail to show proactive interference (Bjorklund & Hock, 1982). Adult recall of a series of word lists involving semantically related items becomes progressively worse on successive related lists; children do not show this effect until adolescence. Hence, based on these data, we would expect that children would be less apt to note that the words *bed, rest, tired, awake* and so on all have to do with sleep—despite understanding each individual word. If the DRM false memory effect is caused by repeated cuing of related gist, then children should be less likely to show the effect because they are less likely to notice the gist theme and thus less likely to accumulate the impact of multiple cues to the same gist.

In the first article published on the DRM effect in children, Brainerd, Reyna, and Forrest (2002) showed that the DRM effect was not present to any significant extent among a sample of 60 five-year-olds in a recall task. For the sake of comparability to adult data, identical lists and procedures were used as in many experiments with adults; children recalled 10 lists seriatim with 12 words per list. Children recalled 23% of studied words per list on average. Intrusions of critical lures occurred for only 6% of lists, compared with about half of the lists in experiments with adults using the same materials (Payne et al., 1996; Roediger & McDermott, 1995). The qualitative adult patterns were also absent in the young children. Adults readily appreciate the gist theme of each list, and not only do they recall critical lures that are consistent with the gist theme of the lists, they also rarely intrude items from different (categorically unrelated) lists. For children, although the critical nonpresented word was recalled for only 6% of lists, 22% of lists produced recall of unrelated words from earlier lists.

Two subsequent experiments replicated and extended these findings. In the second experiment, 5- and 7-year-olds were compared to determine whether onset of formal schooling or other developmental changes from 5 to 7 might increase false memories

(Sameroff & Haith, 1996). Furthermore, lists known to produce the highest levels of false recall in adults were included (and compared with those that produce low levels) to maximize the opportunity to observe an effect. In contrast to patterns for adults, "low" lists produced better recall of presented words than "high" lists for 5- and 7-year-olds—but there was no difference between high and low lists for false recall. There was an age increase in true recall, but not in false recall, which remained very low, as it had been in the first experiment. For example, 5-year-olds recalled 34% and 7-year-olds recalled 40% of the studied items on the low lists. However, only 7% of lists produced false recall of the critical lure. In a third experiment, both recall and recognition were tested, and the age span was widened to include 5-year-olds, 11-year-olds, and young adults. Across this wider age span, differences in false recall were now detected, as one might expect. For young children, false recall of critical words remained very low (7% pooled across the three experiments), high-low list differences were nonexistent but then emerged with age, and intrusions from earlier lists were more prevalent than intrusions of critical words. Adolescents showed qualitative and quantitative patterns that were intermediate between those of young children and those of adults. For example, by adolescence, false recall increased to 27% (compared with 53% in adults). Recognition elicited the same developmental trends in false memory, although false memory effects could be detected even in young children because recognition is a more sensitive measure of memory. These results are clearly consistent with fuzzy-trace theory's prediction that young children will have difficulty connecting the conceptual dots among list words (which results in repeated cuing of the same gist) and thus will be less likely to show DRM false-memory effects.

Brainerd, Holliday, and Reyna (2004) also studied false recognition in children and adolescents with the use of both the DRM paradigm and standard categorized word lists. The novel feature of this research was that an experimental procedure, called *conjoint recognition*, was used that delivers separate measurements of processes that contribute to the DRM illusion, including distinguishing the usual gist-based memory reports that are accompanied by familiarity phenomenology versus gist-based memory reports that are accompanied by phantom recollection (i.e., vivid illusory recollection). In the DRM experiment, children ranged in age from 7 to 14 years and were presented with three blocks of DRM lists, and each block was followed by a recognition test. The probes on recognition tests consisted of studied targets, semantically related distractors (such as critical lures), and other distractors that were unrelated to list themes. Each block consisted of three different DRM lists, for a total of nine lists.

Consistent with the earlier findings of Brainerd et al. (2002) for recognition, the false alarm rates for critical lures were substantial at 51% for 7-year-olds (the youngest age tested), but rates increased appreciably during this age range to near-adult levels of 71%. The conjoint recognition model was used to mathematically separate the relative contributions of different memory processes to these effects. Application of the conjoint recognition model revealed the reasons for this developmental trend: it was due wholly to phantom recollection. Specifically, the tendency of children to falsely recognize critical lures on the basis of familiarity did not change with age, whereas the parallel tendency to falsely recognize critical lures on the basis of phantom recollection increased dramatically with age. Thus, the results of this experiment not only replicate the earlier developmental trend in the DRM effect; they localize the trend within this intriguing illusory phenomenology (which is associated with repeated cuing of gist).

