

Episodic and Autobiographical Memory

HENRY L. ROEDIGER III AND ELIZABETH J. MARSH

Stages in Learning and Memory: Encoding, Storage, and Retrieval 476

EPISODIC MEMORY 477

Factors Prior to Encoding of Events 478

Encoding of Events 479

Retention of Events 481

Retrieval Factors 483

AUTOBIOGRAPHICAL MEMORY 485

Factors Prior to Event Occurrence 486

Factors Relating to Events 487

Factors Occurring During the Retention Interval 488

Factors at Retrieval 490

CONCLUSIONS 493

REFERENCES 493

The aim of this chapter is to discuss research on topics of episodic and autobiographical memory. Some researchers have treated these terms as synonyms and written about "episodic or autobiographical memory." Although the concepts are related, we believe there are good reasons to treat them separately because they refer to different psychological constructs, researchers investigating them work in distinct traditions with different techniques, and unique issues of interest arise in these separate (if overlapping) fields of inquiry. Whole books have been written about these topics (e.g., Conway, 1990; Tulving, 1983), so our treatment here will perforce hit only some high points in these areas of inquiry.

Episodic memory was originally defined as memory for events; in retrieval of information from episodic memory the time and place of occurrence of the event must be specified (Tulving, 1972). The query *What did you do on your vacation last summer?* requests information about an episode from life. The request *Recall the pictures and words that I showed you yesterday in the lab* is a laboratory task requiring episodic memory. When Endel Tulving proposed the concept of episodic memory in 1972, he argued that most laboratory tasks that psychologists had used over the past century to study memory could be classified as requiring episodic mem-

ory. (We consider these tasks shortly). In 1972, the primary contrast with episodic memory was *semantic memory*, the general store of knowledge that a person has (Tulving, 1972). The definition of the word *elephant*, the meaning of H_2O , the name of the third U.S. president, and myriad other facts are all components of semantic memory. One need not recall the time and place in which these facts or concepts were learned to answer queries asking for this knowledge—hence the notion that these are general or generic memories.

The study of episodic memory has typically occurred in laboratory studies of human memory, but this statement is also true of formal studies of semantic memory. In the past 15–20 years, the concept of episodic memory has not only been treated as a psychological construct useful for heuristic and descriptive purposes, but has been used to refer to a specialized mind-brain system (see Tulving, 2002, and Wheeler, 2000, for recent treatments of the concept). Tulving (2002) provides a compelling case for episodic memory as representing a unique mind-brain system that is (probably) unique to humans and that permits us to travel backward mentally in time to re-experience earlier events through remembering. The system also permits us to think about possible future scenarios and to think about and plan our futures, a capacity that may again be unique to humans and that may have helped pave the way for humans to have developed complex civilizations unlike those of any other animal (Tulving, 1999, 2000). For purposes of this chapter, we concentrate on the more traditional study of episodic memory in laboratory situations.

Writing of this chapter was supported by Grant RO1 AG17481-01A1 from the National Institutes of Aging to the first author, and by an NRSA postdoctoral fellowship from the National Institute of Mental Health, No. 1F32MH12567, to the second author.

Autobiographical memory refers to one's personal history. Memories of one's 5th-grade experiences, of learning to ride a bicycle, of friends one had in college, or of one's grandparents are all autobiographical memories. So, too, are memories of last summer's vacation or of pictures and words presented yesterday in an experiment, which we used as examples of episodic memory (see Conway, 2001, for a discussion of the relation between autobiographical and episodic memory). Therefore, we can think of autobiographical memory as encompassing information from both episodic and semantic memory. It is the knowledge of oneself and the memories surrounding this self-knowledge. We all know what city we were born in and on what date, so these facts are part of autobiographical memory; but we cannot remember the event itself, so it is not part of episodic memory. Autobiographical memories can also represent other types of information, such as *procedural learning* (knowing that we know how to drive, to play tennis, and so on). Therefore, unlike episodic memory, the study of autobiographical memory is not directed to a specific neurocognitive system but to consideration of many different types of memory that are all directed to the self.

Stages in Learning and Memory: Encoding, Storage, and Retrieval

All episodes of remembering involve successful completion of three stages. This is true of both episodic and autobiographical memory. *Information must be acquired or encoded, it must be retained across time in the nervous system, and it must be retrieved when needed.* These phases are referred to as *encoding* (or *acquisition*), *storage*, and *retrieval* (Melton, 1963). Imagine the situation in which subjects are presented with information to be learned (for example, a list of 50 unrelated words, presented at a rate of 5 s per word) and then are tested 24 hrs later. Subjects receive a blank sheet of paper with the instruction to "recall as many words as possible that were presented yesterday, in any order, without guessing" (a *free recall* test). Let us assume a subject recalled 16 words (thereby forgetting 34). For all items recalled, we can be assured that the encoding, storage, and retrieval phases were successful (if we ignore success by sheer guessing, which is unlikely in recall of unrelated words). Yet, what about the forgotten words? Is there a way to pinpoint at what stage or stages the breakdown occurred?

Let us consider the possibilities. First, perhaps the words were not encoded in the first place. Perhaps the subject closed his or her eyes for 10 s and missed two words entirely. The words were then never encoded. However, in most memory experiments, this cause of poor performance is unlikely because researchers take care to present information under optimal conditions. Still, with fast rates of presentation or a high level of distraction, encoding of information might be

minimal. (Ordinarily, we would not refer to someone as forgetting information if the information was never encoded. Encoding is a necessary condition for a later failure to be deemed *forgetting*.)

Encoding essentially refers to accurate perception in the most minimal case. The process of encoding changes the nervous system; every experience one has leaves the nervous system in a different state than before the experience. This change in the nervous system as a function of experience can be referred to as *creation of memory traces*. According to research and theorizing in modern neuroscience, memory traces should not be conceived as tiny packets of neural information stored in discrete locations somewhere in the brain, but rather as an interacting distribution of neural circuits used for registering the events. When the mind-brain system is given a query (e.g., *What were those words you studied yesterday?*), retrieval processes somehow gain access to stored information—the memory traces—and convert (some of it) to forms that can be consciously recalled. Exactly how any of these three processes—encoding, storage, and retrieval—operate is an open question, not yet well explained in either psychological or neural terms. Psychologists and neuroscientists have many theories but there are no definite answers.

Often it is difficult or impossible to separate encoding, storage, and retrieval processes (Watkins, 1990; Roediger & Gynn, 1996). Consider again the 34 words forgotten by our hypothetical subject. Even assuming they were all accurately perceived, how can we know whether their forgetting owes to failures in encoding, in storage, or in retrieval? Here are some possibilities. The words might have been encoded briefly (held in a short-term store or state) but not encoded more permanently. We have all had the experience of looking up a telephone number, being momentarily distracted, and then having no inkling of the number by the time we get to the telephone. Perhaps this experience can be ascribed to a failure of transfer from a short-term to long-term state (see the chapter by Nairne in this volume).

Alternatively, the experience may be stored, but the distributed trace is fragile and has become disorganized or decayed over the 24 hrs; that is, it is "lost" from storage. A further possibility is that the trace is perfectly intact after 24 hrs, but cannot be used or retrieved. Evidence for this last possibility can be obtained by treatments that permit recovery of the seemingly forgotten information. For example, a further test for the 34 forgotten words on a recognition test or another test that used strong retrieval cues might show that people can remember many of the "forgotten" words when tested under better conditions (Tulving & Pearlstone, 1966). That is, many experiments reveal a distinction between information that is available (stored) in memory and information that is accessible (retrievable under a certain set of conditions). Psychologists

would like to have measures that faithfully assess availability of information. However, no measure is a faithful measure of information or trace availability. Rather, any test shows only what information is accessible under a particular set of retrieval conditions (Tulving & Pearlstone, 1966; Weiner, 1966).

Although it is difficult to provide a clean separation among encoding, storage, and retrieval processes, making these distinctions is still of critical importance to keep us aware of what kinds of conclusions may be permitted by our experimental procedures. The example we have used, that of remembering a list of words, is an example of an episodic memory task. We could have used a similar example from autobiographical memory. For example, imagine the situation in which a professor insists that he or she told student A about a paper's due date, whereas the student claims to have no memory for this event. Assuming that the event did actually occur (perhaps student B witnessed the event), why does student A fail to remember the event? Perhaps student A was asleep during class or not listening to the professor during the lecture; the due date was then never encoded. Perhaps student A heard the assignment but was then distracted by a joke from a classmate, and thus the due date was not stored more permanently. Alternatively, student A might remember the interaction with the proper retrieval cues, such as a classmate's prompting him or her with other details that were related by the professor at the same time.

In actual practice, experiments on memory may involve manipulations during one or more of four stages in a typical experiment, as shown in Figure 17.1. In order to understand both episodic and autobiographical memory, we need to consider factors (a) prior to the events or episodes to be remembered; (b) during presentation (encoding); (c) during the retention interval between presentation (encoding) and testing (retrieval); and (d) during the test itself. In the following sections, we consider variables operating during these four periods or phases in the learning and memory process. We briefly deal with each phase in turn, beginning with the consideration of some typical manipulations that should illustrate

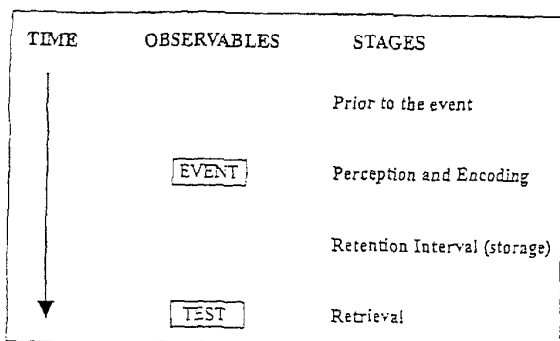


Figure 17.1 The four stages of the learning-memory process that are relevant to understanding how an event is remembered.

issues and problems in the laboratory study of episodic memory. We then do the same for the experimental study of autobiographical memory. The issues overlap, but the standard techniques for study are typically quite different. Ideally, these two research traditions should overlap and inform one another. They should not be seen as being in conflict.

EPISODIC MEMORY

As noted before, *episodic memory* refers to memory for events, and in order to retrieve such memories the time and place of occurrence of the events must be specified (explicitly or implicitly) in the retrieval query (Tulving, 1972). Many of the laboratory techniques developed by psychologists over the years—recall of stories, or pictures, or words learned in the lab—primarily test episodic memory (although some aspect of performance on these tests may reflect the contribution of other memory systems, too). The following nine tasks can all be classified as episodic memory tasks because they require subjects to think back to the time of occurrence of the events in question (Tulving, 1993). (The place is usually given as “in the lab where you are,” but outside the lab the place may need to be specified, too).

