MEMORY AND SUGGESTIBILITY IN THE FORENSIC INTERVIEW

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Processes Affecting Accuracy and Distortion in Memory: An Overview

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The empirical study of human memory is 115 years old, dating from Ebbinghaus's (1885/1964) pioneering investigations. Throughout most of the history of the study of memory, investigators focused on factors that affect accurate remembering: repetition of information, spacing of repetitions, retention interval, types of material, retrieval cues, and dozens more. Researchers have usually assessed accurate responding on memory tests or they have measured *forgetting*, typically defined as omissions of response on tests as a function of delay. Researchers rarely provided systematic investigations of various errors in memory, although a few early studies examined errors (see Roediger, 1996; Schacter, 1995, for the history of memory distortion research). It has only been relatively recently (since about 1970) that experimental psychologists began the systematic investigation of errors of memory. We may refer to *memory illusions* as occurring when people remember events quite differently from the way they originally happened or, in the most dramatic case, remembering events that never happened at all (Roediger, 1996). The goal of this chapter is to provide a brief overview of factors affecting both veridical and illusory memories that may be relevant for forensic purposes.

We choose as our object of understanding a person's encoding, storage, and retrieval of an event. Each term in the previous sentence needs elaboration. The term *event* is ambiguous and may refer to simple events (studying a list of words or pictures, or even the study of a single word or picture in a list) or complex ones, such as witnessing an armed robbery.

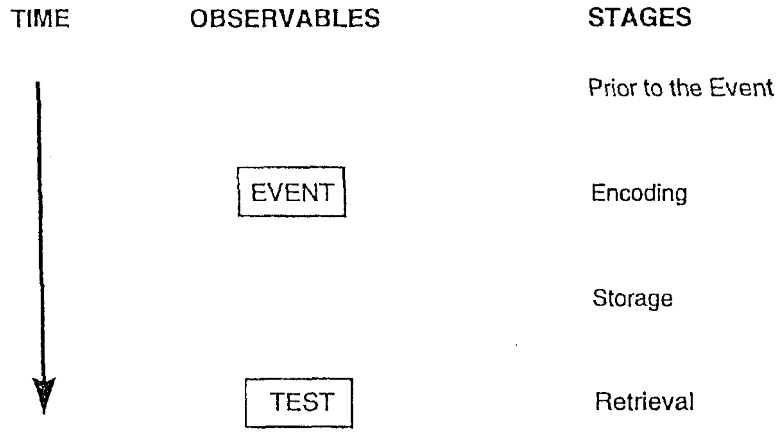

FIG. 1.1. The four stages of the learning–memory process that are relevant to understanding how an event is remembered. Although factors occurring at each stage can influence later remembering, only the event in question and the response to retrieval query (test) can actually be observed. Note that these stages are theoretically useful, but difficult to separate in experiments.

No matter what the scope or complexity of an event, however, the description of memory for it can be usefully separated into encoding of the event (its original perception and acquisition), its retention over time due to some change in the nervous system that can be called memory storage, and its later retrieval in response to some query.

Figure 1.1 provides the organizational theme of this chapter. We examine the retention of events in terms of (a) factors occurring before the event in question, (b) factors operating during encoding of the event, (c) processes occurring after the event that might alter its retention, and finally (d) processes operating during retrieval of the event. Some factors operating at each stage may enhance memory for the event, whereas others may hamper future retrieval and increase the likelihood of erroneous retrieval. Our goal in writing this chapter is not to be exhaustive—we could not be—but to highlight some salient points at each stage in the learning–memory process that should be kept in mind when considering the forensic issues of memory.

FACTORS OCCURRING PRIOR TO THE EVENT

It might seem odd to consider factors that operate prior to the occurrence of an event as affecting its later retention, but in fact such prior factors can be critical. Even if several people experience "the same" event, they will interpret it differently depending on their prior experiences. Each person perceives an event with different backgrounds and proclivities. Each of us has had different experiences and likewise has different attitudes, knowledge, dispositions, and biases. Bartlett (1932) captured these differences in background knowledge with the term *schemata*, which are mental structures that organize our past experiences. Bartlett argued that memory is affected by how well (or poorly) we can encode new experiences in terms of schemata developed from our past experiences.

Bartlett (1932) conducted some casual experiments requiring English college students to remember a Native American folktale, "The War of the Ghosts." Because this story, filled with supernatural elements, was unlike the typical stories or experiences of his students, their schemata were not sufficiently developed for remembering the story. The students inserted systematic errors into their recalls of the story, making it more like a fairytale in its retelling. They had adapted the story to their own schemata. In general, past knowledge can distort memory by providing us with a set of categories into which we try to pigeonhole our new experiences, whether or not they fit.

Past experience can also enhance retention. If new information fits well with prior knowledge or schemata, retention of the information is generally better than when information does not fit. This point is aptly demonstrated in the psychological literature; people who are experts in some domain usually remember new information about that domain better than other people with less background knowledge. In these instances, background knowledge allows us to organize and make sense of incoming information. More prosaically, memory for material that is organized meaningfully is better remembered than when the same material is presented in a scrambled and less meaningful manner.

Consider a thought experiment: Two groups of subjects are asked to remember a long string of digits in order, after it is read once at the rate of one second per digit. Try it yourself by covering up the page after reading these digits and recalling them: 1, 4, 9, 1, 6, 2, 5, 3, 6, 4, 9, 6, 4, 8, 1. In our hypothetical experiment, one group would be tested as you were and they would not remember the series well, getting perhaps seven or so digits correct. Another group, however, would be instructed before they read the digits that the numbers would represent the squares of the numbers 1 to 9 (1 squared is 1, 2 squared is 4, etc.). For this group, the same list would be read, but recall would be perfect. The two groups experienced "the same event" being read to them, but in one case relevant knowledge (the schema for the digits) had been activated prior to study, whereas in the other case it had not. Again, retention is usually better when material can be interpreted in terms of relevant prior knowledge.

