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Fuzzy-Trace Theory and False Memory

Memory Theory in the Courtroom

CHARLES J. BRAINERD

VALERIE F. REYNA
University of Arizona

DEBRA A. POOLE
Central Michigan University

In psychology, interesting empirical effects have a way of accumulating more rapidly than theoretical understanding. This gap can become very wide when a topic captures broad scientific attention, provoking simultaneous experimentation in many laboratories. The burgeoning literature on false memory is a case in point. At the moment, spontaneous and implanted false memories are being intensively studied, outside as well as inside the laboratory, new research paradigms are being developed, and variables are being identified that affect levels of false reporting (see other chapters in this volume). Although the clinical community is still vigorously debating the pervasiveness of potentially falsifying therapeutic techniques (e.g., Berwin, 1997; Pope, 1996), there is no longer any serious doubt about the pervasiveness of memory falsification in the scientific (e.g., Loftus, 1995) and legal (e.g., *State v Hungerford*, 1995; *State v Moran*, 1995) communities.

However, our ability to account for false memories theoretically, to explain them as consequences of underlying processes that systematically distort recollection, is not what it should be. Consider, in this connection,

a featured conclusion of the American Psychological Association's interim report on adults' false memories of childhood sexual abuse: "It is possible to construct convincing pseudo-memories for events that never occurred, although the mechanisms by which this occurs are not well understood" (Denton, 1994, p. 6). Consider, too, Ceci and Bruck's (1993) conclusion, in their review of studies of implanted false memories in children, that "the exact mechanisms involved in producing distortion in young children's reports are still being debated" (p. 432).

Why is theoretical explanation essential? The traditional scientific objectives of prediction and control are perhaps the first answers that come to mind. If researchers can spell out general theoretical principles that cut across experimental paradigms, they can predict new situations in which false memories will be present and, by manipulating the processes that are specified in those principles, they can control resulting levels of falsification. There is another, more practical, answer, however: forensic application.

As experimental demonstrations of false memory have multiplied, so has its use in prosecution and defense submissions in certain types of cases. Although false memory has figured most prominently in allegations of sexual abuse involving children or adults who were children at the time of the alleged abuse, it is cropping up in other types of cases, such as assault and personal injury (e.g., *Dosh v. Block Estate*, 1997). The typical false memory case has three characteristics. First, there is little or no physical evidence that bears on the central allegations. Second, the relevant evidence therefore consists overwhelmingly of witness's recollections of events. Third, attorneys for plaintiffs, defendants, or both have some rationale for claiming that key witness recollections are based on false memories.

In such cases, memory researchers have been asked to provide expert testimony on this claim, often in pretrial evidentiary hearings. The researcher is confronted with the task of reviewing and explaining scientific findings that bear on the case, such as elucidating conditions that are associated with false memories (see Henthrooke & Ceci, 1998, for discussions of expert testimony). If the case ultimately goes to trial, that information may be entered as evidence during direct examination. Under the rules governing admission of expert testimony, experts must demonstrate that the conclusions they offer have achieved general acceptance within the community of experts (Frye test) or were derived from appropriate scientific methods (Daubert test).

What evidence does an expert supply to educate the trier of fact? In the absence of generally accepted theoretical principles, some specific ex-

periment or group of experiments, will normally be cited, with analogies being drawn between its methodology and the details of the target case. Legal cases, however, present unique features that are not captured by individual experiments or groups of experiments. Cross-examining attorneys home in on this fact, identifying salient points of difference between the cited research and the details of the case. The objective is to convince the trier of fact that owing to numerous and fundamental points of difference, the expert's opinion is little more than a leap of faith.

If generally accepted theoretical principles are available, on the other hand, they provide grounds for the expert to select appropriate empirical findings and to argue their relevance to the issues at hand. Theoretical principles, referring as they do to underlying processes that are tapped by the designs of all experiments, are inherently transparent, contrasts in a sea of methodological flux. Scientific theories are predictive because they are, by their nature, applicable to new situations that differ in important respects from the research paradigms from which the principles evolved. Thus, when supplying scientific grounds for the types of conclusions that experts are asked to render in court, a good theory is a very practical thing.

In this chapter, therefore, we focus on theoretical explanations of false memory, with a view toward their forensic ramifications. The chapter is divided into three main sections. In the first, we describe phenomena that are experimental analogues of the false memories that are problematical in legal contexts. In the second, we review a series of theoretical principles that explain those phenomena and that also generate novel predictions that can be used to test the validity of the principles. In the third, we show how these same principles deliver the forensic goods. Predictions that show how these same principles make on four topics of significant forensic interest are considered: age differences in memory falsification; the relative memorability of truth and fiction, including the phenomenon of false confession; the relative consistency of true and false reports; and the effects of nonsuggestive questioning. With each topic, we show how predictions made on theoretical grounds, predictions that have been confirmed empirically, are at odds with the law's view of memory.

CORE PHENOMENA

The scientific study of false memory deals with two broad classes of phenomena: *spontaneous false reports* and *implanted false reports* (Reyna, 1995). The former are products of endogenous distortion mechanisms that are

trace theory (FTT), to show how its principles account for the basic effects in standard paradigms and show how they explain developmental variability. In the next section, we explore predictions about selected forensic questions and summarize recent findings on those predictions.