In a second experiment, Brainerd et al. (2004) used the conjoint recognition procedure with categorized lists to test the idea that repeated cuing of gist induces phantom recollection. The subjects in this experiment were in the 5–11-year age range. The procedure was very similar to that of the first experiment. The children received three lists, with a recognition test following each list. Each list was composed of three subgroups of words that were taxonomically related (e.g., exemplars of furniture, colors, and animals). As in the first experiment, the recognition test that followed each list was composed of studied targets, semantically related distractors that were unstudied exemplars of each category, and unrelated distractors that were exemplars of nonpresented categories. Note that there were three gist themes per study list and each gist theme was cued by fewer exemplars, compared with the much larger number of cues to shared gist in the DRM paradigm. Therefore, we would expect less phantom recollection with these materials. In line with this prediction, measured levels of phantom recollection were much lower than in the first experiment, though phantom recollection increased with age as in the first experiment.

In another study using the DRM paradigm, Howe, Cicchetti, Toth, and Cerrito (~~in press~~) focused on special populations of children and conducted both recognition and [AQ6] recall tests. Howe et al. were concerned with the effects of chronic stress associated with child maltreatment on basic memory processes. Differences in basic memory processes between maltreated and nonmaltreated children were examined in an experiment in which middle SES (socioeconomic status), low-SES maltreated, and low-SES nonmaltreated children (aged 5–7, 8–9, and 10–12 years) studied 12 DRM lists. They found that both true and false memories increased with age regardless of whether recall or recognition measures were used, and, contrary to some speculation, these trends did not differ as a function of a history of maltreatment. Like results for older children in the two studies by Brainerd et al., false memories were more likely with high than with low lists, although true recall did not differ. This pattern held for all samples regardless of SES. However, there were differences in memory performance as a function of socioeconomic status (low-SES children had lower accuracy), consistent with other findings in the literature.

Brainerd et al. (2002, 2004) and Howe et al. (~~in press~~) used word lists that had [AQ7] been composed for adults and normed on adults. In several unpublished studies, Reed, Mangan, Warren, Price, and Metzger (2003) and Metzger et al. (2004) used "child appropriate" lists (ones generated by the children themselves) and obtained the same age trends found in the studies of Brainerd et al. (2002, 2004) and Howe et al. Price, Metzger, Williams, Phelps, and Phelps (2001) also found that false recall and recognition of the critical nonpresented words increased between childhood and adolescence and again between adolescence and adulthood. Thus, the adult materials used by Howe et al. and other studies do not seem to produce spurious age trends in true and false memories due to correlations between age and word difficulty.

The finding of Howe et al. that false memories increased with age is consistent with the other findings we have reviewed for the DRM procedure (e.g., Brainerd et al., 2002 and 2004, as well as the unpublished studies discussed above and dissertations discussed below) and is consistent with fuzzy-trace theory's gist-connection explanation. Because it is critical that gist relations among list items be extracted for strong false memories to be generated, younger children whose gist processing is less well developed than that of older children are less likely to be susceptible to the DRM illusion. Indeed, across studies using the DRM paradigm, younger children's overall accuracy (especially for recall) was often found to be higher than older children's because false memory increased more with age than true memory did. Thus, contrary to the literature on children's suggestibility, in which younger children are generally portrayed as being more susceptible to misinformation than older children (see review by Bruck & Ceci, 1999), spontaneous, gist-based false memories in the DRM paradigm are more likely in older than in younger children.

Three additional unpublished studies echo this theme; they all showed developmental increases in the DRM effect (Forrest, 2002; Holliday, Reyna, & Brainerd, 2004; Karibian, 2003). In an unpublished dissertation, Karibian (2003) administered the DRM task to 64 second and fifth graders, 32 at each grade level. Half of the children at each grade level were identified (and had been formally evaluated) as learning disabled and the other half, drawn from the same schools, were not. Karibian presented eight 12-word lists (four high lists, those that produce high levels of false memory in adults, and four low lists) followed by a terminal recognition test. Children either recalled the lists prior to recognition or did not, another factor known to increase levels of false memory on subsequent recognition tests in adults. Analyses comparing ages and disability groups were conducted to determine effects of general learning ability on false memory. Recognition tests included targets, critical lures, other semantically related distractors (the remaining three items from the original 15-item lists), and unrelated items taken from nonpresented DRM lists. Children were tested immediately and after a 1-week delay.

Although null effects (findings of no difference) are subject to the criticism that the study lacked sufficient statistical power to detect differences, the general pattern of results is similar to prior studies with larger sample sizes. As in earlier studies, for recall, the critical distractor was not the most common intrusion. Predominant intrusions were not related to the list theme, in contrast to intrusions for adults, which are almost exclusively related to the list theme. Although recalling DRM word lists increases false recognition in adults, there was no such effect in children.

For recognition, again as in earlier studies, false recognition effects were obtained at all age levels. Although younger children were not significantly less likely to show false recognition effects (the "younger children" were 8.6 years old), learning-disabled children at each age level showed less false recognition than nondisabled children. At the delayed test, both age groups showed false recognition effects, and a small age increase in false recognition emerged.