Exposure to prior material can also interfere with new learning and retention (Underwood, 1957). Consider the case in which you might have to remember details of a crime scene over long periods of time. If you have seen many crime scenes because you are a police detective, it might be difficult to remember the current scene because of interference from many crime scenes that you previously observed and studied. The process of similar events becoming confused in memory is referred to as *interference*. When prior events are confused with memory for a more recent event, it is called *proactive interference* (we discuss other types of interference later). Proactive interference in memory for an event is generally weak immediately after the event is experienced, but increases over time. To return to the case of the police detective who visits many crime scenes, she might have good retention for the most recent crime immediately after she studied it. But, if queried weeks later, the many prior crime scenes might provoke interference in her memory for the particular scene of interest. In general, the more closely the events in memory resemble one another, the more difficult it is to remember the details of one particular event without interference from the others.

Background characteristics of a person can also affect how well he or she retains events. In general, young children usually remember events less well than older children or adults, whereas older adults remember more poorly than young adults. Relative to young adults, both children and older adults are also more susceptible to interference effects. Memories from early in life, typically before the ages of 3 to 4, are often unreliable. The terms *infantile amnesia* or *childhood amnesia* refer to the notion that people generally recall little or nothing from this early period of life once they reach adulthood. However, children are clearly learning during these early years; the difficulty is consciously recollecting the information later (see Howe & Courage, 1993, for a review). Other people showing signs of profound amnesia are those who have suffered brain injuries (strokes, closed head injuries, damage from neurosurgery to remove tumors, etc.). Some debilitating neurological diseases (e.g., Alzheimer's disease) and other psychiatric illnesses (schizophrenia) can impair memory. Depressed people also generally show declines in memory.

Other personality characteristics can also affect retention. For example, some evidence suggests that a measure of how "spacy" people are predicts the occurrence of false memories in several paradigms. The measure is called the Dissociative Experiences Scale (DES), and it asks people to estimate how often they have experiences such as "listening to someone talk and they suddenly realize that they did not hear part or all of what was said," or "not being sure whether things that they remember happening really did happen or whether they just dreamed them" (Bernstein & Putnam, 1986). People who score high on this test tend to be more susceptible to false memories (Hyman & Billings, 1998; Winograd, Peluso, & Glover, 1998).

This section described some background factors that individuals bring to events that are relevant to accuracy and distortions in remembering. However, the statements in this section tell only part of the story. In order to influence memory, these background factors must affect how people encode, retain, or retrieve events. We return to some of these variables later.

THE ENCODING, STORAGE, AND RETRIEVAL FRAMEWORK

The remainder of this chapter is organized around the standard encoding-storage-retrieval conception of memory (Melton, 1963). As previously noted, encoding refers to the initial registration of information—its perception and the immediate postperceptual processing. *Retention* or *storage* refers to the maintenance of information over time, once it has been encoded. *Retrieval* refers to the utilization of stored information. When performance on a memory test reflects accurate responding—a person successfully remembers some past event—an inference can be made that all three stages were intact.

Although this three-stage conception of the learning-memory process is logically sound, in actual practice it is problematic for two reasons (Roediger & Guynn, 1996). First, it is difficult to separate the processes of encoding and storage. When does encoding end and storage or retention begin? Similarly, when forgetting occurs (response omission), or when there is an error of commission—a false memory—it is difficult to determine where the problem occurred. Was the information miscoded? Did processes operating during the retention interval produce interference, thereby causing the information to be misremembered? Or, was the information never encoded in the first place, and wrongly reconstructed during retrieval?

A second problem is that all three stages of the learning-memory process are intertwined and depend on each other. Encoding is an obvious prerequisite to storage, except in unusual cases. In addition, how information is encoded and stored determines what cues will be effective in its later retrieval (Tulving, 1974). It is important to note, however, that encoding and storage alone do not guarantee that information will be remembered. Retrieval is the critical process that must occur in order to convert latent information into a conscious experience (Roediger, 2000; Tulving, 1983).

Despite these caveats, we used this encoding-storage-retrieval framework for simplicity. We discuss a number of variables that can be manipulated during study (encoding), retention interval, and later test or retrieval query.

ENCODING FACTORS

The distinction between perceiving and remembering is often blurry, as the two processes overlap. When does perceiving and encoding end and retention and memory begin? The answer is arbitrary. Phenomena such as *iconic* and *echoic memory*—lingering sensory representations in the visual and auditory systems, respectively—reveal the fine line dividing perceiving and remembering. If events happen so rapidly that they cannot be accurately perceived and encoded, then they cannot be remembered later. Usually these events would not be considered forgotten because the concept of forgetting presupposes that the events were encoded and potentially could be remembered at some point in the future. However, it is not necessary for an event to be presented to the senses to be remembered. For instance, when dealing with errors of memory, it is possible for people to remember events that did not actually occur (e.g., Roediger & McDermott, 1995), a point that we discuss later. These events might have been internally generated by the rememberer—they could have been imagined or constructed—but were never actually experienced.

The perceptual world is vast. Try another thought experiment. Walk outside and survey a busy scene. Now close your eyes quickly and try to recall as much as you can. You probably found that you could not remember much of the detailed information that was before your eyes. If you did poorly on such a test when trying to recall immediately after the experience, think how much worse you would do after a long interval. One tactic lawyers sometimes use to discredit eyewitnesses of a crime is to produce a picture of the crime scene so that the judge and jury can see it, but the witness cannot. Then the lawyer asks the witness about details of the scene, usually resulting in a poor description. This demonstration appears to show poor retention on the witness' part, but the test is unreasonable. Although the judge and jury can pick out the details of a picture and may wonder why they are not recalled by the witness, virtually no one could pass such a test. Our minds are not capable of making complete records of events; rather, we encode features selectively. Even when we remember events reasonably well, we do not come close to remembering all the fine details that are part of the event. We are not like video recorders, faithfully taking in and storing all the details in a scene.

A key concept necessary in understanding processes occurring early in acquisition is coding, or recoding (Miller, 1956): We do not remember events as they happened, but rather as our minds have coded them. Think back to the hypothetical experiment. Two groups would try to remember the digit string 1, 4, 9, 1, 6, and so on. Both groups would see the same events, the 15 digits, but one group would code it as "squares of 1 to 9," whereas the other group would probably code it in a less meaningful manner, and hence would remember it less effectively.