Principles of FTT

Parallel Verbatim Gist Storage. The first principle deals with the types of memories that participants store about targets and about interpolated misinformation. Many findings suggest that adults and children deposit verbatim traces of targets' surface forms and other item-specific information ("The robber demanded money from the clerk"), plus gist traces of targets' semantic, relational, and elaborative properties ("armed robbery story"; for a review of FTT, see Reyna & Brainerd, 1995). Although verbatim and gist traces are stored for the same inputs (indeed, they are alternative representations of inputs), gist traces do not seem to be extracted from verbatim traces, but, rather, verbatim and gist traces appear to be stored in a parallel manner. Key experimental results that favor parallel storage are ones in which targets' meanings are deposited before the targets themselves have been fully processed (for a review, see Brainerd & Reyna, 1993). The missing-letter effect (Moravcski & Healy, 1995) provides an example: Participants can often fail to recognize the constituent letters of familiar words, even though they have processed and stored the words' meanings. Other examples come from problem-solving tasks in which participants identify global relations among targets after encoding only a few of them (e.g., Brainerd & Reyna, 1995; Reyna & Brainerd, 1990).

Dissociated Verbatim-Gist Retrieval. The second principle is concerned with functional relations between verbatim and gist traces. Prior research on the accessibility of these memories (for reviews, see Brainerd & Poole, 1997; Reyna & Tuckomb, 1996) points to two factors as being especially important in determining whether verbatim or gist traces are retrieved on a memory test: (a) the retrieval cues that are supplied by the test and (b) the rates at which verbatim and gist traces are forgotten. Regarding the first factor, when targets are presented as test items ("The robber demanded money from the clerk"), they are usually better retrieval cues for verbatim than for gist traces, assuming that both types of memories are still accessible (Brainerd, Reyna, & Kneer, 1995). When meaning-sharing distractors are presented ("The robber carried a pistol"), they are usually better retrieval cues for gist traces than for verbatim traces (Reyna & Kiernan, 1994). Consequently, target hits are predominately verbatim

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based, whereas distractor false alarms are predominantly gist based. Although this idea is consistent with modern theories of retrieval (e.g., Tulving & Thomson, 1971), empirical support comes from studies of on-line relations between the retrieval of verbatim and gist memories on memory tests (Ackerman, 1992, 1994; Brainerd & Gordon, 1994; Brainerd & Reyna, 1995; Marx & Henderson, 1996; Reyna, 1996a; Reyna & Kiernan, 1994, 1995). In such studies, it has been found that hits and false-alarms to meaning-sharing distractors often are independent, that some manipulations affect hit rates but not false-alarm rates, that other manipulations affect false-alarm rates but not hit rates, and that still other manipulations have opposite effects on hit and false-alarm rates.

Regarding the second factor, forgetting rates, there is a research tradition that favors the view that verbatim traces become inaccessible more rapidly than gist traces (e.g., Gernsbacher, 1985; Murphy & Shapira, 1994). As time passes, then, the putative memorial basis for initial hits fails more rapidly than that for false alarms. The memories that are accessed by targets therefore will tend to switch from verbatim traces ("The robber demanded money from the clerk") to gist traces ("armed robbery story"), whereas the gist traces that are accessed by distractors ("armed robbery story") will be more stable (Brainerd, Reyna, & Brandse, 1995; Reyna & Kiernan, 1994).

Experiences of Remembrance. The third principle is concerned with the types of subjective impressions that are provoked by the information that participants retrieve on a memory test. Since the appearance of an influential paper by Mandler (1980), a test item has been thought to provoke at least two distinct subjective reactions. One, which has been variously called *recollection* or *feeling of remembering* or *explicit memory*, involves remembrance of having encountered specific items earlier in the experiment. The other, which has been variously called *familiarity* or *feeling of knowing* or *implicit memory*, involves global impressions of having experienced certain meanings or relations earlier in the experiment, impressions that are not grounded in recollection of specific items. One line of evidence that bears on this distinction consists of data showing that the two types of remembrance can have opposite effects on false-alarm rates (Horlton, Pavlick, & Moulin-Julian, 1993). Another line of evidence comes from research on Jacoby's (1991) process-dissociation model. This model contains separate parameters for item-specific recollection and nonspecific familiarity, and manipulations have been identified (e.g., dividing attention at study or at test) that affect one parameter but not the other (for a review, see Brainerd, Reyna, & Mojtardin, 1999).

meaning-sharing distractor, and "The clerk saw the robber's face" would be an inconsistent distractor. Unrelated distractors are administered to secure measures of response bias, which is the tendency to accept an item on some irrelevant basis (e.g., confusion, guessing, response sets).