In another unpublished dissertation, Forrest (2002) had substantially more power to detect differences, with 60 children at each of two age levels, and a wider age range: kindergartners and sixth graders. Forrest presented sixteen 12-word lists, eight high and eight low lists, and half of the lists contained words ordered from strongest to weakest association to the critical word (and the other half were ordered weakest to strongest). The recognition test consisted of the same types of items as on Karibian's test, and recall versus no recall was again manipulated (but within subjects; subjects recalled half of their lists). Finally, half of the lists were tested immediately and all of the lists (previously tested and not) were tested after a delay.

Although adult false recognition has been found to be greater for high (vs. low) lists, strong-to-weak ordered lists (vs. weak-to-strong ordered lists), and lists that have been previously recalled (vs. not recalled), none of these effects were found for the younger children. Only the high-low effect was evident for the older children. As demonstrated in other studies, false recognition and false recall of critical distractors increased substantially with age. True recognition and true recall also increased with age, but as in previous studies, not as substantially as false recognition and recall. Levels of false recall and recognition in younger children, for example, were almost identical to levels observed for the same age group, kindergartners, in the study by Brainerd et al. (2002), and, like that study, levels for older children were higher, but did not quite reach adult levels.

There were qualitative similarities to prior work as well. For younger children, intrusions on the recall test were not predominantly semantic; intrusions were mainly from prior lists that were semantically unrelated to list themes. For older children, approximately half of the intrusions were semantically related to list themes, consisting of a mix of critical lures and other semantically related words. The effects obtained on immediate tests were also obtained on delayed tests. Naturally, the effect of prior (recall) testing could only be evaluated on the delayed (recognition) test. As in the mere-memory testing effect discussed earlier for standard word lists (e.g., Brainerd & Reyna, 1996; Reyna & Lloyd, 1997), prior testing increased false recognition of semantically related items. These findings further support a gist-based explanation for the DRM false memory effect and for its development with age.

Thus far, the studies we have discussed on the DRM paradigm have uncovered similar developmental trends, and their results have resembled one another quantitatively and qualitatively. We have reviewed three published articles containing a total of five experiments (Brainerd et al., 2002, 2004; Howe et al., ~~in press~~): two unpublished [AQ8] dissertations (Forrest, 2002; Karibian, 2003) and three additional unpublished studies (Metzger et al., 2004; Price et al., 2001; Reed et al., 2003), which together suggest that false memories increase with development and that memory errors shift to reflect the gist themes of semantically related word lists. However, in one of the first published studies using the DRM paradigm, Ghetti, Qin, & Goodman (2002) found seemingly contradictory results. As shall become apparent, however, Ghetti et al. implemented methodological changes that place this study in the category of research on resistance to false memories rather than false-memory susceptibility (see the section below on recollection rejection). The key evidence for this claim is that adults failed to show the usual false-memory effects, and children did not differ significantly from this adult pattern.

Ghetti et al. presented 10 lists of 7 words each (rather than the usual 12–15 words) to children (5- and 7-year-olds) and adults. Half of the subjects watched a videotape of an experimenter reading the words, and the other half watched a videotape of the experimenter reading the words but also showing a line drawing of the object named by the word. Source was manipulated by having a male and a female experimenter each read 5 of the 10 lists, in counterbalanced order. Recall occurred after each list was presented, and after all 10 lists were presented, children received a recognition test. The recognition test consisted of 60 items, 30 studied words (3 items from each of the 10 lists) and 30 nonstudied words: 10 critical lures (one from each list), 15 items from nonstudied word lists, and 5 critical lures from nonstudied lists. Children also provided confidence judgments for their recognition responses, using a child-friendly 3-point scale, anchored by a picture of a confident-looking child and an uncertain-looking child.

Ghetti et al. found an improvement in true recall for studied items at each age level, but no difference across age in false recall. However, the overall percentage of false recall was only 20%, and the picture manipulation decreased levels of false recall. Even in the no-picture condition, adults did not show the usual DRM pattern; they recalled 88% of the studied items and a meager 15% of the critical lures. (As we have discussed, the decrease in the number of studied words would be expected to lower false memory levels [Robinson & Roediger, 1997].) When differences in false recall were not detected, Ghetti et al. calculated an alternative measure of false recall and subjected it to planned comparisons involving age. Using this measure (which involved dividing the number of critical lures recalled by the total number of studied and nonstudied words recalled), they found that 5-year-olds had significantly higher false recall scores than older children and adults. However, this measure will yield higher false recall scores in younger children if true recall improves with age and false recall does not change because the same numerator (false recall) would be divided by a bigger and bigger denominator (i.e., true recall that is increasing with age). Thus, it is not accurate to conclude from the alternative scores analysis that false recall is decreasing with age when it is actually not changing.