As previously noted, past experience and knowledge can prompt different people to encode "the same experience" in different ways. Bartlett (1932) relied on "the old and familiar illustration of the landscape artist, the naturalist, and the geologist who walk in the country together. The one is said to notice the beauty of scenery, the other details of flora and fauna, and the third the formation of soils and rock. In this case, no doubt, the stimuli, being selected in each instance from what is present, are different for each observer, and obviously the records made in recall are different also" (p. 4). Many years later, Underwood (1963) captured this idea by distinguishing between the *nominal* and *functional* stimuli in learning and memory. A nominal stimulus is the complex event as it exists in the world; a functional stimulus is that part of the nominal stimulus that is coded and may (potentially) be remembered. Because the environment provides a complex array of information, coding is selective: Only some features are encoded for later retention.

The idea that different perspectives can lead to different coding of events was demonstrated in a famous experiment by Hastorf and Cantril (1954). They capitalized on a rivalry between two colleges and their favorite football teams. The event that motivated their study was a particularly acrimonious football game in which Dartmouth played against an undefeated Princeton team. The game was marred by fights, penalties, and injured players (including Princeton's star, Dick Kazmaier, who had just been featured on the cover of *Time* magazine). Princeton won, but a debate swirled for weeks over which team was responsible for the game's roughness, with students at each school blaming the opposing team. This polarized student opinion led Hastorf and Cantril (1954) to their experiment. They asked students at each school to watch a film of the game and judge the number of penalties that each team committed. The results are indicated in Fig. 1.2.

As noted in the figure, the Dartmouth students counted 4.3 infractions committed by their own team and 4.4 by the Princeton team. This outcome was in accord with the general belief of the Dartmouth students that the game had been rough but fair, and the Dartmouth team was not out to wound the Princeton star. On the other hand, the Princeton students judged the Dartmouth team to have committed 9.8 penalties, compared to only 4.2 for the Princeton team. This confirmed their belief that Dartmouth's players had resorted to dirty play to stay competitive with Princeton, which was (according to a writer for the *Daily Princetonian*)

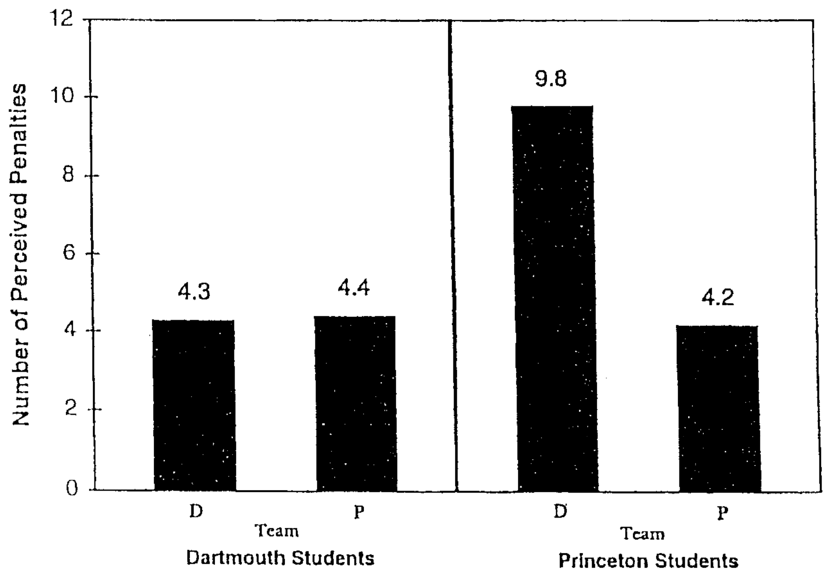

FIG. 1.2. Data from Hastorf and Cantril (1954). Even though both groups watched the same game, the Princeton students reported more than twice as many penalties committed by the Dartmouth team than did the Dartmouth students.

"obviously the better team." Background attitudes shaped perceptions in this case and, surely, if Princeton and Dartmouth students had their memories tested, their recollections of the game would have been consistent with their different perceptions.

Obviously, a false perception typically results in a false memory. But some cases can be tricky to classify. Consider an experiment reported by Roediger and McDermott (1995). They presented adults with lists of words such as *door, glass, pane, shade, ledge, sill, house, open, curtain, frame, view, breeze, sash, screen,* and *shutter*. Participants were asked to recall the words in any order immediately after hearing them and admonished not to guess. After studying and recalling many lists, the adults took a recognition test that included both items from the study lists and items not from the lists (i.e., lures or distracters). Their task was to differentiate between words that had been presented on the original list (studied, or "old" words) and words that were not on the list (nonstudied, or "new" words). In addition, for words deemed "old" or studied, participants were further asked to make remember/know judgments (Tulving, 1985). For this decision, they were asked if they recognized the word because they could remember its actual occurrence on the study list or rather because they knew that the word was in the list, but could not actually remember any details about its occurrence.

There is interest in this paradigm because it provokes remarkably high levels of false recall and false recognition. The list of words presented above was derived from associates of the word *window*, but that word did not appear on the list. The data from the immediate recall test are shown in Fig. 1.3. These data form a serial position curve, plotting the probability of correctly recalling a word (on the ordinate) as a function of the word's position in the list (on the abscissa). Data were averaged over many lists and many participants. Note that items studied at the beginning of the list were recalled better than those studied in the middle (the primacy effect), as were items studied at the end of the list (the recency effect). Primacy and recency effects occur often in memory tests with various kinds of study materials. However, for present purposes the most interesting finding (represented by the dashed line) was the probability of recalling words like *window* as in the list although they were not actually presented. Participants recalled *window* as though it had occurred on the list; in fact, recall of such critical items was higher than that for words that were presented in the middle of the list.