1. *Free recall.* The person is exposed to a set of words, pictures, or other material and is asked to recall them in any order after a brief delay with no retrieval cues. If the words or pictures are seen once, the test is called *single-trial free recall*. In a variant, the words or pictures can be presented repeatedly (often in a new random order each time) with a test after each presentation trial. Then the task is *multiple-trial* (“*multitrial*”) *free recall*.
2. *Serial recall.* The person is given a series of digits, words, or pictures and is asked to recall them in the order of occurrence. Variations might include giving one item from the series and asking for the item that appeared before or after it. Either single- or multiple-trial procedures can be used.
3. *Paired-associate recall.* The person learns pairs of items that might be related (e.g., *giraffe-lion*) or unrelated (*tightrope-pickpocket*), and is later given one of the items (e.g., *tightrope-_____*) and is asked to recall the other item. This task measures formation of associations. Again, single- and multiple-trial procedures can be used.
4. *Cued recall.* The person is given a series of words, pictures, or sentences and is then given a cue (often something not presented) and asked to recall a related event from the series. If the person studied sentences such as *The fish attacked the swimmer*, the word *shark* might be given as a cue. Paired-associate learning is a type of cued recall task with the cue item being *intralist*, or coming

from within the list itself. There are many variations on this theme in studies of cued recall.

5. *Recognition.* These tests, as the name implies, require the person to decide whether he or she recognizes an item as being from the studied set. In a typical laboratory paradigm, the subject might study a list of 100 words (under various conditions) and then be given a test with 200 words, half studied and half not studied. The task is to select the previously studied words. If a subject sees the words one at a time, the subject judges whether each one was studied and responds *yes* or *no*. This is called a *free-choice* or *yes-no recognition test*. If a subject is tested with pairs of words, one old and one new, he or she must pick the word that was studied. This is called a *forced-choice recognition test*. Free- and forced-choice recognition tests resemble true-false and multiple choice tests used in educational assessment. Another variation is the *continuous recognition test*, in which a long list of items (words, faces, pictures, etc.) is shown and the subject's task is to judge each item as already seen (*yes*, or *old*) or not seen (*no*, or *new*) in the series.
6. *Absolute frequency judgment tasks.* The subject studies items such as words or pictures various numbers of times (say, one to eight times). At test the subject is given the item and has to judge how many times he or she studied it. The task can also be converted for relative frequency judgments. Two pictures can be given during the test, and the subject must judge which one was presented more frequently during the study phase.
7. *Relative recency judgments.* The subject studies items and then is given two and asked which one occurred earlier (or later) in the series. This task captures subjects' estimates of the distance of events in time.
8. *Source judgments.* To-be-remembered information is presented to the subject from a variety of sources (say, spoken or written words, or if all items are spoken, by a male or a female voice). At test the subject is given each item and asked to identify the source—spoken or written? Male or female?
9. *Metamemory judgments.* People can be asked to give other kinds of ratings that are thought to reflect features of episodic memory. Confidence judgments ask for ratings (on, say, a 7-point scale) as to how confident a person is about whether an event occurred, with 7 representing *certain it did* and 1 *certain it did not*. People can also be asked, for items they recall or recognize, to judge whether they remember the moment of occurrence of the item or rather know only that it was presented but cannot remember the moment of actual occurrence (Tulving, 1985). These kinds of remember-know judgments have been extensively studied (e.g., Gardiner & Richardson-Klavehn,

2000) because remember judgments are thought to reflect a pure manifestation of episodic memory: People can mentally travel back in time and re-experience the past (Rajaram, 1993). People can also be asked to evaluate more specifically the sensory, emotional, and contextual characteristics of their retrieved memories (e.g., by using the Memory Characteristics Questionnaire developed by Johnson, Foley, Suengas, & Raye, 1988).

All these tests (and others) tap some aspect of episodic memory by requiring subjects to retrieve from specific times in the past. However, not all performance on the episodic (or explicit) memory tests just listed necessarily reflects "pure" manifestations of episodic memory, because performance from relatively automatic (Jacoby, 1991) or noetic (knowing) states of awareness (Tulving, 1985) might also affect performance, especially on tests with strong retrieval cues. The remember-know judgment task is one way of obtaining a measure that is thought to reflect more purely episodic memory (Tulving, 1985; Gardiner, 1988). Jacoby (1991; Jacoby, Toth, & Yonelinas, 1993) has also developed a procedure for separating conscious recollection from more automatic, nonconscious uses of memory.

The concept of episodic memory has changed over the years since Tulving (1972) first proposed it, but it remains a central organizing concept in cognitive psychology and cognitive neuroscience (see Tulving, 1999, 2000, 2002, for recent treatments). We turn now to discussing some of the research on episodic memory, using the four-stage framework described earlier.

Factors Prior to Encoding of Events

It might seem odd to begin our analysis of how one remembers events with factors that occur before the events in question have occurred. However, these a priori variables are critical determinants of remembering in most situations. First, there are characteristics of the individual rememberer to consider. In general, on episodic memory tests young adults perform better than children or older adults. Performance is especially impaired for older adults with Alzheimer's disease or some other severe condition that affects neural processes, such as Huntington's chorea, a brain tumor, or a myriad of other conditions. In addition, people with certain other types of psychiatric neural disorders (clinical depression, schizophrenia) similarly have great difficulties in situations demanding episodic memory retrieval.

Another general factor is expertise. What we know before some experience occurs determines what we will remember after it. If you know a tremendous amount about baseball and a friend going to a game with you knows nothing, you

would both look at the same game—but you would encode and remember it very differently than your friend would. In general, the more expert a person is about a topic domain, the more he or she will remember about an experience in that domain. However, not all prior experiences have positive effects on later memory for events. There can also be *proactive interference*, wherein prior events and activities have interfering effects later on memory for new events. We will consider such proactive interference effects later in the chapter.

Encoding of Events

There is no clear distinction between perception and memory. The perception of an event from the outside world, even such a simple one as seeing a word or picture presented in a list, is extended in time. In many experiments on perception, a stimulus is presented and the researcher asks (essentially) “What did you see?” In memory experiments, the researcher typically shows a larger set of material and asks “What do you remember?” If *kangaroo* is the 15th word presented in a list, however, and immediately after its presentation the procedure is stopped and the experimenter asks for recall of the last word, is the experimenter testing perception or memory? The two processes shade into one another, and the fact that our sensory systems have brief “memories” associated with their operation further clouds any sharp border between perceiving and remembering. (*Iconic memory* is the sensory store for vision and *echoic memory* for audition; see Crowder & Surprenant, 2000, and the chapter by Nairne in this volume.)

Perception is normally thought to be a prerequisite for remembering events. However, the occurrence of false memories shows that this is not necessarily the case, because people can have the full-blown experience of recalling, recognizing, and “remembering” (in the sense of making a “remember” judgment) for events that never happened (Roediger & McDermott, 1995). False memories represent the extreme; but in general, what is encoded does not match exactly what is available for perception. A critically important concept for understanding encoding processes is the distinction between nominal and functional stimuli (Underwood, 1963). The *nominal stimulus* is the event as it happened in the world—all the physical features that might be counted and measured. Imagine walking into a large room containing several people and many objects; the full scene is the *nominal stimulus*. The *functional stimulus* is that part of the scene to which the individual attends and encodes; these features will be only a subset of the huge number of features and details that could be potentially encoded. Underwood (1963) pointed out that for the understanding of learning and memory it is the functional stimulus that is critical, not the nominal stimulus. That is, when we consider what may be remembered, it is usually the

case that an individual will potentially remember only what was originally encoded (if we ignore, for the moment the case of false memories just discussed). Although any situation in the world affords a huge variety of potential features that may be encoded, only a subset will typically be encoded, and this selection during encoding is critical to remembering.

Recoding is a second critical concept for understanding encoding processes; this refers to the conversion of the nominal stimulus of the world into the functional stimulus that can be potentially remembered (Miller, 1956). Miller pointed out that people typically recode information from the world into a form that the cognitive system can more easily handle, and that in fact, for enhancing memory, recoding is often a critical step. (All mnemonic or memory improvement systems provide the rememberer with effective recoding techniques.) Suppose you give a group of people the task of remembering the following 15 digits in order. Try it yourself; read the following series one time aloud and then look away from the book and try to repeat it: 1, 4, 9, 1, 6, 2, 5, 3, 6, 4, 9, 6, 4, 8, 1. Most people get 6 or 7 digits correct when they do try this task, but some people get all 15. That seems impossible to naive listeners (such as bright undergraduates in classes in which we have tried this task). Why do some find it trivially easy and others find it impossible?

The answer to this puzzle is *recoding*. The 15 numbers are the squares of the numbers 1 to 9 ($1 \times 1 = 1$, $2 \times 2 = 4$, $3 \times 3 = 9$, . . . $9 \times 9 = 81$). If one notices this rule during presentation of the digits (or is told beforehand), then the task becomes trivially easy because the numbers can be easily encoded. If not, and the person tries to remember the sequence like a rote telephone number, then it is impossible.

Consider another example of how past experience and knowledge can lead different people to encode the same scene in quite different ways, with important consequences for later memory. Bartlett 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 the 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. (1932, p. 4)

Again, the same nominal stimulus is recoded in different ways so that the functional stimulus later available to be remembered would be quite different for the three individuals.

The literature on episodic memory is replete with more formal experiments documenting the power of recoding. One of the most famous, and justifiably so, comes from a voluminous literature on the levels of processing effect. Craik and

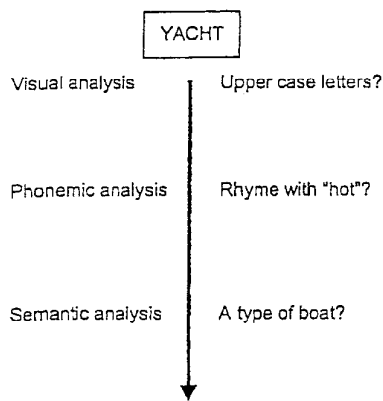


Figure 17.2 The levels-of-processing (LOP) procedure.

Lockhart (1972) proposed that encoding occurred as a byproduct of perception and that perception occurred in a series of stages. For verbal materials, they proposed that people process words through at least three stages: analysis of visual or orthographic features, analysis of the phonemic (sound) properties of words, and analysis of meaning (or semantics) of the words. This set of stages can be considered as occurring to different levels or depths, with *visual features* at the top and *meaning* at the bottom (see the left side of Figure 17.2).

Craik and Tulving (1975) provided an experimental technique for studying the levels of processing approach. People are asked questions before they see words, and the questions are meant to direct attention to a particular level of analysis. For example, for the target word *BEAR*, the questions might be "Is the word in uppercase letters?" or "Does the word rhyme with *CHAIR*?" or "Does the word name an animal?" In each case the answer is *yes*, but the first question directs subjects to a shallow (visual) level of processing of the word, the second question to an intermediate phonemic level, and the third question to a deep, semantic level of analysis. In the actual experiments, Craik and Tulving used many words and questions; half the time the correct answer was *yes* and half the time it was *no*, so subjects had to process the questions and words carefully.