In spontaneous false-memory experiments, three general findings are that (a) targets are accepted at higher rates than distractors, (b) consistent meaning-sharing distractors are accepted at higher rates than the other two types of distractors, and (c) inconsistent distractors are accepted at higher rates than unrelated distractors (for illustrative data, see Ackerman, 1994; Brainerd & Mojardin, 1998; Brainerd & Reyna, 1996; Reyna & Kiernan, 1994, 1995). The extent to which false alarms to meaning-sharing distractors exceed baseline responses (false alarms to unrelated or inconsistent distractors) is a measure of spontaneous memory falsification (called the *false-recognition effect*). Finding B shows that spontaneous memory falsification responds to variations in the degree of overlap between presented and unrepresented material.

In implantation experiments, the misinformation that is presented before memory is tested typically consists of suggestions about unrepresented but related material that either conflicts with specific targets (e.g., "Do you remember that the clerk saw the robber's face?") or does not conflict with specific targets (e.g., "Do you remember that the robber carried a pistol?"). Two general findings are that (a) hit rates are lower for targets when conflicting information has been presented than when it has not been, and (b) false-alarm rates for distractors are higher when they have been presented as misinformation than when they have not (e.g., Belli, 1989; Mojardin, 1998; Pezdek & Roe, 1995, 1997; Tversky & Tuchin, 1989). Although both results have been called *misinformation effects*, we distinguish them by referring to the former as *hit suppression* and the latter as *false-alarm elevation*.

EXPLAINING FALSE MEMORIES

The preliminary criteria of generality that a theory of false memory should meet are (a) its principles should cut across the standard paradigms in which false memories have been studied; (b) those principles should explain both spontaneous and implanted false memories; (c) those principles should explain developmental variability in false memories; and, crucially, (d) those principles should make novel predictions, including ones about everyday memory phenomena that may have forensic implications. In the present section, we summarize a candidate theory, fuzzy-

part of the everyday functioning of memory (e.g., Wulf, 1922), whereas the latter have the additional feature that they correspond to exogenous misinformation that has been accidentally or deliberately implanted in individuals' memories (e.g., Loftus, 1979). Although many procedures have been used to study these phenomena (cf. other chapters in this volume), most experiments share three characteristics. First, the experimental participants, adults or children or both, are exposed to some memory targets. Depending on the experiment, they may be lists of words, pictures, sentences, statements that form a narrative, or staged events (live or filmed). Second, there is an interpolated activity of some sort. Third, the subjects respond to a memory test.

The first characteristic ensures that false-memory experiments inform forensic work. In legal cases, it is difficult to know which witness statements are based on false memories because there usually is no physical record (e.g., an audio or video recording) of events. In experiments, events are controlled by researchers, so that subsequent false reports can be identified reliably. The second characteristic determines whether an experiment deals with spontaneous or implanted false memories. If spontaneous false memories are the focus, the interpolated activity (e.g., solving arithmetic or spatial problems) is irrelevant to the memory targets (and to later tests). If implanted false memories are the focus, the activity (usually called the *misinformation phase*) presents information that conflicts with target events. The third characteristic supplies measures of true and false reporting. Although recall tests are sometimes administered (e.g., Cassel & Bjorklund, 1995; Cassel, Roehrs, & Bjorklund, 1996), recognition tests are more common (e.g., Brainerd, Reyna, & Brandse, 1995; Ceci, Ross, & Toglia, 1987).

On recognition tests, participants are instructed to accept items that were presented as targets and to reject all other items. Such tests contain some or all of four types of items: targets, unrepresented items that are irrelevant to the targets (*unrelated distractors*), unrepresented items that overlap in meaning with targets and do not conflict with them (*consistent meaning-sharing distractors*), and unrepresented items that conflict with the meaning of targets (*inconsistent meaning-sharing distractors*). For instance, suppose that the targets are statements comprising a narrative about an armed robbery in a store. The statements "The robber wore a mask" and "The robber demanded money from the clerk" appear in the narrative, but the statement "The robber carried a pistol" does not. "The robber demanded money from the clerk" and "The robber wore a mask" would be targets, "There was a shopping cart in the parking lot" would be an unrelated distractor, "The robber carried a pistol" would be a consistent

subsequently exonerated by DNA evidence. Newspapers continue to report cases in which, although neither extreme coercion nor psychopathology was evident, suspects confessed to crimes during interrogation but were exonerated by DNA evidence before trial.

According to FTT, confessing to crimes that were not committed can have a firm basis in suspects' natural memory processes. Because strong gists are operative in criminal investigations, gist-based similarity judgments may make it seem as though events that cannot be remembered must have happened, to suspects as well as to investigators (Reyna, 1998). Furthermore, the fact that strong gists can support illusions of item-specific recollection means that suspects may have clear (but illusory) memories of physical details of crimes that they did not commit (Reyna, 1996b). These principles, that the processing of strong gist memories may support both feelings of familiarity and illusions of item-specific recollection by suspects about events in which they did not participate, leads to predictions about the content of confessions that are known or suspected to be false.