Recognition is sometimes assumed to be a more sensitive test than recall in assessing stored information. However, like recall, the recognition re-

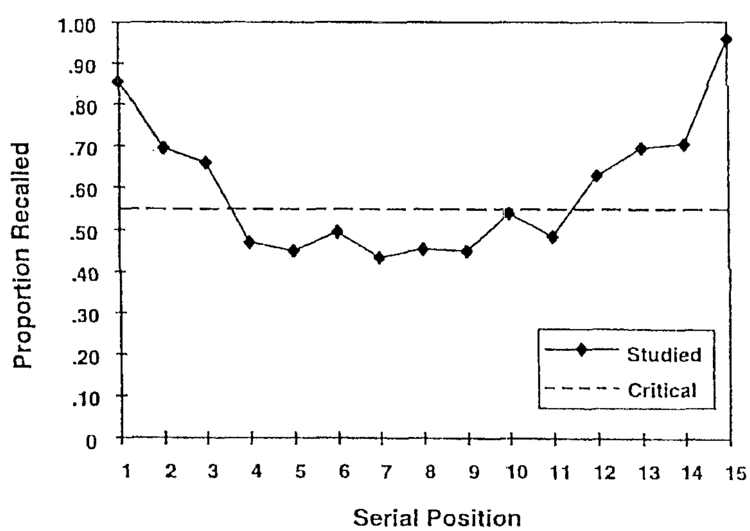

FIG. 1.3. Free recall data from Roediger and McDermott (1995), Experiment 2. The probability of falsely recalling the nonpresented critical items (e.g., *window*) was at least as high as the probability of correctly recalling the items from the middle of the list.

sults shown in Fig. 1.4 show a robust memory illusion. Participants claimed to recognize the critical lures like *window* at high rates, similar to those of the studied items. In addition, they claimed to "remember" the moment of occurrence of words like *window* at about the same rates as for the studied items, as shown in the black part of the bars in Fig. 1.4. The data in Figs. 1.3 and 1.4 reveal a powerful memory illusion occurring in a straightforward paradigm: People recall, recognize, and remember the occurrence of events (words appearing in a list) that objectively never happened.

Why does this illusion occur? One idea is that during study of the list, the word *window* might (consciously or unconsciously) have been activated as an *implicit associative response* to hearing the related words (Roediger, Balota, & Watson, 2001; Underwood, 1965). Basically, participants inferred the word, even though it was not presented, and then falsely recollected that it was presented. Like perceptual illusions, this memory illusion is difficult to modify. Although instructing adults about the nature of the illusion and then testing them with the lists causes a dampening of the illusion, people still falsely recall and recognize nonpresented words at a high rate (Gallo, Roberts, & Seamon, 1997; McDermott & Roediger, 1998). Although it is difficult to argue that the illusion in the Roediger–McDermott paradigm represents an encoding error exclusively, at least some evidence points to this conclusion (McDer-

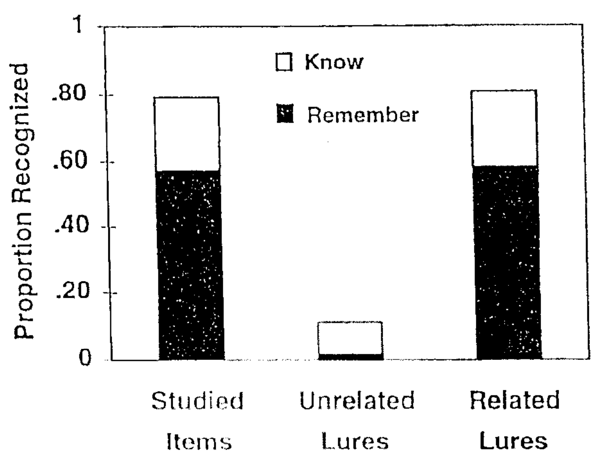

FIG. 1.4. Recognition test results from Roediger and McDermott (1995), Experiment 2. The related lures were falsely recognized as often as the studied words were correctly recognized, while recognition of unrelated lures was relatively low. Note that participants reported "remembering" the related ones about as often as they reported "remembering" items they had actually studied.

mott, 1997; Roediger et al., 2000; see Roediger, McDermott, & Robinson, 1998, for a review).

The general implication of these results for understanding truth and distortion in memory is that humans are inference machines--we make inferences in order to understand the world around us. We do not remember just the literal information in a message (e.g., the words in the list), but also what is implied (*window*). Research on retention of prose agrees that inferences can be remembered as having been explicitly stated (e.g., Brewer, 1977; Owens, Bower, & Black, 1979). Inferences are useful and the ability to derive them reflects human intelligence. However, especially in legal contexts, remembering events that were only inferred as actually having happened can be problematic, to say the least.

Although most of the foregoing has concentrated on errors people might make in encoding, experimental psychologists have spent much of the last century exploring encoding factors that enhance retention (although, to repeat, these variables may also affect retrieval processes). In the next paragraphs we provide a terse review of some of the most powerful encoding variables that affect performance on recall and recognition tests. These are standard measures of conscious recollection used in memory research. Each generalization provided is based on dozens and sometimes hundreds of studies. We cite only one reference that both documents the point and provides a useful starting place to examine the literature. Further, each statement carries an *e ceteris paribus* clause with it—all other things being equal—because in most cases there is an extreme circumstance that might invalidate the generalization. Nonetheless, the following statements are generally true.

Meaningful material is better remembered than less meaningful information, as previously noted. Similarly, organized material is more easily remembered than disorganized material (e.g., Marks & Miller, 1964). Pictures and highly concrete information are better remembered than words or abstract information (e.g., Paivio, 1986). Information presented slowly is better retained than information presented quickly (e.g., Glanzer & Cunitz, 1966). Material that receives a person's full attention is better retained than material that is presented under conditions of distraction (e.g., Fisk & Schneider, 1984). Repeated information is better retained than information presented only once, and the benefit of a repetition usually increases with the amount of time between the two presentations (Melton, 1970). Repetitions beyond two will continue to increase retention, although with diminishing returns (Challis & Sidhu, 1993). If conditions are conducive and enable people to reflect on the meaning of information when it is presented, they will remember it better than if attention is directed toward less meaningful aspects of the information (Craik & Tulving, 1975). Similarly, if people actively generate or interact with material, they generally remember better than if it is passively acquired (Jacoby, 1978; Slamecka & Graf, 1978). For example, people remember the word *cold* better if they generate it from the clue "opposite of hot" than if they just read the word *cold*.

Another powerful variable aiding retention is distinctiveness: Unusual or distinctive events are better remembered than more mundane and usual events (Hunt & McDaniel, 1993). Similarly (and perhaps for the same reason), emotional events are often easily remembered—the death of a loved one, a national crisis, or other salient and powerful events. In fact, such events are sometimes said to create "flashbulb memories," a phrase referring to the idea that people often believe they remember even fine details of highly emotional events as though they had been caught in a photographic flash (Brown & Kulik, 1977). However, some studies show that the strong impression of accuracy in flashbulb memories is not entirely warranted (Neisser & Harsch, 1992), even though memories for these events are probably better than for any reasonable set of control events.