Later, subjects were given a recognition test on which the studied words were intermixed with other, similar words, and the subjects' task was to examine each word and decide whether it had been seen in the earlier (encoding) phase of the experiment. In this particular recognition test, chance performance was 33%. The results are depicted in Figure 17.3 and show a powerful effect of this levels-of-processing manipulation. When people examined the word to answer a question about its visual appearance, performance was barely better than chance. When they answered a question about its meaning, performance was nearly perfect (at least when the

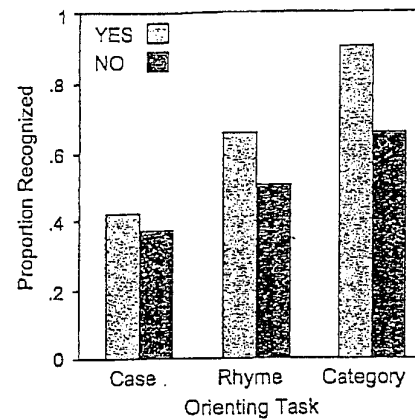


Figure 17.3 The levels-of-processing (LOP) effect. Mean proportion of words recognized as a function of orienting task and type of response to the question (*yes* or *no*). Adapted from Craik and Tulving (1975, Experiment 9B).

answer was *yes*). Therefore, levels of processing strongly determined level of recognition, an outcome that has been replicated many times. The fact that the effect was much stronger for the positive (*yes*) answers than for negative (*no*) answers was not predicted by the levels of processing framework, although it might be explainable by using related concepts such as congruity of the recognition test item with the way the information was encoded for deeply processed questions. For example, if the test word is *bear*, the subject might think "Was I asked about the category of animals?" to help make a decision. If the response were *yes*, this tactic would help, but if *BEAR* had been studied with the question "Does the word name a type of furniture?" then the tactic would fail to aid retrieval of *BEAR*. Although the study of these levels-of-processing effects has continued for more than 30 years, there are still unanswered questions about why the effects arise (Roediger & Gallo, 2002).

The general point for present purposes is that the levels-of-processing effect demonstrates the power of recoding. In all three conditions of the experiment the nominal stimulus is the same—single words presented at slow rates. The question causes the words to be recoded differently, with some types of processing providing for much better recognition than others. Many variables known to affect memory are held constant—the materials used, the knowledge that a test would be given, the individuals tested, and so on. The questions were even all easy ones that could be answered in a fraction of a second. Nonetheless, this split-second difference in encoding of the words created huge differences in recognition.

Many other variables manipulated during encoding phases of experiments have been shown to affect episodic memory performance across a range of tests. Active involvement in learning, such as generating information rather than reading

it, promotes retention (Jacoby, 1978; Slamecka & Graf, 1978). This *generation effect*, as it is called, occurs even under conditions in which the generation seems trivially easy. Jacoby (1978) had people either read word pairs (*foot-shoe*) or generate the second word from a word fragment (*foot-s_ _ e*). The fragments were easy (because the words were related) and so the target word could almost always be easily generated. At test subjects were given the first word and asked to respond with the paired word. When subjects had generated the second word they remembered it much better than when they had only read it, even though the generation process involved little effort. Slamecka and Graf (1978) produced similar results in a somewhat different paradigm. Again, this generation effect can disappear under certain conditions, but it has fairly wide generality, especially when the same subjects both read and generate information (that is, when the variable is manipulated within subjects; see Begg, Snider, Foley, & Goddard, 1989; McDaniel, Waddill, & Einstein, 1988; Slamecka & Katsaiti, 1987).

A third variable that reliably affects episodic memory tasks is repetition. In general, and not surprisingly, repeated items are better remembered than items presented only once (the *repetition effect*; see Crowder, 1976, chapter 6). However, less intuitively, the spacing of repetitions matters. *Massed* repetition refers to the situation in which an event is studied twice in succession, whereas *spaced* repetition refers to the case in which time and intervening items occur between repetitions. For tests of long-term retention, spaced presentation almost always leads to better retention than does massed presentation, and, up to some limit, the greater the lag or spacing between two presentations, the better the retention (e.g., Melton, 1970; Dempster, 1988). This *spacing* or *lag effect*, as it is called, occurs on practically all tests and under most conditions. Interestingly, one exception occurs when a test occurs very quickly after the second of two presentations; under that condition, massed presentation leads to better retention than spaced presentation (e.g., Balota, Duchek, & Paullin, 1989).

Fourth, concrete materials generally produce better retention on episodic memory tests than do abstract materials. For example, pictures are better recalled than words (the names of the pictures), a finding which is called the *picture superiority effect* (Paivio & Csapo, 1973; Paivio, Rogers, & Smythe, 1968). Also, words that refer to concrete objects (*umbrella*, *finger nail*) are better retained than abstract words (*democracy*, *ambition*) matched on such qualities as word length, part of speech, and frequency of occurrence in the language (Paivio, Yuille, & Rogers, 1969). The same holds true for prose materials (Paivio & Begg, 1971). To generalize, speakers and professors who can explain an abstract theory (e.g., the kinetic theory of gases) by using a concrete analogy or

metaphor (molecules of gas behaving like billiard balls on a pool table) can often make their subject matter easier to understand and more memorable. Using imagery is one of the oldest techniques for improving memory, known since the days of the Greeks and Romans, and it relies on the same principle now as then: The mind generally grasps and remembers concrete concepts better than abstract ones.

Finally, distinctive items are generally better remembered on episodic memory tests than is one event in a more or less uniform series (e.g., Hunt, 1995; Hunt & McDaniel, 1993). For example, a picture embedded in a list of words should be better remembered than the same picture embedded in a series of pictures. *Distinctiveness* has been used to explain superior memory for such items as bizarre sentences (McDaniel, Dunay, Lyman, & Kerwin, 1988), unusual faces (Light, Kayra-Stuart, & Hollander, 1979), atypical category members (Schmidt, 1985), and words with unusual orthographies (Hunt & Elliot, 1980). Distinctiveness may increase attention to and processing of an item at study. Distinctive items also provide excellent retrieval cues because no other memories are associated with them; if one picture is embedded in a long list of words, the cue *picture in the list* provokes only one item whereas the cue *word in the list* would lead to many items. Distinctiveness may underlie some of the effects we have already discussed. For example, the better memory associated with pictures and concrete objects may be due to the distinctiveness of their encoding. Similarly, deeper, semantic processing of words leads to more distinctive encoding and retrieval cues than does more shallow phonological or orthographic processing.

The various effects just discussed—the levels-of-processing effect, the generation effect, the picture superiority effect, the spacing (or lag) effect, and the distinctiveness effect—represent merely a sample of important variables that can affect episodic memory performance during encoding or study. However, the fact that these variables are manipulated during learning does not mean they affect only the encoding of memories. As demonstrated in our discussion of why one picture studied amid many words may be well remembered, retrieval processes are critically important in the study of episodic memory. We consider retrieval more fully later in this chapter, but the point here is that many manipulations during the encoding phase of the experiment may have their effects as much during retrieval as during encoding.

Retention of Events

Manipulations occurring between encoding of events and their later test can greatly affect memory, either positively or negatively. After experiences are first encoded, a consolidation

process occurs that is extended in time. This process has been known for more than a hundred years and is gradually becoming better understood (see McGaugh & Gold, 1992, for an overview). *Consolidation* refers to the fact that neural processes apparently must persevere for some period of time to permit memories to progress from a labile (easily forgotten) state to one that is more permanent. If a person or animal has an injury to the brain (a concussion) shortly after some experience, forgetting of that experience often occurs. The forgetting of experiences from before the concussive event is called *retrograde amnesia*; the forgetting of events happening after the concussion is called *anterograde amnesia*. The fact of retrograde amnesia implicates a consolidation process: Even though the events in question have already occurred, the brain injury causes their forgetting. Furthermore, retrograde amnesia occurs in a graded fashion, such that events immediately before the injury are remembered less well than older memories. After a period of time following the injury, memories will sometimes gradually recover. However, for severe injuries, the events that occurred just before the concussion usually are never recovered.

Purely psychological manipulations during the retention interval can affect performance on later memory tests. We discuss here only three of the variables that come into play during the retention interval: the passage of time, the rehearsal of to-be-remembered items, and exposure to potentially interfering materials.

Perhaps the most easily manipulated factor that affects retention is simply the passage of *time*. All other things being equal, the longer a test is delayed after encoding, the worse is retention of some experience. Ebbinghaus (1885/1913) discovered this fact in the first experiments on long-term retention, and it has been demonstrated hundreds of times since then. In general, forgetting is rapid at first and then becomes more gradual over time. Of course, "time" per se does not cause forgetting, and most researchers pinpoint some sort of interference as the cause of the forgetting observed over time (McGeoch, 1932; Underwood, 1957). As time passes, people are exposed to more and more information that may impair or interfere with their ability to remember the original target events. We will discuss these kinds of interference effects later in this section.

Repeated covert retrieval of information (rehearsal) can increase memory for the retrieved event, but its effectiveness depends on the timing and spacing of rehearsals. The same laws seem to govern rehearsal and the actual repeated presentation of material. That is, massed rehearsals (like massed presentations) have either no effect or a small positive effect on most memory tests. Spaced rehearsals are much more effective in improving recall and recognition. Landauer and

Bjork (1978) compared a variety of rehearsal schemes and showed that an expanding retrieval schedule is most effective. For example, if a person were trying to learn the name of a new person, it would be best to rehearse the name just after hearing it to make sure it is encoded. Then the person should wait a slightly longer period and try to rehearse the name again; the third covert retrieval would then be prompted after a somewhat longer interval, and so on, until the new name could easily be retrieved when the face is seen. Of course, in practice, remembering to continue covert retrieval can be a problem, but this expanding retrieval practice has been shown to be quite effective in new learning.

Activities during the retention interval can create interference for learned information. When events that follow some critical event of interest inhibit recall of these critical events, the name applied is *retroactive interference*. Retroactive interference is contrasted with proactive interference (the interfering effects of prior learning on events learned later). Figure 17.4 shows the standard experimental designs for studying proactive and retroactive interference. The minimal conditions for studying retroactive interference are shown at the top; two groups of subjects learn identical material, and then later one group learns a different set of material that may interfere with the original learning. Subjects in the control condition either learn irrelevant items or simply perform a distractor task for the same amount of time. In a typical interference experiment, subjects might learn pairs of words (e.g., *dogwood-giraffe*) in the first phase, and in the second phase of the experimental condition they would learn competing associations (e.g., *dogwood-rhinoceros*). The control group would either perform a distractor task during the second

Retroactive Interference

	Target List	Interference List	Test
Experimental	A-B	A-D	A-B
Control	A-B	rest or learn C-D	A-B

Proactive Interference

	Interference List	Target List	Test
Experimental	A-D	A-B	A-B
Control	rest or learn C-D	A-B	A-B

Figure 17.4 The standard experimental designs for studying retroactive and proactive interference.

phase of the experiment or learn completely unrelated pairs (*record-basketball*). All subjects would then take a memory test that provided the stimulus (left-hand) member of the first pair (*dogwood-_____*), and the task would be to recall the paired item (*giraffe*). However, subjects who learned the interfering association (*dogwood-rhinoceros*) would perform worse than subjects in the control condition. Such retroactive interference shows damage created by new learning during the retention interval.