First, statements in which suspects acknowledge that certain things must have happened even though they cannot specifically recollect those things as having happened should be common features of such confessions. According to FTT, these are the sorts of subjective experiences that accompany similarity judgments. In this connection, Ceci and Bruck (1995) provide examples of such statements in questionable confessions that were obtained in child abuse cases. Other examples can be found in the transcript of a confession in a recent California case (*State v. Henderson*, 1997). The defendant, William Martin Henderson, allegedly confessed to a count of child sexual abuse during an interview in which he was moderately intoxicated. However, a review of the transcript reveals that the statements made by Mr. Henderson, which the prosecution represented to the jury as a confession, consisted of instances in which he agreed with assertions by the police interrogator, Detective Martin Eberling, that he must have improperly touched two children. Such instances were accompanied by assertions by Mr. Henderson that although he believed improper touches must have occurred for reasons provided to him by Detective Eberling, he had no recollection of having touched the two children in the alleged manner. Even Detective Eberling's report of the interrogation acknowledged that Mr. Henderson "denies being able to recall the incident, but believes that if his sons saw it, and told him it was true, that it must be." Nevertheless, Mr. Henderson was convicted of sexual abuse, and in post-trial interviews, jury members cited his confession as the principal basis for conviction.

The second prediction that FTT makes is that even when confessions are demonstrably false, they may contain clear recollections by suspects of having participated in events in which they could not possibly have participated. This, of course, is one of the most bewildering features of cases in which competent defendants confessed to crimes, were convicted and imprisoned, but were later exonerated by unimpeachable physical evidence. In some of those cases, the confessions contained vivid recollections of specific events and physical details of crimes that must have been confabulations. According to FTT, suspects can have illusory recollections of specific experiences, even when those experiences have not been suggested to them by interviewers because of reliance on strong gist memories.

The prediction that false confessions routinely contain statements that certain events must have happened but cannot be remembered seems sensible, but the prediction that, in the absence of extreme coercion and psychopathology, false confessions may also be supported by illusory recollections of specific events and physical details vexes our intuition. Prospective evidence from experiments in which the events that suspects experienced are fully known to researchers, rather than retrospective evidence from legal cases, therefore is crucial. Such evidence can be found in a recent study by Kassir and Kiechel (1996). Participants performed a computer reaction-time task and were told that if they deliberately or accidentally pressed a certain key, serious damage to the computer system would result. The computer crashed while subjects were performing the task, and the experimenter accused them of having pressed the key. Computer logs showed that none had actually pressed the key. Following interrogations by a confederate and by the experimenter, however, 69% of the subjects falsely confessed to pressing the key and signed a false confession. Of these subjects, 13% confabulated specific events or details to support their confessions (e.g., "I hit it with the side of my right hand right after you called out the 'A'"). Of special theoretical interest, false confessions were obtained from 100% of the participants in a condition that made it difficult to process verbatim details during the reaction-time task (Method A above), and 35% of these participants confabulated specific events.

True Reports Are More Consistent Than False Ones

It is commonplace for witnesses' statements to contradict each other. Mutually contradictory statements cannot both be true, and, without physical records of events, it is impossible to be certain where the truth lies. However, triers of fact must assign degrees of credibility to conflicting statements in rendering verdicts, and attorneys must decide which

for distractors such as *doctor* and *furniture* averaged 67%. McDermott, using free recall tests, found that after a 2-day delay, correct recall of targets averaged 17%, but incorrect recall of meaning-sharing distractors averaged 24%.

In the same vein, Brainerd and Reyna (1998b), using materials that combined Methods C and E, found that meaning-sharing distractors were accepted at higher rates than targets immediately after presentation when participants were urged to focus on the substance of their experience while responding to memory tests (Method B). Research on such instructions is highly relevant to the memory reports that figure in legal cases, and in psychotherapy as well because, in both instances, practices are used that encourage people to rely on the substance of experience. Brainerd and Reyna (1998b) noted that during the evidence-gathering phase of criminal investigations, police interviewers are trained to use interrogation procedures that coax witnesses to assent to things that they cannot clearly remember (e.g., "Was the robber carrying a pistol?") because those things are consistent with the gist of events that witnesses do clearly remember, or with the gist of witnesses' previous statements, or with the gist of statements made by others. Concerning psychotherapy, they noted that several practices are in routine use (e.g., bibliotherapy, guided imagery, memory regression, memory work, and self-hypnosis) that encourage patients to go beyond what they explicitly remember and recollect things that could or should have happened to them on the basis of beliefs or feelings about their lives. The targets to which the participants in Brainerd and Reyna's (1998b) experiments were exposed consisted either of materials like those in Table 5.1 or of word lists containing multiple exemplars (e.g., *collie, poole, spaniel; Boston, Chicago, New York*) of familiar categories (*dog, city*). When participants were instructed to rely on the substance of their experience, distractors whose meanings had been repeatedly cued (e.g., *dog, city*) were accepted at higher rates than targets (e.g., *collie, Boston*) on immediate memory tests.

Summing up, as predicted, the memorability of events that were not experienced has been found to increase relative to the memorability of actual events when retrieval of gist traces is facilitated. Moreover, also as predicted, evidence has accumulated that under certain conditions, the memorability of nonvents equals or exceeds that of actual events. Such evidence bears on the assumption that witnesses are more likely to remember true events than false ones because, as several writers have commented (e.g., Ceci & Bruck, 1995; Poole & Lindsay, 1995), there are inherent factors that favor reliance on gist in interviews and in sworn testimony, factors that parallel laboratory methods of stimulating gist processing.