For recognition, the picture manipulation both increased true recognition and decreased false recognition. As in recall, there was a significant effect of age on true recognition (adults differed from both groups of children), but no age difference for false recognition. Confidence ratings also differed for studied items and critical lures; studied items were endorsed with higher confidence. The typical developmental trend in source discrimination accuracy was obtained (younger children were more accurate than older children and adults in correctly judging which experimenter had read the word), but it was significant only for the picture condition. Apparently, the younger children were inferior in source-monitoring ability (null effects are inconclusive, not evidence against a hypothesis, meaning that the age difference in the picture condition is the only relevant evidence pertaining to source monitoring). However, source monitoring could not explain age differences in false recognition because there were no differences. As in recall, the recognition data for adults were unusual; adults in the no-picture condition correctly recognized 88% of studied items but falsely recognized only 36% of the critical lures (and an even lower percentage of lures in the picture condition, 28%). These unusually low levels of false recall and recognition for adults would make it more difficult to detect age differences, especially age increases in false recall and recognition. Well-known effects of using pictures (memory performance is better for pictures than words, and even better when dual presentation modes are used) and shortening the word lists explain why false recall and recognition were so low. (Perhaps presenting word lists via videotape as opposed to audiotape was also engaging and enhanced encoding.) Therefore, the Ghetti et al. study provides a straightforward test of the main explanatory hypothesis concerning recollection rejection discussed in the next section, namely, that enhancing verbatim memory in traditional ways reduces false memory.

Ghetti et al. compare the major theories of false memory, differentiating the theories' developmental predictions concerning age trends as well as their implications for phenomenological experience. They point out, for example, that the distinctiveness heuristic (e.g., Israel & Schacter, 1997; Schacter, Israel, & Racine, 1999) is based on metacognitive awareness that true memories of studied items should include recollection of distinctive details. For example, if every word has been presented with a picture, people should be less likely to say that a word has been presented if they cannot retrieve the distinctive picture. Because this is a strategic decision process involving adopting a conservative response bias, it is unlikely that young children could implement the distinctiveness heuristic. However, use of item-specific information to better discriminate studied from nonstudied items (or improved encoding or accessibility of verbatim memory traces) would be within the abilities of young children. Thus, the fact that the picture manipulation significantly reduced false recall and recognition in children argues against the use of the distinctiveness heuristic in favor of more basic memory discrimination processes. Ghetti et al. also note that complex inferential processes used to attribute sources to memories (as described by Mather, Henkel, & Johnson, 1997) are also unlikely to be within the abilities of young children.

Ghetti et al. made true memories more distinctive and thereby reduced false memories. However, what underlies the more typical pattern that false memories increase with age? If the fuzzy-trace theory explanation for age differences in DRM effects were correct, it would pinpoint a highly delimited factor to explain the low levels of false-memory effects in young children. The undoing of that factor ought to be correspondingly simple. If children fail to notice that the words all fit a gist theme, then false memories ought to be induced by telling children the gist theme (e.g., names of fruit, words about sleep) of each list prior to study. (Children may also fail to semantically elaborate on each item, which would not necessarily be greatly affected by a single cue prefacing the entire word list.). Brainerd et al. (2004) implemented this simple manipulation of cuing the gist theme for categorized lists (which generally show less false recognition than DRM lists, even in young children), and Holliday et al. (2004) implemented it for DRM lists. As predicted, Brainerd et al. found that false recognition and corresponding levels of phantom recollection increased significantly for both younger and older children (the latter group of fifth graders would be at the threshold of showing clustering effects in free recall and thus could still benefit from cues to connect the gist across items). Holliday et al. also found that false recall rose to significant levels in young children, as predicted.

In focusing on the main explanation for the main findings concerning the DRM effect in children, we do not mean to imply that the inability to connect gist is the only determinant of children's false memory performance. Children's false memory performance is also known to be influenced by less in-depth understanding of the gist of infrequent words, the ability to engage in some rejection processes (i.e., memory for verbatim targets that allows rejection of related lures, reviewed below), and the general developmental trend of increasing dissociation between verbatim and gist processing with age (e.g., Reyna, 1995; Reyna & Kiernan, 1994). Hence, for some difficult or infrequent words on DRM lists, children may have less understanding of their gist; they may be less successful in extracting the gist of such words (although similar age trends have been obtained with easier words). Regarding dissociation, younger children are more likely to rely on gist memories in a verbatim task (such as the DRM or sentence memory tasks that we have discussed) or on verbatim memories in a gist task (e.g., responding on the basis of the literal contents of memory in a comprehension task; Brainerd & Reyna, 1993). Thus, they would be more apt to interpolate gist memories into the DRM task, assuming that those gist memories had been successfully extracted for each item and connected across items. It is unlikely that children engage in some of the other processes that may affect adult performance in the DRM task, such as strategic monitoring (metacognition, or strategic thinking about one's own cognition, is a late-developing skill). This discussion highlights that there is evidence for multiple, countervailing influences on children's false memory. However, it is important to point out that these multiple influences are predicted to influence false memories in specific ways under specific circumstances and that mathematical models have been used to disentangle the relative contributions of underlying opponent processes on manifest behavior. Therefore, despite countervailing influences, it is possible to derive clear expectations for children's false memory performance under a range of concrete conditions.