Retroactive interference can change one's memory, often without one's awareness. Loftus, Miller, and Burns (1978) showed this effect in experiments meant to simulate the conditions of an eyewitness to a crime. Students saw a traffic accident in which a car came to an intersection where it should have paused to let another car pass. However, the car proceeded into the intersection and hit another car. Depending on the condition, subjects saw either a stop sign or a yield sign at the intersection. Let us take the case of subjects who saw the stop sign. During a later series of questions the students were asked questions in which the sign was referred to as a *stop sign* (the consistent-information condition), a *yield sign* (the misleading-information condition), or a traffic sign (the neutral-information condition). The question of interest was whether the verbally presented misleading information would be incorporated into the scene and cause the students to misremember the nature of the sign. The students were tested on a forced-choice recognition test in which they were given two scenes (one with a stop sign and the other with a yield sign) and were asked which one had been in the original slides. The results are shown in Figure 17.5, where it can be seen that (relative to the neutral condition) the presentation of consistent information augmented recognition of the

correct sign, but the misleading information decreased correct recognition. This misleading-information effect is a type of retroactive interference and shows how malleable our memories can be (see Ayers & Reder, 1998, for a review of work on this topic).

This section has sampled some manipulations during the retention interval that can have powerful effects on memory. Proper consolidation and repeated covert retrieval can enhance memories, whereas a blow to the head or presentation of interfering material can cause forgetting, making material more difficult to retrieve. We turn now to the retrieval process.

Retrieval Factors

A common experience is to forget some bit of information—the name of an acquaintance, where you left your keys—and then suddenly retrieve the information later. Sometimes the recovered memory seems to occur spontaneously, but in other cases it is prompted by cues. Such recovered memories show that forgetting is not necessarily due to loss of information from memory—degraded memory traces or the like—but rather that the information was available in memory (stored), but not accessible (retrievable) (Tulving & Pearlstone, 1966). Psychologists may wish for a perfect measure of what is stored in memory, but they will never have one; all measures reveal only the information accessible under a particular set of conditions. The study of retrieval processes is therefore a key to understanding episodic memory (Roediger & Guynn, 1996; Roediger, 2000; Tulving, 1974).

One surprising fact of retrieval is that giving the same test repeatedly can increase recall. For example, if subjects study a list of 60 pictures and are given a free recall test on it, they might recall about 25 items. (Subjects usually are asked to recall names of the pictures, if they are simple line drawings.) If a few minutes go by and the subjects are given the same test again, they typically recall more pictures (despite the increased delay until the second test). If a third test is given, recall will increase even more (Erdelyi & Becker, 1974). On each successive test, subjects will forget some pictures from the previous test, but they will also recover pictures on the second test that were not recalled on the first test. This recovery of items is called *reminiscence*, and when the number of items recovered outweighs the number forgotten, to produce an overall increase between tests, the effect is called *hypermnnesia*. This hypermnesic effect can continue to expand over a week since original study of material (Erdelyi & Kleinbard, 1978). The phenomenon of hypermnnesia is not well understood theoretically, but shows that retrieval phenomena can be quite variable (especially on tests of free recall). Humans

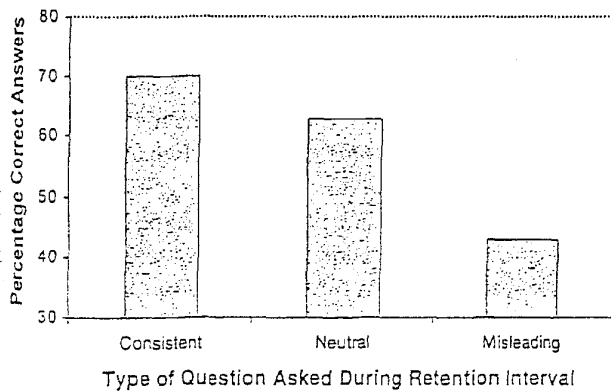


Figure 17.5 The eyewitness suggestibility effect. Exposure to the correct answer during the retention interval increased subjects' ability to answer the critical question at test. However, exposure to misinformation during the retention interval reduced correct answers at test. Adapted from Loftus, Miller, and Burns (1978).

em to have a limited retrieval capacity at any one point in time, so that recall of some items seems to limit other memories from being recalled (Tulving, 1967; Roediger, 1978).

Although repeated attempts at retrieval will usually permit memories to be recovered, providing appropriate retrieval cues can sometimes greatly increase the remembering of past events relative to free recall (Tulving & Pearlstone, 1966; Roediger & Guynn, 1996). The *encoding specificity hypothesis* (or principle) is the basic idea used to guide research in this area. The basic assumption has been discussed already: When an event is encoded, only some of the features in the complex nominal stimulus become functionally encoded. The encoding specificity hypothesis states that, all other things being equal, the more completely features encoded from a retrieval cue overlap (or match) those in the encoded trace, the greater the probability the cue will revive one's memory of the original event. So, for example, if the words *giraffe*, *elephant*, *rhinoceros*, *chimpanzee*, and *lion* were placed in a long list of words, they would be more likely to be recalled if subjects were given the cue *animals* during the test than under conditions of free recall. If subjects were given the cue *African animals*, recall of the words might be even greater. Considerable evidence is consistent with the encoding specificity principle (Tulving, 1983; Roediger & Guynn, 1996).

Often, recognition tests provide powerful retrieval cues because they provide a copy of the event to be remembered. So, if someone studied *chair* in the middle of a 200-word list, the ability to recall the word might be quite low, but the ability to recognize it might still be relatively good if *chair* were presented on a recognition memory test (along with many other distractors). This fact has led some researchers to assume that recognition tests avoid the problem of retrieval and provide a direct measure of the information that is stored. However, this assumption is incorrect. Although retrieval processes are probably quite different in recognition than in recall, recognition memory still involves more than one type of retrieval process (Mandler, 1980; Jacoby, 1991). In fact, sometimes events can be recalled when they cannot be recognized!

Tulving and Thomson (1973) had subjects study pairs of words in which there was a very weak association between the words, as with the pair *glue-CHAIR*, with instructions to remember the capitalized word. Later, subjects were given a free association test in which they were given words like *table* and asked to produce as many as six associates to the word; of course, they quite often wrote down *chair* as a response. In a third phase of the experiment, the subjects were told to use their responses as a recognition test and to go back through all the words they had written down and circle the

ones that they recognized as having occurred in the list. When they did this, they correctly circled 24% of the words they had produced. Finally, Tulving and Thomson (1973) gave their subjects a cued recall test with the original left-hand member of the pair as the cue (*glue-_____*). Now the subjects recalled 63% of the words. So, surprisingly, subjects did not remember seeing *chair* when they saw the word itself on the recognition test, but they did remember it when they saw the cue *glue!* Here is a case in which subjects could recall the word to a cue (*glue*) better than they could recognize it when provided with the word itself (*chair*). This finding has been replicated many times with all sorts of variations in the conditions used for the testing. Although it is surprising that recall can be greater than recognition under some conditions, the encoding specificity hypothesis can account for the outcome. When *chair* is encoded in the context of *glue*, a specific set of features about *chair* may be encoded (e.g., how chairs are constructed). When *chair* is generated from *table*, the features activated might be quite different. So the cue *chair* in this case might overlap with the features originally encoded from the original *glue-chair* complex less well than in the case of the cue *glue*, which is just what the data suggest.

This example of the recognition failure of recallable words illustrates that recall and recognition measures may not always agree. Let us give one more example, of how a manipulation may differentially affect a recall versus a recognition test. Typically, words that occur in the language with high frequency are better recalled on a free recall test than words that occur with lower frequency (e.g., Hall, 1954). Thus, we might conclude that high-frequency words simply produce stronger or more durable memory traces than do low-frequency words. However, this simple idea is ruled out by recognition experiments. When high- and low-frequency words are presented and then retention is measured by recognition, low-frequency words are better recognized than are high-frequency words (Kinsbourne & George, 1974; Balota & Neely, 1980). The fact that different patterns of outcome are often obtained when different memory tests are used is a fundamental fact that must be understood.

Two general ideas that have been forwarded to explain encoding-retrieval interactions are the encoding specificity principle (Tulving & Thomson, 1973), which we have already discussed, and the principle of transfer-appropriate processing (Morris, Bransford, & Franks, 1977; Roediger, 1990). Both principles maintain that retention is best when the conditions of retrieval match (complement, overlap, recapitulate) the conditions of learning. The transfer-appropriate processing principle states that experiences during learning transfer to a test to the extent that the test requires appropriate cognitive

operations to permit expression of what was learned. Tests may be more or less appropriate to tap the knowledge that was learned.

To explicate this, let us revisit the levels of processing effect shown earlier in Figure 17.3. Subjects were best at recognizing words for which they had made category judgments (a "deep" level of processing), next best at recognizing words judged with the rhyme task, and worst at recognizing words for which they had made case judgments (Craik & Tulving, 1975). In all cases, the dependent measure was proportion of items recognized on a standard recognition test. Morris et al. (1977) made the following criticism: On a recognition test containing many semantically unrelated words, subjects presumably decide whether a word was studied based on its meaning rather than on its sound or its physical appearance; thus the standard recognition test best matches the deep, semantic encoding condition. Would performance in the shallow conditions be improved if the test cues better matched the functional stimulus? In their experiment, subjects read words in sentence frames that were designed to promote either phonemic or semantic encodings. For example, some subjects read the word *eagle* in a phonemic sentence frame such as "_____ rhymes with legal," whereas others read the semantic sentence frame "_____ is a large bird." Subjects responded *yes* or *no* to each item; of interest is memory for the *yes* responses. There were two different memory tests; a standard semantic yes-no recognition test, and a rhyme test that required subjects to respond *yes* to test items that rhymed with studied words (e.g., "Say *yes* if you studied a word that rhymed with *beagle*"). On the semantic test, the standard levels-of-processing effect was obtained: Performance was better in the deep semantic condition than in the shallow rhyme condition. However, the pattern reversed on the rhyme test: Performance was better in the rhyme condition than in the semantic. Thus, the type of test qualified the interpretation of the levels of processing effect. The larger point—that the match between encoding conditions and test is critical—is supported by much evidence in episodic memory research (see Roediger & Gynn, 1996, for a review) and may hold across all memory tests (Roediger, 1990).

We have discussed at length how finding the appropriate retrieval cues can benefit memory; we turn now to an example of how retrieval cues may mislead the rememberer. In a demonstration of this point, Loftus and Palmer (1974) showed subjects a video of a traffic accident in which two cars collided. Later, subjects were asked a series of questions about the accident, including "How fast were the two cars going when they *contacted* each other?" Other subjects were asked the same question about speed, but with the verb changed to *hit*, *bumped*, *collided*, or *smashed*. This simple

manipulation affected subjects' speed estimates; the speed of the cars grew from 32 mph (when *contacted* was the verb) to 41 mph (when *collided* was the verb). The wording of the question changed the way subjects conceptualized the accident, and this changed perspective guided the way subjects reconstructed the accident. This example emphasizes the theme of this section: that how a question is asked (or how a memory is tested) can determine what will be remembered, both correctly and incorrectly.

The study of episodic memory is a huge topic, and we can barely scratch the surface in this section. Tulving's (1983) book, *Elements of Episodic Memory*, is a good starting place for further study of this critical topic. Much of episodic memory research has been laboratory based. A somewhat different tradition of research, but one that is also concerned with personal experiences, goes under the rubric of *autobiographical memory*, to which we turn next.