Of course, many other encoding variables affect retention besides the ones described in the preceding paragraphs. In considering factors that can lead to poor retention, simply take the opposite of these factors. For example, meaningless information is difficult to encode and harder to accurately remember. This is also the case for information that is presented rapidly, under massed presentation conditions, or processed in a superficial manner. In addition, if the event is ordinary, or does not stand out, it will be more poorly remembered than a distinctive event.

This section focused on factors that strongly affect memory. We included them here because the manipulations provoking these effects usually occur during original learning. However, to reiterate, storage and retrieval must also be involved and are critical in producing the previously discussed effects. In the next section, we discuss factors that operate during the retention interval.

BETWEEN ENCODING AND RETRIEVAL

In studies of memory, the time between original encoding and later retrieval is referred to as the *retention interval*. As previously noted, providing a dividing line between the end of encoding and the beginning of the retention interval is somewhat arbitrary. However, it is clear that processes operating after encoding can greatly affect memory for an event.

One such process is *memory consolidation*, the idea that memory traces for an event may become stronger after the event is over. At the beginning of the 20th century, Müller and Pilzecker (1900) hypothesized that neural processes created by the perception of events perseverate after the event. At first the perseveration is labile and easily changed, but over time this perseveration of neural activity (consolidation) creates lasting neural traces. Hebb (1949) argued for two processes in consolidation. The first (labile) phase was identified with short-term memory and the more permanent condition with long-term memory. The primary evidence for such consolidation processes is found in studies of *retrograde amnesia*, a term that refers to forgetting events that occurred prior to some type of brain injury. For example, if someone is involved in an automobile accident and is rendered unconscious, he or she is unlikely to remember events that happened just prior to the accident (retrograde amnesia) and perhaps even for a few hours after the accident (anterograde amnesia). The prior events may have been in a labile state when the injury occurred and were not permanently consolidated. Over time the recollection of some events (those most distant in time from the injury) might be recovered, although events immediately surrounding the crash itself may not be. The severity of the amnesia is determined by the nature of the brain injury.

Memory for an event may also be altered during the retention interval by psychological means. *Retroactive interference* refers to the interfering effects of new events on prior events. If you park your car in slightly different places every day on your way to work, try to remember where you parked it 1 week ago. Assuming you have been to your place of work steadily during the previous week, you will probably find this a difficult task. The various places you parked every day during the past week would exert retroactive interference on your ability to remember where you had parked a week ago. If you had not been to work in the past week, the task would have been considerably easier. Again, as was the case with proactive interference, the more similar the events are to the critical event, the greater the interfering effect.

Loftus, Miller, and Burns (1978) showed how information occurring after a witnessed event can distort recollection of the event. In their experiments, adults viewed pictures of 30 colored slides depicting an automobile accident resulting from a car that failed to yield the right of way and caused a collision. A critical detail manipulated in one of the slides was whether a stop sign or a yield sign was present at the intersection. (Across participants, each sign occurred equally often). Participants were later asked a series of questions about the slides. One group was not asked about the sign (the control group), another group was asked "Did the car pass the red Datsun while it was stopped at the stop sign?", and a third group was asked this same question with "at the yield sign" instead. These questions provided information that was either consistent or inconsistent (misleading) with respect to the actual scene witnessed earlier. During a delay, participants completed a task unrelated to the experiment and next a memory test was given. One item on the test addressed the original type of sign that had appeared at the intersection (Was there a stop or a yield sign?). The results were straightforward: Adults who were given consistent information had better retention of the slides (70% correct) relative to the control group, which was given the information only once (63% correct). However, the most dramatic finding was the effect of the misinformation; responding in this condition was only 43% correct. Loftus et al.'s (1978) interpretation of this finding was that the misinformation caused adults to recode their memories for the original event so that they now included the erroneous sign.

In general, information given later about a witnessed event can mold and alter our retention of the event. If the following information is accurate, our memories may improve; if the information is inaccurate or misleading, we may nonetheless incorporate it into our recollections of the past. This misinformation effect, as it has come to be called, is a type of retroactive interference that has been often studied in the laboratory, and abundant literature employs the paradigm (see Ayers & Reder, 1998; Loftus, 1991, for reviews). The implications for the accuracy of eyewitness testimony are profound: Questions or statements occurring after an event can alter eyewitness accounts.

Another type of retroactive interference, *imagination inflation* (Garry, Manning, Loftus, & Sherman, 1996), refers to the finding that if people are asked to imagine events, they sometimes begin to believe they actually occurred. Garry et al. (1996) gave adults a Life Events Inventory that asked if particular events had ever occurred during the person's childhood ("Did you ever break a window with your hand?"). The adults were asked to imagine participating in half of the unlikely events. The other half were considered control items, and the adults were not asked to imagine them. Questions during the imagination session were intended to provoke vivid visual imagery. Later, participants were again asked to fill out the Life Events Inventory (they were told the first ones had been lost). On the retest, items that had been imagined during the intervening interval were judged as more likely to have occurred during childhood than items not imagined. Imagining the event inflated participants' confidence that it had actually occurred.

Of course, a counterargument is that imagining might have actually provoked memories of events similar to the one being tested, so perhaps the increase in confidence indicated a more accurate rather than a less accurate recollection of childhood events. Because testing childhood memories does not permit a researcher to know what events actually occurred during childhood, either interpretation of the Garry et al. (1996) results can be accepted (although we believe their interpretation is the correct one).

Goff and Roediger (1998) developed a laboratory paradigm that eliminates this interpretive problem. Action events, such as "Break the toothpick" or "Pick up the toy car," were used. Sometimes adults heard the command, sometimes they heard the command and imagined performing it, and on other occasions they heard the command and actually performed the task (using toys placed in front of them at the appropriate time by the experimenter). Later, the adults were engaged in an imagination session and were asked to imagine performing tasks when given the commands (some they had already heard, some were new). The question examined was whether imagining events would make people remember that they had actually performed them. When they were tested, results indicated that imagining actions prompted adults to report that they had actually performed them in the original session, even though they never had. Further, the more times the adults were required to imagine, the more likely they were to remember performing the action.