These countervailing or opponent processes are illustrated in the study by Holliday et al. (2004). In addition to investigating gist cuing, Holliday et al. examined the effect of verbatim repetition on children's false recall and recognition. Children (7-, 9-, 11-, 13-, and 15-year-olds) studied six DRM lists, recalled each list after it was presented, and then responded to a recognition test. Once again, false-alarm rates for nonpresented words increased with age in free recall and recognition tests as predicted by fuzzy-trace theory. As alluded to above, gist cuing increased false recognition of nonpresented words at all age levels. Also as predicted by fuzzy-trace theory, verbatim repetition of lists increased true recall and recognition of targets and decreased false recall and recognition of nonpresented words. As we now discuss, the latter effect pertains to processes that support correct rejections of false items in recognition and resistance to false intrusions in recall.

RESISTING FALSE MEMORIES

The phenomena we have discussed involve factors that generally induce or increase false memories. Although we have noted that false memories result from natural processes of encoding and storing meaningful events, are there equally natural processes for rejecting false memories? If we understood such processes, it should be possible to create conditions that would facilitate accurate memory reports. In many legal cases, memory reports are the main and sometimes the sole evidence concerning a crime—especially for child victims of sexual abuse (for illustrative cases, see Brainerd & Reyna, ~~in press~~). Improving [AQ9] the accuracy of testimony of child victims and witnesses is an attainable goal if we apply the scientific research that is currently available.

The memory-independence finding (e.g., that memory for inferences and other true nonpresented sentences is independent of memory for the presented sentences on which the inferences are based) and the other evidence favoring separate gist and verbatim memory representations suggest a very specific mechanism for rejecting false memories. Remembering exact events becomes increasingly difficult as time passes. The *independence* effect occurs at an intermediate point in time at which experienced events can still be recognized (by retrieving verbatim memories). At a later point in time, only gist memories are accessible and are used to recognize both experienced events (e.g., presented sentences) and gist-consistent items (e.g., true inferences), producing *positive dependency*: remembering the gist of what happened supports saying "yes" in a memory test to both actually experienced events and gist-based reconstructions.

What about the earliest point in time, immediately after events have occurred while they are fresh in one's mind? In that case, verbatim memories would be accessible, given any cue related to the event. An item that expresses the gist of what occurred would remind the witness of what actually happened, which could still be retrieved. Naturally, a verbatim replica of what was experienced would also be an excellent reminder of what actually occurred. Note that retrieving a verbatim memory for what actually occurred should lead to opposite responses: "yes" to the verbatim replica but "no" to the gist-based facsimile. The better the witness remembers the original experience, the easier it would be to reject related (but nonexperienced) lures. The latter relation is one of *negative dependency*.

Reyna and Kiernan (1995) reasoned that the key to inducing negative dependency, the ability to reject nonexperienced lures based on accurate verbatim memories, would be maximizing verbatim accessibility. As we discussed earlier, there are a number of factors that are known to increase the strength or accessibility of verbatim memories, such as materials to be remembered, age of the witness, and delay between the experience and the memory report (e.g., Reyna & Brainerd, 1995). Reyna and Kiernan (1995) obtained the predicted negative dependency with memorable novel metaphors (for which verbatim wording is crucial in conveying meaning) as the to-be-remembered materials, young adult subjects as "witnesses" (who have better verbatim memories than children and older adults), and immediate rather than delayed testing after metaphor presentation. (Metaphors were presented along with other sentences as part of narratives in the study phase, and multiple types of true and false sentences were tested in a recognition task immediately and after a week's delay.) As these levels of factors were replaced, for example, testing children rather than adults, negative dependency decreased and eventually became insignificant.

Brainerd and Reyna (2002) re-analyzed these and other data, using the conjoint recognition model discussed earlier. Parameters of the mathematical model estimated the contribution of verbatim-memory-based rejection of false memories and gist-memory-based acceptance of false memories. Brainerd and Reyna referred to the former process as "recollection rejection." Model parameters estimating these processes responded appropriately to experimental manipulations (e.g., the gist memory parameter increased after delays), providing some assurance that the parameters measure what they purport to measure. (In 12 experiments, Brainerd, Reyna, Wright, & Mojardin [2003] also demonstrated that the recollection rejection parameter responded predictably to verbatim manipulations, such as list repetition and presentation in unusual type fonts.) Consistent with expectations about developmental differences in verbatim memory, there were significant improvements in recollection rejection with development (defined either as age differences or as differences between developmentally delayed and control children of the same age). When the task was not the DRM or other paradigms that involved repeated cuing of the same gist, developmental improvements in recollection rejection overtook developmental improvements in gist-based memory processing, resulting in a net decrease in false memory reports. Also, when younger children did correctly reject false-but-gist-consistent items, their basis for doing so was sometimes different from that of older children. Younger children rejected gist-consistent items, in part, because they failed to access gist representations. For older children, rejection of gist-consistent items occurred despite access to gist representations. However, it should be stressed that recollection rejection significantly contributed to performance even at the youngest age groups (6 years old) tested.