AUTOBIOGRAPHICAL MEMORY

As noted earlier, the term *autobiographical memory* refers to one's personal history. Memories for one's college graduation, learning to ski, and a friend's e-mail address are all autobiographical to some extent. Some autobiographical memories also meet our definition for episodic memory; for example, memories for one's wedding are indeed easily labeled both *memories for events* and part of *one's personal history*. The critical defining feature for autobiographical memory is the importance of the information to one's sense of self and one's life history. The end result is that autobiographical memory consists of many different types of knowledge, and is not limited to episodes but also includes procedures and facts.

The problem of defining autobiographical memory has been discussed elsewhere in depth (e.g., see Conway, 1990). Brewer (1986) distinguished among personal memories, autobiographical facts, and generic personal memories. *Personal memories*, such as memories of one's college graduation, are described as memories for specific life events accompanied by imagery. These would be episodic memories. *Autobiographical facts*, such as memories for e-mail addresses, are memories for self-relevant facts that are unaccompanied by imagery or spatiotemporal context (much like semantic memories, as defined by Tulving, 1972). Other knowledge, such as knowledge of how to ski, are abstractions of events and unaccompanied by specific images. These could be considered procedural memories, but Brewer refers to them as *generic personal memories*. In this section, we will focus on personal memories, with some attention to generic personal memories.

Historically, psychologists have made surprisingly few attempts to capture autobiographical memory. Galton (1879) first attempted to study personal memories; he retrieved and dated personal memories in response to each of a set of 20 cue words. Other early research included Colegrave's (1899) collection of people's memories for having heard the news of Lincoln's assassination, and Freud's clinical investigations of childhood memories (e.g., see Freud 1917/1982). However, experimental psychologists conducted little research on autobiographical memory until the 1970s, when the pendulum swung in favor of more naturalistic research. The 1970s brought the publication of three important methods and ideas: Linton's (1975) diary study of her own memories for six years of her life; the idea that surprising events imprinted vivid "flashbulb memories" on the brain (R. Brown & Kulik, 1977); and the rediscovery of the Galton word-cuing technique (Crovitz & Schiffman, 1974). Urged on by these results and the changing zeitgeist, experimental psychologists turned to the tricky problem of understanding how people come to hold such vivid memories of their own lives. How does one go about understanding how people remember their own lives, especially when one often has no way of knowing what really happened? Autobiographical memory researchers have developed several paradigms of their own, some of which are adaptations of tasks traditionally used to study episodic memory. To allow for comparison with episodic memory tasks, we list here a few of the methods typically used to study autobiographical memory.

1. *Diary studies.* The subject is asked to record events from his or her own life for some time period, and after a fixed interval is given a test on his or her memories for what actually happened. There are many variables of interest; a few common ones include the time interval between recording and testing, the types of to-be-remembered events, the types of retrieval cues provided at test, and the remembered vividness of the events. Variations on diary studies include using randomly set pagers to cue recording of to-be-remembered events (Brewer, 1988a, 1988b) and having roommates select and record events that may be tested at a later point (Thompson, 1982).
2. *Galton word-cuing technique.* The subject is exposed to a list of words and is asked to retrieve and record a personal life event in response to each word. Sometimes the subject is asked to date these memories, or to rate the remembered events on a number of dimensions such as vividness or emotionality. Often reaction times are collected.
3. *Event cuing technique.* As with the Galton word-cuing technique, the subject is asked to recall life events in

response to cues; however, the cues may be for specific events such as memories for an assassination or for the subject's first week of college.

4. *Priming paradigms.* Priming paradigms are also a variation on the Galton word-cuing technique; of interest is whether presentation of a semantic or personal prime word affects the speed with which people can retrieve a personal memory in response to a second word, the target word (e.g., Conway & Berkerian, 1987).
5. *Simulated autobiographical events.* All of the autobiographical memory methods described thus far rely on memories for events that were created outside experimental settings. In order to gain control over to-be-remembered events, some researchers have created autobiographical events in the laboratory. For example, the subject might drink a cup of coffee or meet an Indian woman in the laboratory, and later be asked to remember these episodes (e.g., Suengas & Johnson, 1988).

We turn now to a discussion of the research on autobiographical memory. As much as possible, we will use the same framework as we used for our discussion of episodic memory. We will consider (a) factors prior to the events or episodes to be remembered; (b) factors during the to-be-remembered event (encoding); (c) factors occurring in the interval between the event and later testing; and finally (d) factors operating during the memory retrieval phase.

Factors Prior to Event Occurrence

Given that the to-be-remembered autobiographical events themselves are out of the experimenter's control, it may seem far fetched to worry about factors that occur before those events. Just as with episodic memories, however, there are factors that need to be in place before new autobiographical memories can be formed. Perhaps the most obvious requirement is a fully functioning brain; for example, amnesics can not form new autobiographical memories, and patients with frontal lesions often confabulate or have difficulty retrieving autobiographical memories (e.g., Baddeley & Wilson, 1986; Wilson & Wearing, 1995). Children's brains are still developing, and events experienced prior to the development of language are remembered at lower rates than would be predicted from Ebbinghaus forgetting curves (Nelson, 1993). *Childhood amnesia* is the concept capturing the fact that events from early childhood generally cannot be remembered later in life.

Individual differences affect the way people will encode, store, and retrieve memories. For example, depressed individuals show a bias toward studying and encoding sad materials

in laboratory studies, they ruminate on negative thoughts, and they are biased toward retrieving sad life events (see Bower & Forgas, 2000, for a review of the effects of mood on memory). They also tend to recall fewer details of events, relying more on the "gist" (e.g., Moffitt, Singer, Neilligan, & Carlson, 1994). Such effects are not limited to clinical populations—*simply being in a bad mood will affect what people remember about their lives* (see the chapter by Eich and Forgas in this volume).

More generally speaking, how and whether people remember a target event is affected by prior events. As will be described in the next section, unique events are more likely to be remembered (e.g., Wagenaar, 1986). When evaluating forgotten (nonrecognized) events from her own life, Linton (1982) classified many as the "failure to distinguish" the target event from other similar events in memory. Although eating breakfast may seem salient at the time, a week later it may be difficult to distinguish that breakfast from all the similar breakfasts that preceded it. Corresponding to how studying related material in laboratory experiments increases interference effects (e.g., Underwood, 1957), autobiographical memory is not immune to proactive interference effects.

Factors Relating to Events

When reviewing the episodic memory literature, we discussed how some types of events tend to be well remembered (e.g., the picture superiority effect) and how some types of encoding tasks led to better memory (e.g., the levels-of-processing effect). What are the analogous effects and processes for individuals remembering their own lives? That is, what types of life events are better remembered? What type of processing during life events yields the best event memories? Before answering these questions, let us note that the answers will be based mainly on retrospective and more naturalistic methods. That is, experimenters assess people's memories for life events that occurred prior to entry into the laboratory study, and these life events were not manipulated experimentally.

When determining what types of events are typically best remembered, researchers often rely on diary studies. As noted already, Marigold Linton conducted the first major diary study within the experimental tradition. Beginning in 1972, she spent 6 years recording descriptions, dates, and ratings of 5,500 events from her own life. She tested herself for recognition of a semirandom sample of events each month. Although Linton was primarily interested in her ability to date these personal events (e.g., Linton, 1975), she did preliminary analyses of the characteristics associated with remembered versus forgotten events. She argued that remembered

events were salient, emotional, and relatively distinctive, and that there was some tendency for positive events to be better remembered (Linton, 1982).

Both White (1982) and Wagenaar (1986) followed up Linton's results, conducting diary studies aimed more specifically at remembering event details rather than dates. Wagenaar collected 2,400 events over a period of 6 years; he recorded the most salient event each day and coded it with four cues: who, what, when, and where. He also rated the salience (distinctiveness) of the event, as well as its pleasantness and his emotional involvement. White recorded one event per day for a year; he haphazardly selected both salient and nonsalient events. For each event, he recorded a description and chose adjective descriptors. He rated each event on a number of dimensions, including how much he had participated in the event, its importance to him, the event's frequency, and its emotionality and physical characteristics (e.g., sights, sounds, smells). Overall, the results from the two studies corresponded well with Linton's observations: Recalled events were unique and, at least in Wagenaar's study, more emotional. In both studies, there was some evidence for the better recall of pleasant events.

Although diary studies provide a rich source of autobiographical memories, such richness comes with methodological costs. Diary studies typically involve only the experimenter as subject, the to-be-remembered events are not randomly selected, and the very act of recording the events probably changes the way they are encoded. As alluded to earlier in this chapter, two different paradigms have been developed to deal with these problems. In one study, Thompson (1982) recruited 16 undergraduates to participate in a diary study; the twist was that the participants recorded events not only from their own lives but also from their roommates' lives. All 32 participants later attempted to retrieve the recorded events and used a 7-point scale to rate how well they remembered them. The critical finding was that memory did not differ between the recorders and their roommates, even though the recorders had selected and recorded the events and had knowledge of the upcoming memory test.

In another clever study, Brewer (1988a) dealt with the event-selection issue by recruiting subjects to carry pagers and record their ongoing events whenever the alarm sounded. Participants also rated their emotional states as well as the frequency, significance, and goal of each event. At test, subjects were given one of five different types of retrieval cues (time, location, both time and location, thoughts, or actions) and were asked to recall the events in question. Compared to events that were not recalled in response to the cues, correctly recalled events were rated as being more associated with remembered sensory details, emotions, and thoughts.

Consistent with the results of earlier diary studies (Wagenaar, 1986; White, 1982), correct recall was associated with exciting, infrequent events occurring in atypical locations. Similar results were also obtained in another beeper study in which the memory test involved recognition rather than cued recall (Brewer, 1988a, 1988b).

We mention here only one of the many other studies that support the idea that vivid memories tend to be for life events that were unique, important, and emotional. Rubin and Kozin (1984) collected data on vivid memories using two paradigms. First, they asked participants to describe their three most vivid memories and then to rate them on a number of scales (e.g., national and personal importance, surprisingness, consequentiality, etc.). Overwhelmingly, participants provided memories of events such as personal injuries or romantic episodes that were rated as high in personal but not national importance (see also Robinson, 1976). Second, participants retrieved autobiographical memories in response to 20 national (e.g., the night President Nixon resigned) and personal (e.g., their own thirteenth birthdays) cues. These cues naturally varied in their ability to elicit vivid memories; vivid memories tended to be associated with consequentiality, surprise, emotional change, and rehearsal (repeated retrieval after the event).