Similar results have been obtained from questioning participants repeatedly. Ceci, Loftus, Leichtman, and Bruck (1994) interviewed children ages 3 to 6 and asked them if they had ever experienced events that were implausible and would probably have been easily remembered if actually experienced. For example, children were asked if they had ever ridden in a hot air balloon. At the first interview, the children usually responded that this had not happened. (Parents had agreed that the events had not happened to the children.) However, the researchers continued interviewing the children every week for up to 10 weeks. About 25% of the children began to have "memories" for the events and, after repeated queries, some of the recollections became full of details. Some children appeared convinced by these new memories. A plausible mechanism for the development of these memories is imagination. Each time the child was asked about the event, he or she might have briefly imagined it. In response to a later query, the child may have confused imagined events with real events and reported the imagined events as real. Once again, the implications for testimony in forensic settings are profound. If repeated questioning encourages witnesses to imagine events, the witnesses may begin to remember the events as having actually occurred.

We have not mentioned the most commonly studied factor during the retention interval: time. Ebbinghaus (1885/1964) first plotted the relation between time and retention and obtained a logarithmic function, shown in Fig. 1.5. At first retention decreases rapidly but then levels off at long delays. This function is general and has been found across many different situations and types of material (Rubin & Wenzel, 1996).

The factors previously discussed focus on forgetting or errors induced during the retention interval. Can memories be improved by postevent processing? Yes. One way, as mentioned, is repetition of the event or some aspects of it. Another way is through retrieval of the event. Many studies have demonstrated *the testing effect*: If people's accurate recollections of

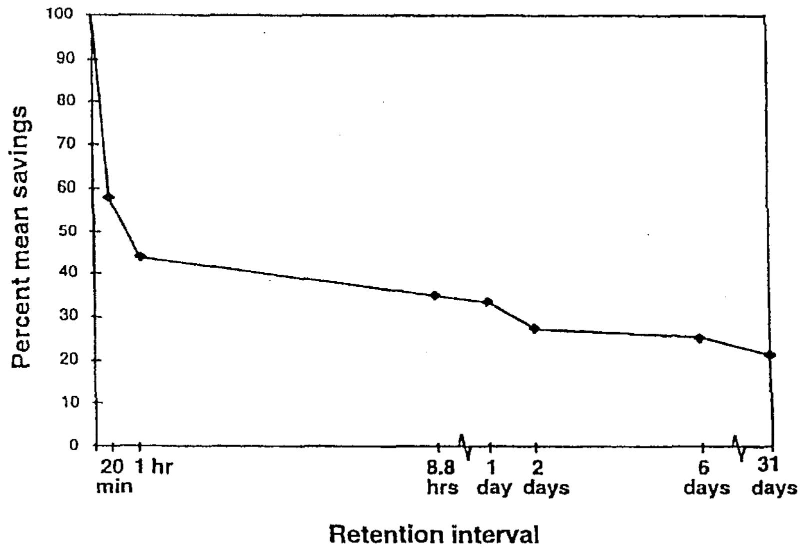

FIG. 1.5. A graph of Ebbinghaus's (1885/1964) famous forgetting function. Ebbinghaus learned material perfectly and measured how long it took him to do so. At later points in time he relearned the material and measured how much less time it took for relearning (the percent savings measure). The idea is that the better the memory for the original material, the greater the savings in relearning. Similarly, the less savings in relearning the material, the more forgetting he displayed. The graph plots retention (measured as savings) as a function of time since original learning. Note that the loss of information from memory (percent savings) is steep immediately after original learning, but becomes more gradual over time.

events are tested, they will remember the events better on future occasions than if they had not been tested. This benefit may be comparable to consolidation or reprocessing of the material. However, one proviso is that the testing effect can also enhance false memories: If someone recalls or recognizes an event incorrectly, that false recollection is also fixed into memory and more likely to reoccur on later tests (McDermott, 1996; Roediger, Jacoby, & McDermott, 1996; Schooler, Gerhard, & Loftus, 1986).

In summary, factors occurring during the retention interval that can have a negative impact on retrieval of an event include neurological trauma, retroactive interference arising from similar events, misleading information, imagining events that did not happen, and the presentation of questions about events that did not happen. However, postevent processing that encourages consolidation or accurate review or recollection of the prior events can improve later retrieval. We turn now to factors operating during retrieval.

RETRIEVAL PROCESSES

Retrieval has been called the key process in understanding memory (Roediger, 2000; Tulving, 1991) and research abounds on this topic (see Roediger & Guynn, 1996, for a review). Throughout most of the history of memory research, the retrieval stage was taken for granted. That is, researchers were concerned about processes of acquiring, storing, and retaining information, with an implicit assumption that if these processes were intact, memory would be good. The idea that forgetting or distortion—two common errors in memory—could be due to problems at retrieval was generally not accepted (although Bartlett's, 1932, work represents an exception). However, the retrieval stage is critical in many ways.

One important consideration is the form of the retrieval query: How is memory to be assessed? Psychologists have created many tests for measuring retention. Some of the primary measures are free recall (recalling information in any order in response to general queries), serial recall (retrieving information in order of presentation, such as one would a telephone number), cued recall (prompting recollection with various cues that can differ in many ways), and recognition (a type of cued response procedure in which various alternatives, including the correct one, are presented, and the rememberer picks the one that seems correct). There are several variants on each of these procedures.

Perhaps the primary conclusion to be drawn from work on retrieval processes is that whether a person remembers an event depends on how memory is assessed. Information that appears forgotten when measured by one type of test (such as free recall) may be expressed on a different test, such as when people are given powerful retrieval cues (Tulving & Pearlstone, 1966). Even more surprising is when the opposite occurs. Sometimes people fail to recollect a past event, even when the event itself is provided as a cue on a recognition test. However, when given a different cue, they will be able to recall the event which they could not previously recognize (Tulving & Thomson, 1973). Consider the following example: Are the names Bell and Ross surnames of famous people? If you answered no, then try again with the cues Alexander Graham ______ and Betsy ______. Something unfamiliar with one cue (even when the cue is a copy of the to-be-remembered information), can be perfectly retrievable with a different cue (Muter, 1978).