In the study by Brainerd et al. (2004) discussed earlier, with DRM materials and categorized lists, the conjoint recognition model was also used to estimate recollection rejection. Developmental trends for both types of word lists paralleled the results for sentences obtained by Brainerd and Reyna (2002), namely, that recollection rejection improved with age. The developmental relationship between true recollection (which concerned the targets that were actually presented) and recollection rejection was as one might expect if they were both based on verbatim memory for presented targets. For example, using the DRM procedure, the parameters for true recollection and recollection rejection both increased from age 7 to age 14 (and similarly for categorized lists from age 5 to age 11). Brainerd et al. (2004) also implemented a gist cuing manipulation (providing children with the gist theme in advance of each list) in connection with categorized lists. They found that this manipulation reduced recollection rejection (i.e., the recollection rejection parameter was lower) and increased phantom recollection, thereby attenuating age differences.

Recollection rejection does not depend on metacognitive knowledge or complex decision strategies and inferences (though what is recollected may be one ingredient in a metacognitive strategy [Brainerd et al., 2003; Ghetti & Alexander, 2004]) and, thus, is within the capabilities of young children. Because recollection rejection depends on the retrieval of verbatim traces, memory test cuing manipulations that selectively enhance the accessibility of verbatim information (e.g., memory for surface information such as exact wording) should decrease false memory reports. As we have discussed, Ghetti et al. (2002) performed such manipulations, including presenting pictures along with words, as did Holliday et al. (2004), who varied verbatim repetition of targets. Both studies showed that these manipulations reduced false memory effects. Brainerd, Reyna, and Kneer (1995) also performed such manipulations. In five experiments, they presented lists of unrelated common nouns (including typical exemplars of familiar categories, such as *cat* from the category of animals, as well as category names, such as *flowers*) to subjects ranging in age from 5 years old to adults, followed by recognition tests. Recognition tests in different experiments contained such items as presented words, typical exemplars of familiar categories, category names, semantic associates, and words unrelated to any that were presented. The accessibility of verbatim memory was enhanced by varying repetitions of target words at study, among other manipulations. For example, in the first experiment, 30 words were presented once, and the other 30 randomly intermixed words were presented three times each (at least 5 items intervened between presentations of repeated items). On the recognition test, some target-resembling distractors were preceded by presentation of the targets to which they were related. Placing the presented words either immediately prior to their related distractors or several words back (4 other test items intervened between the presented target and its related distractor) on the recognition test was also expected to enhance the accessibility of verbatim memory.

Children were tested under two types of conditions in different experiments: easier verbatim recognition (when the same speaker presented words at study and test) and harder verbatim recognition (when different speakers presented words at study and test). Under more difficult conditions for verbatim recognition, younger children (kindergartners) falsely recognized related distractors at a higher rate than unrelated distractors (gist memory rather than verbatim memory drove responses to distractors), but older children (third graders) showed the opposite result: they falsely recognized related distractors at a lower rate than unrelated distractors (verbatim memory rather than gist memory drove responses to distractors). The latter pattern was called "false recognition reversal" because the usual pattern of greater false recognition for related than for unrelated test items was inverted.

As expected, repetition at study and immediacy of verbatim priming at test both significantly enhanced false-recognition reversal. Under easier verbatim recognition conditions, children as young as 5 years old displayed false recognition reversal, and reversals were again larger when studied items had been repeated and when verbatim priming occurred immediately prior to the related distractor than when it occurred several items back on the test. As would be expected, false-recognition reversal was attenuated or eliminated on delayed tests, presumably because verbatim memories had become less accessible. In another experiment, when related items preceded presented targets on the test (either immediately prior or four items prior to the presented target), the usual false recognition pattern was obtained. Thus, reversals occurred only when presented items preceded related words, arguing against general similarity or response bias strategies. Making what was actually presented more accessible in memory allowed children to recall that item and to reject distractors when presented with any reminder or related cue to the original item. According to fuzzy-trace theory, the memory processes underlying false recognition (gist-based comparisons) and false-recognition reversal (verbatim-based comparisons) are within the purview of younger children as well as older ones (Brainerd & Reyna, 1993; Reyna & Kiernan, 1994, 1995). However, younger children are less likely to display false-recognition reversal than older children because verbatim memory ability continues to develop during childhood.

As our brief review reveals, various phrases have been used to describe processes that involve resistance to false memories, beginning with verbatim-based rejection (e.g., Reyna & Kiernan (1994), negative dependency (e.g., Reyna & Kiernan, 1995), nonidentity judgments (e.g., Brainerd et al., 2001), recollection rejection (e.g., Brainerd & Reyna, 2002), false recognition reversal (Brainerd, Reyna, & Kneer, 1995), and, in studies with adults, recall-to-reject (e.g., Gallo, 2004; Rotello, Macmillan, & Van Tassel, 2000). The last phrase, recall-to-reject, resembles the others in that it involves retrieval of memories for experienced events. However, recall-to-reject assumes that the rejection process involves *recall* (which is more a description of a task rather than an underlying process) and that recall is a unitary process—that recall must involve retrieval of the verbatim trace rather than the gist trace (or, that distinguishing between these dual traces is not necessary). For example, recall-to-reject could logically refer to recalling gist and, thus, rejecting lures because they were not consistent with the gist of experienced events.