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Three factors that are invariably present are that witnesses concentrated on the gist of events as they experienced them (Method A), that gist memories that have been repeatedly cued are operative during interviews and testimony (Method C), and that long intervals elapse between events and witnesses' memory reports (Method D). Concerning the first factor, it is well known that unless instructions to the contrary are received, people's natural tendency is to focus on the meaning of experience rather than on exact surface details (Bransford & Franks, 1971). Concerning the second factor, the crimes (e.g., armed robbery) with which defendants are charged constitute strong uniting themes that have been exemplified by many events of which witnesses are aware. Concerning the third factor, although witness interviews sometimes occur shortly after events, delays of days or weeks are normally involved, and sworn testimony is not taken until weeks, months, or years have passed.

A fourth factor, which parallels Method E, is present in many cases. The key events about which witnesses are questioned are often very good examples of the operative theme (e.g., "Did the robber carry a pistol? Did the robber demand money?"). Unlike the first three factors, this one is not always present in legal cases because the events on which many cases turn are incidental to the operative theme. A fifth factor, which parallels Method B, is the one discussed by Brainerd and Reyna (1998b): Police investigative interviews incorporate procedures that urge witnesses to assent to things that they cannot clearly remember but that are consistent with the gist of events.

A Theory of False Confession. The presence in legal cases of a confluence of gist-facilitating factors means that, as a matter of course, some types of false reports may, for purely memorial reasons, be just as likely or even more likely than some types of true reports to be introduced in evidence and accepted as credible by triers of fact. Another particularly interesting implication is that these gist-facilitating factors may supply a memorial explanation of the puzzling but well-established phenomenon of false confession. Triers of fact regard confessions as singularly credible evidence of guilt (Gudjonsson, 1992), and police interrogation techniques (e.g., Inbau, Reid, & Buckley, 1986) are expressly designed to maximize the chances of obtaining confessions from suspects. False confessions traditionally have been viewed as aberrations resulting from either extreme coercion (e.g., the widely discussed Michael Pardue case in Alabama) or psychopathology. In the decade and half since the advent of DNA testing, however, a number of more prosaic examples have come to light of defendants who confessed to crimes, were convicted and imprisoned but were

edges that recollection is fallible. But common sense is equally firm in its conviction that, overwhelmingly, events that are part of individuals' personal histories are more likely to be remembered than events that are not. This conviction is so deeply embedded in individuals' sense of self that it is both difficult and troubling to imagine that it could be wrong. Consistent with this notion, hits to targets ordinarily exceed false alarms to meaning-sharing distractors by a wide margin in studies of both spontaneous and implanted false memories (e.g., Cassel & Bjorklund, 1995; Reyna & Kiernan, 1994; Tussing & Greene, 1998). Nevertheless, FTT identities circumstances in which things that were never experienced could be just as likely to be remembered as things that were, and circumstances in which things that were never experienced could be more likely to be affirmed.

Such predictions fall out because, according to FTT, verbatim traces simultaneously support identity judgments about actual events (hits) and nonidentity judgments about nonevents with similar meaning (correct rejections) and therefore provide the basis for distinguishing events that were actually experienced from those that could have been experienced. Gist traces support similarity judgments about actual events (hits), but they also support similarity judgments about nonevents with similar meaning (false alarms). Although gist traces may be more likely to support similarity and identity judgments about actual events than about nonevents with similar meaning (because the meaning overlap will be greater for actual events), reliance on such traces will increase false-alarm rates, as compared with reliance on verbatim traces. Thus, shifting the general basis for memory performance toward gist ought to increase the subjective memorability of events that were never experienced, relative to those that were. There are many possible methods of accomplishing this, such as (a) instructing subjects to concentrate on meaning at study (e.g., Toghiani, Neuschatz, & Goodwin, 1998); (b) instructing them to do likewise at test (e.g., Reyna & Kiernan, 1995); (c) presenting several targets at study that converge on a single meaning (e.g., Underwood, 1965); (d) testing memory after a retention interval (e.g., Reyna & Kiernan, 1994); and (e) administering meaning-sharing distractors that are especially good examples of the gist of experience (e.g., Reyna, 1996b).

Reyna and Kiernan (1994, Experiment 1) demonstrated that Method D can make it difficult to discriminate targets from meaning-sharing distractors, even when retention intervals are short in comparison with those in legal cases. They presented sentence triads to children in which the first two stated a familiar relation between common objects (e.g., "The cocoa is hotter than the tea. The tea is hotter than the coffee."), and the third

stated a property of one of the objects (e.g., "The cocoa is very sweet."). Participants were instructed to remember these sentences for later memory tests, and they were given a test immediately after. Discrimination of targets from meaning-sharing distractors (e.g., "The coffee was cooler than the tea. The cocoa was hotter than the coffee.") was excellent, with hit rates averaging 76% and false-alarm rates averaging 38%. A week later, however, false-alarm rates for meaning-sharing distractors were the same as hit rates for targets. In a second experiment, Reyna and Kiernan (1994) found that combining Methods A and B made certain types of meaning-sharing distractors just as memorable as targets on immediate tests. They instructed participants to concentrate on meaning and ignore exact wording as statements were presented and to do likewise on memory tests. On tests that were administered only a few seconds after target presentation, the acceptance rate for targets (80%) and did not differ significantly from the acceptance rate for certain types of meaning-sharing distractors (78%).