Free recall, by definition, occurs when the fewest cues are provided (and the ones that are provided are general). A sample test of free recall would be naming all the people with whom you went to high school, in any order. Free recall often produces limited estimates of what one knows. In the previous example, providing pictures from your high school yearbook to serve as cues for people's names would probably produce retrieval of more names than would free recall. The nature of retrieval cues is the critical determinant of retrieval. The important point for forensic purposes is that no single test is a perfectly reliable indicator of "what is remembered." Different tests can provide divergent answers to this question.

What determines the effectiveness of cues? The guiding ideas of the *encoding specificity principle* (Tulving & Thomson, 1973) and the *principle of transfer appropriate processing* (Bransford, Franks, Morris, & Stein, 1979) provide a means to determine cue effectiveness. In general, the encoding specificity principle states that the more a retrieval cue matches (or overlaps or reinstantiates) the way an experience was initially encoded, the more effective it is in provoking a memory for the experience. Pictures provide good cues for the names of high school classmates, in the previous example. As we discussed, during encoding not all features of an event can be coded; coding is selective. Similarly, particular features of a retrieval query or cue are used when a person tries to retrieve information. Cues are effective to the degree that the features of the cue used during the test match those of the encoded experience.

Let us consider an experiment to illustrate the point. Barclay, Bransford, Franks, McCarrell, and Nitsch (1974) presented adults with sentences to remember and later tested them in a cued recall paradigm. Across groups of participants, the sentences used the same nouns, but embedded them in different contexts. For example, different groups received either *The man tuned the piano* or *The man lifted the piano.* These sentence contexts were intended to create different encodings for the word *piano,* either as something that plays music or something that is heavy. The general idea is that the same concept (*piano*) can afford multiple features to be encoded. Later, participants' memory for the sentences was tested by the presentation of cues such as "something heavy" or "something that makes a nice sound." The authors found that when participants were tested with an appropriate cue (e.g., *something heavy* after encoding the sentence about the man lifting the piano), recall of the sentence was much greater than when participants were cued with the other phrase (*something that makes a beautiful sound,* in this instance). This experiment illustrates the encoding specificity principle in action: Cues that tap the encoded meaning produce greater retrieval than those that do not.

The principle of transfer appropriate processing captures much the same idea as the encoding specificity principle, but broadens it by stating that performance on tests assessing memory will benefit to the extent that the information processing demands of the test are similar to those which occurred during study. The greater the similarity, the greater the transfer of information from study to test.

Other evidence supports the broad conclusions of the encoding specificity hypothesis and the transfer appropriate processing principle (Roediger & Guynn, 1996; Tulving, 1983). One example is the phenomenon of *state-dependent retrieval*. Briefly, drugs such as alcohol and marijuana usually have a negative effect on memory. If people are even mildly intoxicated when exposed to information, they may recall the information less efficiently on a test when they are sober than if they were sober when the information was initially presented. This drug-induced amnesia has often been attributed to encoding and storage failures. However, retrieval differences also appear to be part of the problem. Consider an experiment reported by Eich, Weingartner, Stillman, and Gillin (1975). They tested army recruits in four different conditions. On the first day, subjects smoked cigarettes that either contained THC (the active ingredient in marijuana) or did not (a placebo condition). Next, they were asked to learn a list of 48 words. The words were compiled from 24 categories and two words were presented from each category (e.g., Birds: thrush, flamingo). A day later recruits returned to the laboratory and smoked another cigarette; again, for half the recruits the cigarette contained THC, and for half it did not. After waiting for the drug to take effect, recruits were instructed to recall the list. First, they were prompted to engage in free recall (recall the words presented yesterday in any order) and on a second try they were given a cued recall test. During this attempt they were given the 24 category names and asked to recall words belonging to the categories.

The results from the four conditions of Eich et al.'s (1975) experiment are shown in Table 1.1. Examining free recall first, note that participants in the drug–placebo condition showed the poorest recall—6.7 words recalled—substantially worse than participants in the placebo–placebo condition. Poor retention commonly results from using drugs during study. Note, however, that in the drug–drug condition recall was greater than in the drug–placebo condition. This is the state-dependent retrieval effect—reinstituting the same pharmacological state at test as prevailed during study leads to an improvement in performance. Of course, it would be wrong to reach the general conclusion that marijuana improves recall, be-

TABLE 1.1
State-Dependent Retrieval

Condition		*Test Type*	
Study	*Test*	*Free Recall*	*Cued Recall*
Placebo	Placebo	11.5	24.0
Placebo	Drug	9.9	23.7
Drug	Placebo	6.7	22.6
Drug	Drug	10.5	22.3

Note. Data from Eich, Weingartner, Stillman, and Gillin (1975). Number of words correctly recalled out of 48.

cause performance is still worse in the drug-drug condition than in the placebo-placebo condition. In addition, giving marijuana during either study or test impaired free recall. In accordance with the encoding specificity principle, when the "state" cues at test match those during encoding, recall is enhanced. For forensic purposes, the useful point is that drugs have a harmful effect on memory.

Many experiments have confirmed state-dependent retrieval findings in free recall. However, the effect is often not observed in cued recall or recognition experiments (Eich, 1980, 1989). From the right side of Table 1.1, it is apparent that marijuana had a slightly harmful effect on cued recall, but the state-dependent retrieval effect disappeared. Why? One idea is the "state cues" are relatively weak and can be overshadowed by more powerful retrieval cues. Participants relied on the category names to cue recall, and the effect of these cues eliminated the effect of the weaker state cues. Note that cued recall was much better than free recall in the Eich et al. (1975) experiment, because the category name cues matched the meaningful way the information was encoded.

Although retrieval cues can provide access to information that could not be retrieved under free recall conditions, memory recovery can occur in other conditions. For example, if people attempt to repeatedly retrieve information, they will often come up with more information on a later test than on an earlier test. Recall of memories on a later test that could not be recalled on an earlier test has been termed *reminiscence* (Ballard, 1913; Roediger & Thorpe, 1978). When overall performance improves—the total number of memories increases on a second test when compared to a first test—the phenomenon is referred to as *hypermnesia* (Erdelyi & Becker, 1974). Such "recovered memories" are not uncommon when people repeatedly retrieve information (see Roediger & Challis, 1989, for a review), but repeated retrieval can also lead to the development of false memories as well as accurate memories (see Roediger, McDermott, & Goff, 1997, for a review). An important point for forensic purposes is that recovery of memories on a later test does not necessarily mean that the seemingly forgotten event was "repressed." Recovery of memories on repeated tests is a perfectly normal occurrence that is obtained in most situations.