Although vivid personal memories tend to be associated with exciting, emotional, unique, and even surprising life events, we would not want to say that emotional memories are special or different from other memories. It was originally argued that unexpected events (e.g., hearing of an assassination) triggered a special mechanism leading to capture of all event details in a very accurate memory trace (R. Brown & Kulik, 1977). However, a spate of research has appeared arguing to the contrary. The so-called "flashbulb memories" may be particularly vivid, rehearsed at high frequencies, and confidently held—but they are not necessarily accurate. Early investigations of flashbulb memories were retrospective only, in that they did not assess the consistency of participants' stories over time (e.g., Yarmey & Bull, 1978). A different picture emerged from studies that involved the comparison of initial reports to later memories. For example, Neisser and Harsch (1993) compared initial reports of having learned about the space shuttle Challenger explosion to those collected 32–34 months later. Even though their subjects reported high confidence in their memories, just three subjects' (8%) accounts contained only minor discrepancies. Twenty-two subjects were wrong on two out of three major memory attributes (location, activity, and who told them); the remaining 11 subjects were wrong on all three. Other similar studies of disasters such as bombings and assassinations have confirmed that what characterizes flashbulb memories is the

confidence with which they are held (e.g., Weaver, 1993) rather than their consistency and accuracy over time (e.g., Christianson, 1989).

The observant reader has noticed two things. First, we have answered the question *What types of events are better remembered?* rather than *What types of processing lead to better memory?* Experimenters do not have a way of manipulating the level of processing during the occurrence of natural life events. In addition, we can assume that the equivalent of "deep processing" for real events (e.g., listening carefully, contributing to the event, attending to as many details as possible) is confounded with event characteristics—a person is more involved with more meaningful, unique, and emotional events. Second, the so-called "encoding variables" that we have just described are likely confounded with processes occurring during other stages in the memory process. For example, a unique emotional event is probably also less susceptible to proactive and retroactive interference, more likely to be talked about during the retention interval, and more likely to be retrieved. With autobiographical memories, it is particularly difficult to pin down the cause of memorability to one particular stage in the process. With that in mind, we turn now to discussing effects occurring during the retention interval.

Factors Occurring During the Retention Interval

In this section, we will discuss four factors: (a) the length of the retention interval, (b) the encountering of new information during the retention interval, (c) the way people continually talk about and retrieve life events over time, and (d) whether people can deliberately avoid thinking about life events.

The Passage of Time

As the retention interval increases, so does forgetting (Lintor, 1978). Crovitz and Schiffman (1974) had college students recall and date life events in response to a series of cue words; a logarithmic relation existed between the number of memories recalled and the passage of time, with forgetting being rapid at first and then slowing (see also Rubin, 1982). This is similar to forgetting curves obtained in standard laboratory studies of episodic memory. However, an Ebbinghaus-type forgetting function is obtained only when young adults are recalling memories from the past 10 or 20 years of their lives. A different picture emerges when retention across the entire life span is examined. First, the decline is accelerated for memories from early childhood. Memories from the 1st and 2nd years of life are almost nonexistent, and memories from the first 5 years

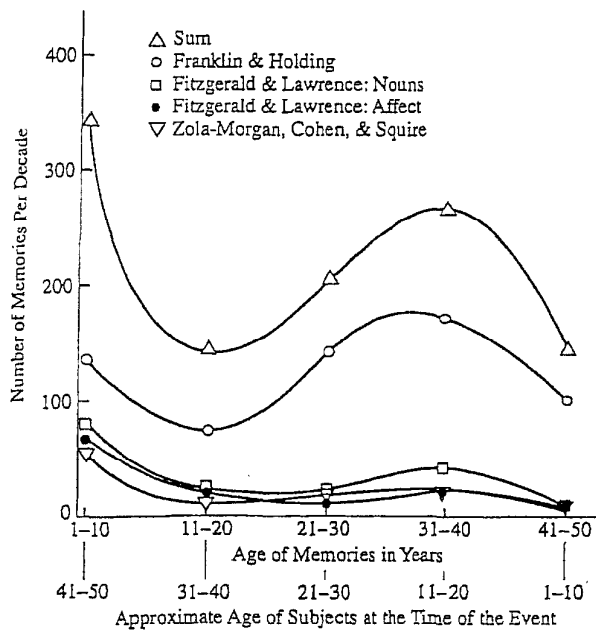


Figure 17.6 Distribution of autobiographical memories across the life span. In four studies, represented by the lower four curves in the figure, 50-year-old subjects remembered and dated life events in response to cue words. The top curve collapses over studies and sums over the lower four curves. Subjects recalled a disproportionate number of events from adolescence and early adulthood (reminiscence bump). Source: From Rubin et al. (1986) and reprinted with permission of Cambridge University Press.

of life are infrequent (Freud 1905/1930; Wetzler & Sweeney, 1986). As noted before, this phenomenon is called *childhood* or *infantile amnesia* (Howe & Courage, 1993). Second, a different function occurs for older adults than for college students. When older adults recall and date memories in response to word cues, they still show childhood amnesia and log-linear decline for recent memories. However, as shown in Figure 17.6, they also show what is called the *reminiscence bump*: A greater proportion of retrieved memories are dated to the period of 20–30 years of age than would be expected, given the rest of the distribution (e.g., Rubin & Schulkind, 1997). Numerous reasons have been suggested to account for the so-called reminiscence bump, including a preponderance of “firsts” occurring during the 20-something time period, the importance of that time period for identity formation, and greater rehearsal frequencies for the types of events occurring during one’s 20s. The exact reason for the bump remains uncertain.

Exposure to Additional Events

Just as it is not immune to proactive interference, autobiographical memory is susceptible to retroactive interference. An event may be confused with similar events occurring

before or afterward. Although one’s first few visits to a coffee shop may be discriminable soon afterward, retrieval of specific episodes may become difficult with the passage of time and with continued visits to the coffee shop. This is again Linton’s point that unique events are best remembered, and repeated events are susceptible to interference.

People do not exist in a vacuum during the retention interval; as we move through life, we are exposed to sources that provide us with information about our prior experiences. Other people tell us their versions of our shared experiences, we look back at photographs, we reread our diaries, and so on. We have already described how autobiographical memories are susceptible to proactive interference; now we are describing how retroactive interference can affect autobiographical memories just as it does episodic memories created in the laboratory. Although oftentimes this postevent information is correct, it may also be incorrect. Just as in laboratory studies of episodic memory, misleading postevent information can affect how we conceptualize original events and impair our ability to retrieve the original events.

In one clever demonstration of this, Crombag, Wagenaar, and van Koppen (1996) asked Dutch subjects whether they remembered having seen a video of the 1992 crash of an El Al airplane into an apartment building in Amsterdam. There was no actual footage of the moment of impact. However, more than half of participants accepted the suggestion from the interviewer and reported having seen the video. A substantial number of those subjects were then willing to elaborate on their memories, answering questions such as “After the plane hit the building, there was a fire. How long did it take for the fire to start?”

People may be particularly prone to suggestions or postevent information from legitimate sources who might very well have knowledge about their pasts. Elizabeth Loftus and her colleagues developed a procedure using family and friends as confederates to get subjects to misremember entire events. In one version, the trusted confederate asked the subject to repeatedly recall five childhood events for a class experiment; unbeknownst to the subject, one of the events had never occurred. Over a series of sessions, participants were willing to describe detailed recollections of the false event, such as being lost in a shopping mall (e.g., see Loftus, 1993). Similar data have been reported by Hyman and Pentland (1996), who found that participants who imagined knocking over a punch bowl at a wedding were more likely to create false memories for having done so. Consistent with the other memory errors described thus far, however, one is more likely to accept a false memory when it is plausible and consistent with the rest of his or her life history. For example, participants were more likely to accept a false memory for a

religious event when the ritual was of their own faith (Pezdek, Finger, & Hodge, 1997).

Rehearsal of Life Events

People continue to talk and think about life events long after their occurrence, and such rehearsal will have consequences for the way the events are remembered. In one series of studies, Johnson and colleagues manipulated how subjects talked and thought about events performed in the laboratory (Hashtroudi, Johnson, & Chrosniak, 1990; Johnson & Suengas, 1989; Suengas & Johnson, 1988). Subjects did actions like writing a letter or wrapping a present, and then thought about either the perceptual characteristics of the events or their emotional responses. Subjects who focused on emotional reactions later rated their memories as containing less perceptual detail, an important finding given that people often base source judgments on this type of information (Johnson, Hashtroudi, & Lindsay, 1993).

Whereas laboratory rehearsal instructions typically emphasize accuracy (e.g., "Practice recalling this list so you can repeat the words back to me in order"), no such guidelines constrain the way people talk about their own lives. Subjects' retellings of movies and fictional short stories are veridical only in the standard laboratory context, with accuracy instructions and an experimenter as audience (Hyman, 1994; Wade & Clark, 1993). Storytelling is different when goals and audiences are more realistic, as when one tells a story to friends with the goal of entertaining them. In fact, accuracy appears to be the exception when talking about one's own life. In a recent diary study of people's retellings of events from their own lives, people reported telling "inaccurate" stories almost two thirds of the time! This occurred even though people are likely to underestimate how inaccurate they are in storytelling, due to both ignorance of the inaccuracy and the social desirability of truth-telling (Marsh & Tversky, 2002). The issue is that biased retellings lead to memory distortion in laboratory analogs of the storytelling situation (Tversky & Marsh, 2000). Thus, when people talk about their own lives and take liberties with events in order to entertain or to make a point, memory distortion may result.

Such rehearsal processes may lead to the creation of false memories for entire events. For example, repeatedly imagining an event initially believed not to have happened leads to an increase in one's belief that the event actually occurred (e.g., Garry, Manning, Loftus, & Sherman, 1996; Heaps & Nash, 1999). In these studies, subjects initially rated the likelihood that events had occurred (e.g., *You broke a window with your hand*), and then imagined a subset of events. In the third part of the experiment, subjects again rated the likelihood of events; imagined events were now rated as more likely to have

happened. We all think, ruminate, and daydream about our lives and what might have happened; such processes may lead to memory distortion.

Active Avoidance of Life Events

We have described how various forms of rehearsal can affect memory for life events; now we consider the opposite situation, namely the effects of actively avoiding rehearsal of (undesirable) life events. The concept of repressing or suppressing traumatic memories originated with Freud (1901/1971), and recent surveys suggest that most undergraduates believe in the concept of repression (Garry, Loftus, & Brown, 1994). However, repression has been traditionally without laboratory support (Holmes, 1995). It is difficult to study repression of real autobiographical memories. Perhaps most relevant are findings that people have difficulty *not* thinking about traumatic events. At the extreme, post-traumatic stress disorder (PTSD) is characterized by intrusive memories of the precipitating trauma. Similarly, depressed individuals ruminate on negative events (Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998). Even nonclinical populations such as college undergraduates report that intrusive memories occur commonly (Brewin, Christodoulides, & Hutchinson, 1996). Thus, even though a laboratory demonstration of suppression was recently published (Anderson & Green, 2001), it is not clear that such results will generalize to the emotional memories that people may seek to suppress in real life. In their study, Anderson and Greene (2001) taught students a series of weakly related paired associates (e.g., *ordeal-roach*); the subjects were later instructed to suppress some of the associates when presented with the first word in the pair. The more often subjects attempted to avoid thinking of the target words, the less likely they were to remember them on later memory tests, even when a different cue was used. Although subjects may be trained to suppress thoughts of relatively neutral words (e.g., *roach*), the wealth of data on intrusive memories in normal and depressed individuals makes it questionable as to whether people can force themselves to avoid thinking of painful personal events.