Roediger and McDermott (1995) and several other investigators have recently demonstrated that Methods C and E can make meaning-sharing distractors seem just as memorable as targets immediately after study. Participants studied a series of short word lists (cf. Table 5.1), with the targets on each list instantiating a certain theme (e.g., furniture and medical themes in Table 5.1). A word that is an especially good example of a list theme was omitted from each study list (*chair* and *doctor* in Table 5.1), but it was included in test lists. On immediate memory tests, false-alarm rates for these distractors did not differ significantly from hit rates.

Other experiments have established that combinations of the methods listed previously can make events that never happened seem even more memorable than events that did. For instance, Payne et al. (1996) and McDermott (1996) reported experiments in which they combined the procedures of Roediger and McDermott (1995) with a long-term retention interval (Method D). Payne et al. found that after a 1-day delay, hit rates for targets such as *hospital* and *sofa* averaged 56%, but false-alarm rates

TABLE 5.1
Lists of Targets That Converge on Shared Meanings

Shared Meanings	Targets
Furniture words	Table, sit, legs, seat, couch, desk, recliner, sofa, wood, cushion, swivel, stool, sitting, rocking, bench (critical missing word: chair)
Medical words	Nurse, sick, lawyer, medicant, health, hospital, dental, physician, ill, patient, office, stethoscope, surgeon, clinic, cure (critical missing word: doctor)

False Memories Are More Common in Children than Adults

As previously noted, the possibility of false-memory reports is a central concern in cases involving children or adults who were children at the time of alleged events because the law has long held that children's memories are more malleable and prone to falsification than adults'. The prevalence of this assumption is demonstrated in the competency voir dire for children under a specified age (McCrough, 1994). Although there has been a trend in recent years to eliminate statutes that require children to demonstrate competency (Ceci & Bruck, 1995), nonetheless many child witnesses still participate in voir dire, and investigative protocols often include preliminary assessments of children's competency (Poole & Lamb, 1998). These practices have been reinforced by recent literature reviews, which have concluded that preschoolers are more susceptible to misinformation than older children (Ceci & Bruck, 1993; McAuliff, Kovera, & Viswesvaran, 1998).

Contrary to the law's assumption, FTT predicts that there that there is no single, monolithic developmental trend in memory falsification and that, instead, different trends (i.e., age increases, decreases, invariances) can be observed under different conditions. This prediction follows because FTT contains *opponent processes* that (a) have opposite effects on memory falsification but that (b) vary in the same direction with age (Brainerd & Reyna, 1998a). Insofar as spontaneous false memories are concerned, one process supports false alarms to meaning-consistent distractors (gist-based judgments of similarity or false identity), but the other process supports correct rejections (verbatim-based nonidentity judgments). Because both processes improve with age between early childhood and young adulthood, the false recognition effect ought to exhibit developmental decreases within this age range when experimental conditions (e.g., instructions, materials) favor verbatim retrieval, developmental increases when conditions favor gist retrieval, and age invariance when conditions provoke comparable rates of verbatim and gist retrieval.

Insofar as implanted false memories are concerned, we saw that hit suppression is attributed to the retrieval of verbatim traces of misinformation, whereas false-alarm elevation is attributed to this mechanism and to the retrieval of gist traces of targets and of misinformation. As with the false recognition effect, then, memory processes that make performance more accurate and memory processes that make it less accurate both are improving with age (between early childhood and young adulthood). Concerning age variability in hit suppression, the accessibility of verbatim and gist traces of targets improves with age, all of which increase hit rates,

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but so does the accessibility of verbatim traces of misinformation, which decreases hit rates. Concerning age variability in false-alarm elevation, accessibility of verbatim traces of targets improves with age, which decreases false alarms, but so does accessibility of verbatim and gist traces of misinformation and gist traces of targets, which increases false alarms. Hence, inconsistencies in observed developmental trends in misinformation effects can be expected because the opponent memory processes that contribute most to acceptance rates for targets and distractors will vary from study to study as a function of design factors (Reyna, 1996a).

Recent literature reviews have been more consistent with FTT's analysis of developmental change than the law's. Concerning spontaneous false memories, Reyna and Kiernan (1994) reviewed developmental studies of false recognition of meaning-sharing sentences. As predicted, they found that developmental trends varied from study to study. For instance, findings of no age change were obtained in some studies (e.g., Paris & Carter, 1973), whereas other studies obtained contrasting age trends in different conditions (e.g., Brown, Smiley, Day, Townsend, & Lawton, 1977; Paris & Mahoney, 1974). Brainerd and Reyna (1998b) and Tun et al. (1998) reviewed the parallel child and aging literatures, respectively, on false recognition of meaning-sharing words. They, too, noted between-study variations in reported trends.