The other phrases, in contrast, were all used in the context of fuzzy-trace theory and refer to the same process of retrieving a *verbatim* memory for experienced events in order to reject related items. Because this process involves verbatim memories, the properties of which are well known, we can predict the factors that will facilitate rejection of false memories. Among those factors is pictorial encoding (Brainerd & Reyna, 1993; Israel & Schacter, 1997). As we have discussed, pictures enhance verbatim memory performance relative to comparable words. Although pictures figure in research by Schacter et al. (1999), the use of the distinctiveness heuristic discussed by Schacter et al. should be distinguished from recollection rejection; the latter involves the retrieval of verbatim memories but not necessarily metacognitive strategies. The fact that young children exhibit recollection rejection is among the key pieces of evidence that recollection rejection is not identical with the distinctiveness heuristic. Manipulations, such as pictorial encoding, that improve recollection rejection of false memories do not merely enhance memories. Instead, they selectively enhance verbatim memories (e.g., for presented targets in the DRM paradigm). Other manipulations, such as engaging in deeper semantic processing, similarly improve memory for experienced events (e.g., presented targets), but they also *increase acceptance* of false memories (e.g., for critical lures) (Toglia et al., 1999). Therefore, dual representational assumptions that distinguish gist and verbatim memories are necessary to account for memory-enhancing manipulations that reduce false memories.

OVERVIEW: LEGAL AND SOCIAL IMPLICATIONS OF RESEARCH ON FALSE MEMORY

What does research suggest about the legal and social ramifications of false memory? Although it is now widely acknowledged that false memories can be implanted by actively suggesting misinformation to child witnesses, the threat posed by spontaneous false memories is less well known. Spontaneous false memories begin the moment people encounter and encode experiences. They occur when people experience meaningful stimuli, such as words, sentences, narratives, pictures, numbers, and events. Children and adults are more likely to falsely remember semantically consistent versions of events, compared with inconsistent, unrelated, or meaningless versions. Spontaneous false memories are not always entirely spontaneous (see Table 17.1 for a taxonomy of false

TABLE 17.1
A Continuum of False Memories from Internal to External Suggestion: Illustrative Phenomena

1. Autosuggestion (Bransford & Franks 1971; Reyna & Kiernan 1994)

   True Memory: The bird is in the cage. The cage is under the table.
   False Memory: The bird is under the table.

2. Repeated Cuing (Ackerman 1992; Reyna 1996b; Roediger & McDermott 1995)

   True Memory: nurse, sick, hospital, ill, physician, stethoscope, office, lawyer, patient, medicine. . .
   False Memory: doctor

3. Mere Memory Testing (Brainerd & Reyna 1996; Payne et al. 1996)

   True Memory: dog, book, train, picture, color. . .
   False Memory:
   Question: Did the list contain "animal"? Answer: No
   On a later test or interview: Did the list contain "animal"? Answer: Yes

4. Forced Confabulation (Reyna, Holliday, & Marche, 2002; Zaragoza, Payment, Ackil, Drivdahl, & Beck, 2001)

   True Memory: dog, book, train, picture, color. . .
   Forced Confabulation: Regardless of what you remember, go ahead and tell me the list, "animal, book, train, picture, color. . ."
   Answer: Okay, "animal, book, train, picture, color. . ."
   On a later test or interview: Now, be careful, only tell me what you really remember.
   Answer: Okay, "animal, book, train, picture, color. . ."

5. External Suggestion (Loftus, Miller, & Burns 1978)

   True Memory: dog, book, train, picture, color. . .
   Misinformation Phase: How many words did you see on the list that contained the words "animal, book, train, picture, color. . ."?
   False Memory:
   On a later test or interview: Did the list contain "animal"? Answer: Yes

6. Repeated External Suggestion (Zaragoza & Mitchell 1996)

   True Memory: dog, book, train, picture, color. . .
   Misinformation Phase: How many words did you see on the list that contained the words "animal, book, train, picture, color. . ."?
   Second Misinformation Phase: The list that had the words "animal, book, train, picture, color. . ." was the hardest to remember, wasn't it?
   False Memory:
   On a later test or interview: Did the list contain "animal"? Answer: Yes

7. Coercive Leading Questions (Bruck & Ceci 1997)

   True Memory: Accused was asleep when baby died.
   Coercion: I'll let you go home just as soon as you tell me you shook the baby. I can keep you here until you tell me.