Hypnosis is sometimes assumed to aid memory retrieval and dramatic anecdotes demonstrate the point. However, systematic laboratory experiments have failed to find evidence that hypnosis improves memory retrieval (Smith, 1983). As noted by Lynn, Neuschatz, and Fite (chap. 12, this volume), if anything, hypnosis may lead to creation of false memories because the methods used during hypnosis often encourage people to free associate and to generate material without closely monitoring its source. The generated material may then function as misinformation that can distort retention of the original events (e.g., see Roediger, Wheeler, & Rajaram, 1993).

In general, confusions among sources of information can lead to illusions of memory. Johnson, Hashtroudi, and Lindsay (1993) formulated a source monitoring framework to enable understanding of factors that account for confusions about sources of information. For example, when events are close together in time, or similar in modality of presentation, in location, and in other ways, they are more easily confused. Thus, for example, if a witness to a crime is shown pictures of possible suspects soon after the crime and then tested again in a line-up a few weeks later, he might erroneously identify one of the suspects in the line-up as having been the culprit in the crime. The suspect would seem familiar from the photos witnessed earlier, and this familiarity might be misattributed to having seen the person at the crime scene, a process called *unconscious transference* (see Jacoby, Kelley, & Dywan, 1989).

Cues are powerful determinants of memory retrieval, and the way a retrieval query is worded can help determine the quality of the memory elicited. Consider an experiment by Loftus and Palmer (1974). They asked adults to watch a videotape of an automobile accident in which one car was driving by an intersection, and a second car, failing to stop or to yield, drove into the first car. Later the adults were given a long questionnaire that contained the question: "How fast were the two cars going when they contacted each other?" Other groups answered the same question about speed but with the verb changed to *hit, bumped, collided,* or *smashed.* The estimate of speed given by the different groups who received the slightly different questions is shown in Fig. 1.6. People who had read the question with *contacted* as the verb estimated the speed at an average of 32 miles per hour (mph). When the question was given with *smashed* the speed estimate increased to 41 mph. How a question is asked helps determine the answer that is given. If the speed limit had been 30 mph, a police officer asking a witness a question and using *contacted* or *hit* as the verb might conclude that no speeding occurred; however, an officer using *collided* or *smashed* might conclude that the cars were speeding.

As noted previously, the testing of memory is not a neutral event but can affect later retention. However, not all effects are negative ones, as shown in research on the testing effect reviewed earlier. If a person recalls information correctly on a first test, then it is more likely to be recalled accurately on a later test than if the first test had never occurred (e.g., McDaniel & Masson, 1985; Spitzer, 1939; Wheeler & Roediger, 1992). In agreement with the principle of transfer appropriate processing, retrieval of information once provides good practice (and positive transfer) for retrieving the information later.

Geiselman, Fisher, and their colleagues have developed a procedure called the cognitive interview. They incorporated several techniques determined to be efficient in prompting retrieval and have shown that it pro-

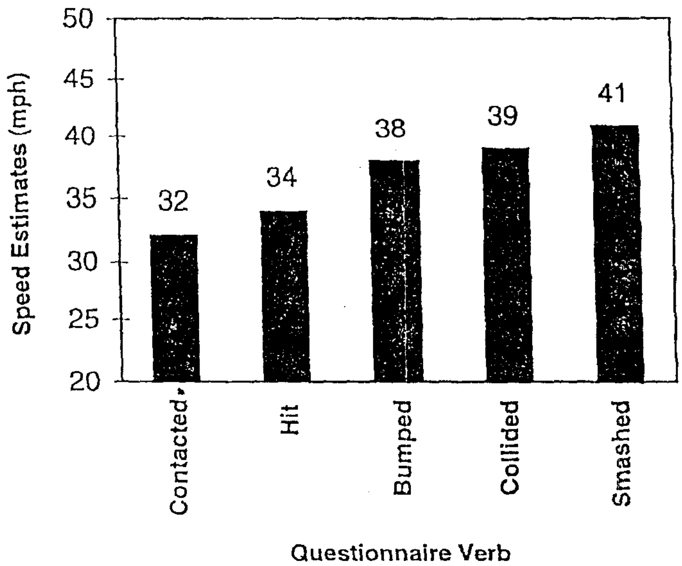

FIG. 1.6. Average speed estimates from the different groups of subjects in Loftus and Palmer's (1974) experiment. Although all the subjects observed the same accident, their estimates of the speed of the cars varied depending on the verb used in one item in the questionnaire.

duces better retrieval than typical interviewing strategies (Geiselman, Fisher, Mackinnon, & Holland, 1985). These techniques include trying to provide good cues, asking people to retrieve from different perspectives, asking them to retrieve sequences of events in different orders, and so on.

The critical question that psychologists (and many others) would like to answer is "Is there a way, long after encoding has occurred, to create conditions in which people will accurately recall events without being led into distortion and error?" The quest is a difficult one, because at the time of retrieval the encoding conditions and retention conditions have already passed. Only retrieval conditions can be manipulated. The cognitive interview is a first attempt to address this issue and to elicit more information from witnesses and others, but it is still in the stage of development (see Fisher, Brennan, & McCauley, chap. 11, this volume).

SUMMARY

This chapter provides a selective overview of factors affecting both veridical and illusory memories. If one considers memory for a single event and the factors that affect its retention, these can be classified as occurring (a) prior to the event, (b) during encoding of the event, (c) during the retention interval between encoding the event and being queried about it, and (d) during the retrieval process. For each of these four categories, some factors increase the probability of successful retrieval of the event and others can lead to forgetting of the event or distortions in its retrieval. Our overview of such factors was illustrative rather than exhaustive. However, we tried to touch on important variables whose understanding is critical for forensic purposes. Schacter (1996) has described human memory as having a "fragile power." The system is powerful, for we can learn and retain new events all our lives and often remember them quite well. On the other hand, the system is fragile, because forgetting and distortions in memory can be brought about easily. This chapter sketched many of the factors responsible for both the power and fragility of remembering events of our lives.

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