Developmental variability in implanted false memories also has been the subject of inconsistent findings (Doris, 1991). In their influential literature review, Ceci and Bruck (1993) reported that age declines in misinformation effects had been obtained in most studies. However, they also observed that age declines have usually not been detected after the preschool years and that some studies that included preschoolers failed to detect age declines (e.g., Howe, 1991; Poole & Lindsay, 1996). Recently, developmental increases in misinformation effects have also been reported (Pezdek & Roe, 1995, 1997). In their first study, Pezdek and Roe observed increases in both hit suppression and false-alarm elevation between preschool and age 10. In one of their conditions, there was a 300% increase in hit suppression and a 157% increase in false-alarm elevation. In a second condition, hit suppression was age invariant, but false-alarm elevation increased by 57%.

Truth Is More Memorable Than Fiction

Relative Memorability of Actual Events Versus Nonevents. The most self-evident of all tenets about memory, whether in the courtroom or everyday life, is that events that actually happened to us are more likely to be remembered than events that did not. Naturally, commonsense acknowl-

then falls out of the fact that one of the bases for false alarms (gist retrieval) necessarily is more frequent with meaning-sharing distractors. Higher false-alarm rates for consistent meaning-sharing distractors ("The robber carried a pistol") than for inconsistent distractors ("The clerk saw the robber's face") follows from the fact that the latter can produce retrieval of conflicting verbatim traces (the statement "The robber wore a mask" appeared in the story) but the former cannot (there were no statements about weapons in the narrative).

Second, to account for implanted false memories, both false-alarm elevation and hit suppression must be explained. As with the false-recognition effect, gist retrieval is one basis for false-alarm elevation: Gist memories of inconsistent distractors will be more accessible if those distractors are presented during the misinformation phase. Unlike the false-recognition effect, verbatim retrieval is another basis for false-alarm elevation: Verbatim traces of inconsistent distractors may be retrieved because those distractors were presented during the misinformation phase. If they are retrieved when such distractors are tested, they can support false identity judgments, assuming that the conflict between these distractors and earlier targets was not detected during the misinformation phase (Reyna & Titcomb, 1996).

Concerning hit suppression, unlike false recognition and false-alarm elevation, retrieval of gist traces should not be the basis for this effect because gist traces support hits (e.g., "armed robbery story" supports acceptance, not rejection, of "The robber wore a mask" and "The robber demanded money from the clerk"). If a target ("The robber wore a mask") is subsequently misinformation ("The clerk saw the robber's face"), although the misinformation implants incorrect memories of a surface detail, it also supplies additional practice at retrieving gist memories ("armed robbery story") that will support acceptance of that target. Thus, gist memories may be more accessible for misinformation targets than for control targets that are not presented during the misinformation phase (Reyna, 1996b). The principal reason for hit suppression should therefore be verbatim rather than gist retrieval. The misinformation phase makes additional verbatim traces available ("The clerk saw the robber's face") that conflict with previously stored verbatim traces ("The robber wore a mask"). When the former are retrieved on memory tests, they can support false nonidentity judgments about targets (i.e., hit suppression), again assuming that the conflict between targets and misinformation was not detected during the misinformation phase.

Summing up, in FTT's analysis of implanted false memories, retrieval of verbatim traces of misinformation can lower hit rates (through false

nonidentity judgments) and raise false-alarm rates (through false identity judgments). Furthermore, retrieval of gist traces of misinformation can increase false-alarm rates (through similarity judgments or false identity judgments). This analysis leads to a straightforward prediction on which data are available. Other things being equal, false-alarm elevation should exceed hit suppression. Misinformation implants verbatim memories that conflict with surface details of target material and that will therefore support false alarms to misinformation-embodied distractors and incorrect rejections of targets. Data that are consistent with this scenario have been reported by Tversky and Tuchin (1989) and by Pezdek and Roe (1995). Tversky and Tuchin found that false-alarm elevation was roughly one third greater than hit suppression, and in Pezdek and Roe's (1995) experiment, false-alarm elevation was roughly five times greater than hit suppression.

THEORETICAL PREDICTIONS AND THE LAW'S VIEW OF MEMORY

It is not widely understood that prediction is the litmus test of theory. Although theories must, of necessity, explain known effects, that is only the first step. Explanations of known effects are postdictions, and the history of psychology teaches that there are many ways of postdicting any set of findings. Explanations should therefore be regarded as promissory notes that need to be tested by assessing their power to forecast new effects, especially ones that are not anticipated by competing theories or that seem counterintuitive on their face. Such predictions have been emphasized in research on FTT (Miller & Bjorklund, 1998).

Our aim in this section is not to undertake a comprehensive review of those predictions but to address a related forensic question: Does FTT make any novel or counterintuitive predictions in the forensic sphere? Experience has shown that it does (e.g., Poole, 1995). Moreover, some of its predictions challenge well-known assumptions that the law makes about the memory reports of witnesses (Reyna, 1998; Reyna & Brainerd, 1997; Wahlmuth, 1997). We examine predictions and data that challenge four assumptions: (a) that false memories are more common in children than adults; (b) that truth is more memorable than fiction; (c) that reports of true events are more consistent than reports of false events; and (d) that neutral, nonsuggestive questioning does not falsify memory. Although these assumptions are cornerstones of the law's view of memory, FTT predicts that each will be violated under conditions that the theory specifies.