Factors at Retrieval

Much of the research on autobiographical memory is aimed at understanding the factors that affect the retrieval and reconstruction of personal memories. This research emphasis is not surprising given that researchers have little control over the earlier stages, but they can directly manipulate factors during the retrieval phase.

It is critical to note that, as with episodic memories, estimates of forgetting are dependent on the type of retrieval cue

tilized. Although diary studies suggest little forgetting of life events, this is probably because they typically provide subjects with excellent retrieval cues, potentially reducing estimates of forgetting. One problem with most diary studies and other early studies was that they did not contain distractor items or other "catch trials" to ensure participants' ability to discriminate between experienced and nonexperienced events. A study by Barclay and Wellman (1986) makes this point nicely. In that study, students took a recognition test on previously recorded life events that included four types of items: duplicates of original diary entries, foils that changed descriptive (surface) details of the original events, foils that changed reactions to original events, and foils that did not correspond to recorded events. Participants were good at recognizing original diary entries (94% correct), but they also accepted a large number of the foils. They incorrectly accepted 50% of modified descriptions and 23% of novel events. These effects increased over a delay such that after a year, subjects were accepting the majority of both semantically related and unrelated foils. Thus, in both autobiographical and episodic memory studies, people falsely recognize events similar to experienced ones, and after a delay may show very little ability to discriminate between what did versus did not occur. However, without the appropriate foils on the recognition test, one would have been tempted to conclude that autobiographical memory was almost perfect.

In general, results from both diary studies and the Galton word-cuing technique suggest that event-content cues are best. Emotion words are not good retrieval cues (e.g., Robinson, 1976), and temporal cues are not as strong as content cues such as *what*, *who*, and *where* (Wagenaar, 1988; but see Pillemer, Goldsmith, Panter, & White, 1988).

What was experienced may not be what is accessible at retrieval. We already noted how Linton (1982) found better memory for unique events and attributed her failure to recognize events to interference from other, similar events in memory. Due to proactive and retroactive interference, only the gist of events may be available at retrieval (e.g., Bartlett, 1932). Although participants may lose access to specific event memories, they may retain more generic personal memories covering a class of related life events (Brewer, 1986). Barsalou (1988) found that students asked to recall the events from their summer vacations most commonly responded with summaries of events (e.g., *I watched a lot of TV*). Only 21% of responses were classified as corresponding to specific events (e.g., *We had a little picnic*).

Reconstruction of the Past

Even though people may complain about their ability to perform tasks such as remembering a long list of words, it often

seems that they feel more confident about their ability to recall events from their own lives. However, although diary studies have suggested that people are sometimes good at recognizing and remembering events that happened to them, they do not prove that people's memories are always accurate. Rather, retrieval times for remembering autobiographical events tend to be slow and variable, suggesting that remembered events are reconstructed. We have already reviewed several mechanisms that may operate during the retention phase to lead to inaccuracy, namely exposure to postevent information, interference, and retelling an event. We now review the literature on reconstructing autobiographical memories at retrieval, beginning with a section on how people date autobiographical memories.⁴ As described earlier, temporal cues are not very useful for recollecting events, probably because people do not normally explicitly encode dates of events. Thus, the domain of dating is a perfect example of how people reconstruct memories at the time of a test. After the discussion of dating, we will describe some of the general strategies people have for reconstructing their pasts.

Dating Autobiographical Memories

On what date did you hear about the attempted assassination of Ronald Reagan? On what date did you receive your acceptance letter from the college that you eventually attended? We suspect our readers will be unlikely to answer these questions quickly or accurately. Numerous studies have shown that people have difficulty in dating their autobiographical memories (see Friedman, 1993, for a review), and that this difficulty increases with the passage of time from the target event (Linton, 1975).

However, as introspection quickly reveals, it is not that autobiographical memory lacks all temporal information, which "would be like a jumbled box of snapshots" (Friedman, 1993, p. 44). Although the "snapshots" may lack explicit time-date stamps, we are quite capable of relating, ordering, and organizing the snapshots into a coherent story. The same subjects who cannot date a series of events within a month of their occurrence (3% correct; N. R. Brown, Rips, & Shevell, 1985) can determine the temporal ordering of the events (rank order correlation of .88; N. R. Brown et al., 1985). There is an entire literature on how people accomplish this; due to space constraints, we will describe here only a few of the strategies people use to reconstruct when events occurred.

In general, people make use of what little temporal information was encoded originally. At least two types of temporal information in memory appear relevant: the temporal cycles that regularly occur in people's lives, and temporal landmarks. First, natural *temporal cycles* or structures are

encoded that later guide memory; examples include the academic calendar (Kurbat, Shevell, & Rips, 1998; Pillemer, Rhinehart, & White, 1986) and the weekday-weekend cycle (Huttenlocher, Hedges, & Prohaska, 1992). Second, people have a better sense of the dates of consequential landmark events, and thus both public and private *temporal landmarks* can be used to guide date reconstruction (e.g., N. R. Brown, Shevell, & Rips, 1986; Loftus & Marburger, 1983; see Shurn, 1998, for a review). Such information about temporal and event boundaries, combined with knowledge of some specific dates, can be used to place a date on a target event. However, people's reconstructed dates tend to be too recent (Loftus & Marburger, 1983).

Other biases come into play when dating autobiographical memories; we will mention only two here. Similar to the availability bias found in decision making, memories for which people have more knowledge are dated as more recent (*the accessibility principle*; N. R. Brown et al., 1985, chapter 24). People also may make rounding errors when they use inappropriately precise standard temporal units (e.g., days, weeks, months; Huttenlocher, Hedges, & Bradburn, 1990).

We turn now to a discussion of more general strategies that people use to reconstruct memories, including implicit theories and motivated searches through memory.

Use of Implicit Theories

Numerous laboratory experiments have shown that people remember their personal histories to be consistent with what they believe should have happened, rather than with what did happen. One way this can happen is via the use of implicit theories of change versus stability.

Ross (1989) has argued that people use their current statuses as benchmarks, and then reconstruct the past based on whether they think changes should have occurred over time. For example, people believe that attitudes and political beliefs remain consistent over time, and so they often overestimate the consistency of the past with the present. In this example, one would assess one's current attitude and then apply a theory of stability to estimate one's attitude in the past. In one study, subjects' attitudes toward toothbrushing were manipulated; subjects exposed to a pro-brushing message overestimated previous brushing reports, whereas participants in an anti-brushing condition underestimated their previous reports (Ross, McFarland, & Fletcher, 1981). Likewise, people may mistakenly remember a nonexistent change if one was expected. In these cases, people also assess their current statuses, but then apply a theory of change inappropriately. For example, in one study participants who took a bogus study skills group (leading to no improvement)

misremembered their prior skills as having been worse than they actually were (Conway & Ross, 1984).

Motivated Remembering

People's theories of "how things shoulda been" go beyond simple theories of change over time; rather, people may be motivated to remember things in a particular way. In general, people tend to think of themselves as being better than average, and may engage in downward social comparisons to support such beliefs (Wills, 1981). People are motivated to misremember their past behaviors in a way that supports their self-esteem. Thus, upon learning the norm for a particular domain, people may be motivated to remember their own prior behaviors as better than the norm.

In one study, Klein and Kunda (1993) examined the effect of knowing the norm on subjects' self-reported frequency of health-threatening behaviors such as eating red meat, drinking alcohol, and losing one's temper. Subjects in a control condition simply reported the frequency of their behaviors using a 7-point scale. Subjects in the experimental condition also used 7-point scales; however, the average behavior frequency (established in pretesting) was indicated with an X on each of the scales. Subjects given the norms reported engaging in the risky behaviors less often per week ($M = 3.18$) than the norm established in pretesting ($M = 3.52$) and than the control subjects ($M = 3.78$). However, the mechanism underlying this effect remains unclear. Subjects may have misremembered the past, or they may have merely misrepresented or misreported it. It does not appear that subjects were simply changing their reports, because subjects in yet another condition with more extreme norms did not display a more extreme shift in reported behavior frequencies (perhaps because they were constrained by what they did remember). In addition, in the next paragraph we will describe converging experimental evidence from another paradigm that suggests people may selectively search their memories for evidence to support their desired self-concepts.

We may be biased in the way we search memory and the events that we select to remember. In one study, Sanitioso, Kunda, and Fong (1990) made Princeton undergraduates desire a certain trait, and then looked to see whether the students' remembered life experiences exemplified that target trait. In the first phase of the experiment, students read that Stanford psychologists had shown that extraverts (or, in another condition, introverts) performed better in academic and professional settings. In a second (seemingly unrelated) experiment, subjects remembered experiences for each of a series of trait dimensions, including *shy-outgoing*. Of interest was whether subjects tended to list an extraverted or

TABLE 17.1 Motivated Retrieval of Autobiographical Memories

First Thought	Success in Academics		Success in Police Force	
	Extravert-Success	Introvert-Success	Extravert-Success	Introvert-Success
Extraverted	62%	38%	26%	39%
Introverted	38%	62%	73%	61%

Source: Adapted from Sanitioso et al. (1990). The table shows the percentage of subjects in each success condition who listed extraverted and introverted memories first. Motivated retrieval occurred only when the domain was one in which subjects wished to succeed.

introverted memory first. Supporting the idea of motivated memory search, the majority of subjects began recall with a memory relevant to the target trait. This effect is shown in the left-hand panel of Table 17.1. This effect disappeared in a second experiment when the subjects were not motivated to see the trait in themselves. The first phase was modified to involve explaining how introversion-extraversion led to success as a police officer; the second phase remained the same. In this version of the experiment, subjects no longer recruited trait-relevant memories first. These data are shown in the right-hand panel of Table 17.1. Thus, the motivated retrieval effect occurred only when the trait was linked to a success outcome in a domain of interest to the Princeton undergraduates (academic success, not success as a police officer).

CONCLUSIONS

We began by noting that the concepts of episodic and autobiographical memory overlap. Memory for one's experiences during an experiment can be classified as either episodic or autobiographical. Accordingly, the two research traditions often provide converging evidence on how memory works. For example, the principle that *unusual events are well remembered* works to describe the results from both list-learning experiments and studies of autobiographical memory. Similarly, there can be proactive and retroactive interference for both episodic and autobiographical memories, and in both domains retrieval cues can bring back memories that could not be recalled without cues. Both research traditions support the idea that falsely remembered events are often plausible and are similar to actual events. The idea that self-involvement and personal relevance matter is obviously critical to autobiographical memory, but it is also present in the episodic memory literature; experimental psychologists have long known the benefits of elaborative encoding strategies such as generation (Slamecka & Graf, 1978) and encoding items in relation to oneself (Bower & Gilligan, 1979).

Nonetheless, it should not be assumed that results from the two research traditions will always converge, because surprises have occurred and will continue to occur. For example, the distribution of memories over the life span is not exactly as predicted by the logarithmic forgetting function first discovered by Ebbinghaus (1885/1913). In autobiographical memory studies, forgetting is generally logarithmic, but with two major exceptions: There is much forgetting of memories from early childhood (infantile amnesia), and older adults remember more from the years of early adulthood than would be predicted (the reminiscence bump). In addition, the two research traditions have different strengths. Traditional episodic memory experiments allow for manipulations during the encoding phase, whereas this is almost impossible for real-life events. Conversely, there are certain variables that are difficult to investigate within the traditional episodic memory experiment. For example, motivation plays an important role in how we remember ourselves, and it is hard to imagine subjects engaging in meaningful, motivated retrieval and reconstruction in a standard episodic memory experiment. In conclusion, then, we conceptualize episodic and autobiographical memory as overlapping sets that nonetheless may differ, with each domain of inquiry making an important contribution to our larger understanding of human memory.