Note: The examples given here do not necessarily reflect those used in the cited papers.

memories that range from internally to externally generated; Reyna & Lloyd, 1997; Reyna, Holliday, & Marche, 2002). Seemingly neutral recall prompts (e.g., *Tell me what happened when you got hurt*.) or recognition probes (e.g., *Did the man who hurt you have a beard?*) can contaminate subsequent memory reports. This contamination operates for semantically consistent suggestions but is far less evident for unrelated material. Thus, it is possible for experts who are familiar with research to identify conditions under which witnesses are likely to report false memories.

In addition, forensic interviews should minimize not only leading questions and suggestions, but also recall prompts and recognition probes that provide information for children to verify. If such prompts and probes are presented, the subsequent history of responses should be tracked. For example, an initial denial that nevertheless cues gist memories, followed by acceptance of gist-consistent suggestions, should be viewed as a potential instance of memory-testing-induced false memory. Research indicates that information provided to children, even indirectly through casual interactions (e.g., with family members) or in formal interviews, can taint memory reports if it reminds children of a particular gist or interpretation of events: Questions such as *Did your step-Dad ever hit you?* and *Did he ever yell at you?* cue the gist that the stepfather is a bad man and increase the probability that he will be remembered as doing a bad thing. This effect is enhanced if the child already harbors such a belief.

Fuzzy-trace theory predicts the results that we have discussed, for example, that when questions cue related gist representations, those representations are more likely to be falsely remembered in subsequent interviews for both children (Brainerd & Reyna, 1996) and adults (Payne, Elie, Blackwell, & Neuschatz, 1996). Although activation, source monitoring, and other false-memory theories might be extended to cover these findings, there are other results that are more difficult to account for, such as memory-independence effects. Moreover, there are patterns of acceptance and rejection of false memories that appear to require opponent process assumptions found in fuzzy-trace theory, specifically, verbatim and gist representations. However, a source-monitoring perspective facilitates considering memory for sources separate from memory for information derived from those sources (contrary to the source-monitoring framework in which source judgments derive from memory for events; Johnson et al., 1993). Furthermore, source-monitoring theories alone, or in combination with an activation metaphor, provide an important perspective on judgment processes that witnesses might use to discriminate internally generated and externally experienced events (Lindsay & Johnson, 2000; Roediger et al., 2001). For example, witnesses can be asked source discrimination questions, such as *Do you remember thinking that he had a knife or did you see the knife? Did you see him hit your friend or did someone tell you that?* However, given the potential for contamination from mere-memory testing effects, such choices should not be offered to children who have not already made related statements and should not be offered to children too young to understand complex sentence structures.

Given that spontaneous false memories are endemic to processing meaningful stimuli, it would seem that they would be pervasive and inevitable. Although meaning-based false memories may be among the most common false memories, research has shown that there are factors—within the capabilities of young children—that can be used to resist false memories. Children's ability to reject false memories by retrieving verbatim memories of experience improves with age and is greater under conditions that foster verbatim memory, such as shorter intervals between events and memory tests. Both verbatim and gist memory abilities improve with age. Ironically, young children's failure to connect the gist across separate instances appears to explain their superior overall memory accuracy, compared with older children and adults, in many studies using the DRM paradigm. This failure-to-connect-the-gist explanation is supported by the shift with age in the nature of intrusions in false recall, which are not predominantly semantic for younger children as they are in adults. The simple manipulation of providing the connected gist theme to children prior to list presentation appreciably increases the rate of false memories. These conditions would be expected to be replicated in forensically relevant contexts when children experience multiple, meaningfully related events (e.g., repeated episodes of sexual abuse). Young children would be expected to be less likely to interpolate gist-consistent events into memory reports that did not occur, compared with older children and adults. Note that older children and adults could have been victimized repeatedly and yet misreport gist-consistent details. The probative status of such misreported details is therefore open to some question. In other words, errors that are gist-consistent do not necessarily throw into doubt either the reliability of the witness or the truth of the remembered event.

These results—that young children are less prone to certain meaning-related memory illusions—are echoed in other research indicating that biased social judgments that reflect prejudices and stereotypes are less likely in young children than in older ones (e.g., Davidson, 1995; Jacobs & Potenza, 1991). Prejudices and stereotypes, unfortunately, develop as children grow older and become more acculturated. Thus, younger children would be less able to distinguish actual experience from gist-consistent alternatives, compared with older children, and yet be less susceptible to false memories that require spontaneously connecting the gist across separate instances. In order to know which situation applies and to judge the accuracy of children's memory reports, it is important to identify factors that promote the accessibility of verbatim and gist memories, which include the age of the child witness, the time interval since the event, the ability of the child to understand the gist of the event, whether multiple related events occurred, the number and nature of recall prompts and recognition probes since the event, and whether pictures or other verbatim prompts can be introduced (without contaminating memory). Although scientific research cannot resolve all uncertainties about the testimony of child witnesses and victims, it can reduce uncertainty and provide a principled basis for best practices in gathering evidence from children.

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