In FTI, retrieval of verbatim traces supports feelings of item-specific recollection, whereas feelings of nonspecific familiarity are supported by retrieval of gist memories (Brainerd & Reyna, 1998a). Retrieval of verbatim traces produces access to representations of particularized surface structures, leading to feelings of reexperiencing those surface structures (e.g., the exact wording of "The robber demanded money from the clerk" is seen in the mind's eye or heard in the mind's ear). On the other hand, retrieval of gist memories produces access to semantic information, which can lead to feelings of reexperiencing familiar meanings ("armed robbery story") that are not accompanied by recollection of specific target events but are consistent with many possible events (e.g., robbers usually wear masks and carry weapons).

Although retrieval of gist memories can support nonspecific impressions of having experienced certain meanings or relations, recent studies suggest that, under some conditions, it can also support feelings of item-specific recollection (for a review, see Reyna & Lloyd, 1997). So far, the two experimental conditions that seem to induce gist-based feelings of item-specific recollection are (a) retrieved gist memories represent meanings that have been repeatedly cued at study and therefore are very strong (e.g., "armed robbery story" is cued by multiple statements in the narrative), and (b) meaning-consistent test items provide privileged access to those meanings, as when statements involving the word "crime" provide privileged access to meanings that were stored during a robbery story (Brainerd & Reyna, 1998b; Reyna, 1996a, 1996b). Although it appears that gist memories can sometimes support feelings of item-specific recollection, it is clear, empirically, that those feelings have a different origin than those that accompany the retrieval of verbatim traces because they can occur for meaning-sharing distractors that were never experienced (cf. Payne, Elie, Blackwell, & Neuschatz, 1996; Reyna, 1996b; Reyna & Kierman, 1994; Robinson & Roediger, 1997).

Identity, Nonidentity, and Similarity. The final principle is concerned with the types of judgments about test items that are supported by item-specific recollection and nonspecific familiarity. Experimental findings (e.g., Brainerd, Reyna, & Kneer, 1995; Hintzman & Curran, 1994) have suggested that feelings of item-specific recollection support all-or-none judgments of identity-nonidentity about test items, whereas feelings of nonspecific familiarity support graded similarity judgments. When a verbatim memory is retrieved, comparison to the surface form of the test item will support a categorical judgment of identity or nonidentity of surface forms (Brainerd, Reyna, & Kneer, 1995). When a gist memory is re-

trieved, the memory produces feelings of nonspecific familiarity; comparison to the gist representation of the test item will support a judgment of degree of similarity between the contents of the representations (Schacter, Verfaellie, & Aves, 1997; Tun, Wingfield, Rosen, & Blanchard, 1998). But when a retrieved gist memory is strong, it can provoke feelings of item-specific recollection (Brainerd & Reyna, 1998a; Reyna, 1996b).

Behaviorally, verbatim retrieval supports target hits (identity judgments) and correct rejections of meaning-sharing distractors (nonidentity judgments; Brainerd et al., 1999; Brainerd, Stein, & Reyna, 1998). For instance, retrieval of the verbatim trace of "The robber wore a mask" supports acceptance of that test item, but it also supports rejection of "The clerk saw the robber's face." Verbatim retrieval leads to across-the-board rejection of distractors such as the latter, as well as meaning-consistent distractors such as the "The robber carried a pistol," because no matter how much meaning overlap there is, a demonstrable mismatch exists between the remembered surface forms of the presented statements and the surface forms of the test items (Brainerd, Reyna, & Kneer, 1995; Clark & Gronlund, 1996). Thus, verbatim retrieval can provoke either judgments of identity of surface forms (e.g., when the probe is the target that produced that trace) or judgments of nonidentity of surface forms (e.g., when the probe is a meaning-sharing distractor or some other target).

Gist retrieval also will support target hits. If the accompanying subjective experience is nonspecific familiarity, hits result when the judged level of meaning overlap is great enough to exceed some subjective threshold. Unlike verbatim retrieval, gist retrieval will also support false alarms to meaning-sharing distractors—again, from similarity judgment if the accompanying experience is familiarity or if the accompanying experience is item-specific recollection.

Explaining Spontaneous and Implanted False Reports

The four principles that we have just summarized are used in the following way to explain the two basic types of false-memory reports. First, to account for spontaneous false memories, false alarms to meaning-sharing distractors ("The robber carried a pistol") can occur for two main reasons: retrieval of gist memories of targets and reliance on various nonmemory processes (e.g., response bias). When gist memories are retrieved, false alarms can be inferences that are based on familiarity of meaning ("It was an armed robbery story and robbers usually carry guns") or illusions of item-specific recollection. The false-recognition effect (i.e., higher false-alarm rates for meaning-sharing distractors than for unrelated distractors)