REFERENCES

- Anderson, M. C., & Green, C. (2001). Suppressing unwanted memories by executive control. *Nature*, *410*, 366–369.
- Ayers, M. S., & Reder, L. M. (1998). A theoretical review of the misinformation effect: Predictions from an activation-based memory model. *Psychonomic Bulletin & Review*, *5*, 1–21.
- Baddeley, A., & Wilson, B. (1986). Amnesia, autobiographical memory, and confabulation. In D. C. Rubin (Ed.), *Autobiographical memory* (pp. 225–252). Cambridge, UK: Cambridge University Press.
- Balota, D. A., Duchek, J. M., & Paullin, R. (1989). Age-related differences in the impact of spacing, lag, and retention interval. *Psychology and Aging*, *4*, 3–9.
- Balota, D. A., & Neely, J. H. (1980). Test-expectancy and word-frequency effects in recall and recognition. *Journal of Experimental Psychology: Human Learning and Memory*, *6*, 576–587.
- Barclay, C. R., & Wellman, H. M. (1986). Accuracies and inaccuracies in autobiographical memories. *Journal of Memory and Language*, *25*, 93–103.
- Barsalou, L. W. (1988). The content and organization of autobiographical memories. In U. Neisser & E. Winograd (Eds.), *Remembering reconsidered: Ecological and traditional approaches to the study of memory* (pp. 193–243). Cambridge, UK: Cambridge University Press.

- Bartlett, F. C. (1932). *Remembering: A study in experimental and social psychology*. Cambridge, UK: Cambridge University Press.
- Begg, I., Snider, A., Foley, F., & Goddard, R. (1989). The generation effect is no artifact: Generation makes words distinctive. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *15*, 977-989.
- Bower, G. H., & Forgas, J. P. (2000). Affect, memory, and social cognition. In E. Eich & J. F. Kihlstrom (Eds.), *Cognition and emotion* (pp. 87-168). New York: Oxford University Press.
- Bower, G. H., & Gilligan, S. G. (1979). Remembering information related to one's self. *Journal of Research in Personality*, *13*, 420-432.
- Brewer, W. F. (1986). What is autobiographical memory? In D. C. Rubin (Ed.), *Autobiographical memory*. Cambridge, UK: Cambridge University Press.
- Brewer, W. F. (1988a). Qualitative analysis of the recalls of randomly sampled autobiographical events. In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory: Current research and issues* (pp. 263-268). New York: Wiley.
- Brewer, W. F. (1988b). Memory for randomly sampled autobiographical events. In U. Neisser & E. Winograd (Eds.), *Remembering reconsidered: Ecological and traditional approaches to the study of memory* (pp. 21-90). Cambridge, UK: Cambridge University Press.
- Brewin, C. R., Christodoulides, J., & Hutchinson, G. (1996). Intrusive thoughts and intrusive memories in a nonclinical sample. *Cognition & Emotion*, *10*, 107-112.
- Brown, N. R., Rips, L. J., & Shevell, S. K. (1985). The subjective dates of natural events in very-long-term memory. *Cognitive Psychology*, *17*, 139-177.
- Brown, N. R., Shevell, S. K., & Rips, L. J. (1986). Public memories and their personal context. In D. C. Rubin (Ed.), *Autobiographical memory* (pp. 137-158). Cambridge, UK: Cambridge University Press.
- Brown, R., & Kulik, J. (1977). Flashbulb memories. *Cognition*, *5*, 73-99.
- Christianson, S. A. (1989). Flashbulb memories: Special, but not so special. *Memory & Cognition*, *17*, 435-443.
- Colegrave, F. W. (1899). Individual memories. *American Journal of Psychology*, *10*, 228-255.
- Conway, M. A. (1990). *Autobiographical memory: An introduction*. Philadelphia: Milton Keynes.
- Conway, M. A. (2001). Sensory-perceptual episodic memory and its context. *Philosophical Transactions of the Royal Society of London*, *356*, 1375-1384.
- Conway, M. A., & Berkerian, D. A. (1987). Organization in autobiographical memory. *Memory & Cognition*, *15*, 119-132.
- Conway, M. A., & Ross, M. (1984). Getting what you want by revising what you had. *Journal of Personality and Social Psychology*, *47*, 738-748.
- Craik, F. I. M., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, *11*, 671-684.
- Craik, F. I. M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General*, *104*, 268-294.
- Crombag, H. F. M., Wagenaar, W. A., & van Koppen, P. J. (1996). Crashing memories and the problem of "source monitoring." *Applied Cognitive Psychology*, *10*, 95-104.
- Crowder, R. G. (1976). *Principles of learning and memory*. Hillsdale, NJ: Erlbaum.
- Crowder, R. G., & Surprenant, A. M. (2000). Sensory stores. In A. E. Kazdin (Ed.), *Encyclopedia of psychology* (pp. 227-229). Oxford, UK: American Psychological Association/Oxford University Press.
- Crovitz, H. F., & Schiffman, H. (1974). Frequency of episodic memories as a function of their age. *Bulletin of the Psychonomic Society*, *4*, 517-518.
- Dempster, F. N. (1988). The spacing effect: A case study in the failure to apply the results of psychological research. *American Psychologist*, *43*, 627-634.
- Ebbinghaus, H. (1913). *Memory: A contribution to experimental psychology* (H. A. Ruger & C. E. Bussnues, Trans.). New York: Teachers College/Columbia University. (Original work published 1885)
- Erdelyi, M. H., & Becker, J. (1974). Hypermnnesia for pictures: Incremental memory for pictures but not words in multiple recall trials. *Cognitive Psychology*, *6*, 159-171.
- Erdelyi, M. H., & Kleinbard, J. (1978). Has Ebbinghaus decayed with time? The growth of recall (hypermnnesia) over days. *Journal of Experimental Psychology: Human Learning and Memory*, *4*, 275-289.
- Freud, S. (1930). Three contributions to the theory of sex (A. A. Brill, Trans.). New York: Nervous and Mental Disease Publishing Co. (Original work published 1905)
- Freud, S. (1971). *The psychopathology of everyday life* (A. Tyson, Trans.). New York: W. W. Norton. (Original work published 1901)
- Freud, S. (1982). An early memory from Goethe's autobiography. In U. Neisser (Ed.), *Memory observed: Remembering in natural contexts* (pp. 64-72). New York: W. H. Freeman. (Original work published 1917)
- Friedman, W. J. (1993). Memory for the time of past events. *Psychological Bulletin*, *113*, 44-66.
- Galton, F. (1879). Psychometric experiments. *Brain*, *2*, 149-162.
- Gardiner, J. M. (1988). Functional aspects of recollective experience. *Memory & Cognition*, *16*, 309-313.
- Gardiner, J. M., & Richardson-Klavehn, A. (2000). Remembering and knowing. In E. Tulving & F. I. M. Craik (Eds.), *The Oxford handbook of memory* (pp. 229-244). New York: Oxford University Press.

- Garry, M., Loftus, E. F., & Brown, S. W. (1994). Memory: A river runs through it. *Consciousness & Cognition*, 3, 438-451.
- Garry, M., Manning, C. G., Loftus, E. F., & Sherman, S. J. (1996). Imagination inflation: Imagining a childhood event inflates confidence that it occurred. *Psychonomic Bulletin & Review*, 3, 208-214.
- Hall, J. F. (1954). Learning as a function of word frequency. *American Journal of Psychology*, 67, 138-140.
- Hashtroudi, S., Johnson, M. K., & Chrosniak, L. D. (1990). Aging and qualitative characteristics of memories for perceived and imagined complex events. *Psychology & Aging*, 5, 119-126.
- Heaps, C., & Nash, M. (1999). Individual differences in imagination inflation. *Psychonomic Bulletin & Review*, 6, 313-318.
- Holmes, D. S. (1995). The evidence for repression: An examination of sixty years of research. In J. L. Singer (Ed.), *Repression and dissociation: Implications for personality theory, psychopathology, and health* (pp. 85-102). Chicago: Chicago University Press.
- Howe, M. L., & Courage, M. L. (1993). On resolving the enigma of infantile amnesia. *Psychological Bulletin*, 113, 305-326.
- Hunt, R. R. (1995). The subtlety of distinctiveness: What von Restorff really did. *Psychonomic Bulletin & Review*, 2, 105-112.
- Hunt, R. R., & Elliot, J. M. (1980). The role of nonsemantic information in memory: Orthographic distinctiveness effects on retention. *Journal of Experimental Psychology: General*, 109, 49-74.
- Hunt, R. R., & McDaniel, M. A. (1993). The enigma of organization and distinctiveness. *Journal of Memory & Language*, 32, 421-445.
- Huttenlocher, J., Hedges, L. V., & Bradburn, N. M. (1990). Reports of elapsed time: Bounding and rounding processes in estimation. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, 16, 196-213.
- Huttenlocher, J., Hedges, L. V., & Prohaska, V. (1992). Memory for the day of the week: A 5 + 2 day cycle. *Journal of Experimental Psychology: General*, 121, 313-325.
- Hyman, I. E. (1994). Conversational remembering: Story recall with a peer versus for an experimenter. *Applied Cognitive Psychology*, 8, 49-66.
- Hyman, I. E., & Pentland, J. (1996). The role of mental imagery in the creation of false childhood memories. *Journal of Memory and Language*, 35, 101-117.
- Jacoby, L. L. (1978). On interpreting the effects of repetition: Solving a problem versus remembering a solution. *Journal of Verbal Learning and Verbal Behavior*, 17, 649-667.
- Jacoby, L. L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory & Language*, 30, 513-541.
- Jacoby, L. L., Toth, J. P., & Yonelinas, A. P. (1993). Separating conscious and unconscious influences of memory: Measuring recollection. *Journal of Experimental Psychology: General*, 122, 139-154.
- Johnson, M. K., Foley, M. A., Suengas, A. G., & Raye, C. L. (1988). Phenomenal characteristics of memories for perceived and imagined autobiographical events. *Journal of Experimental Psychology: General*, 117, 371-376.
- Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source Monitoring. *Psychological Bulletin*, 114, 3-28.
- Johnson, M. K., & Suengas, A. G. (1989). Reality monitoring judgments of other people's memories. *Bulletin of the Psychonomic Society*, 27, 107-110.
- Kinsbourne, M., & George, J. (1974). The mechanism of the word-frequency effect on recognition memory. *Journal of Verbal Learning and Verbal Behavior*, 13, 63-69.
- Klein, W. M., & Kunda, Z. (1993). Maintaining self-serving social comparisons: Biased reconstruction of one's past behaviors. *Personality and Social Psychology Bulletin*, 19, 732-739.
- Kurbat, M. A., Shevell, S. K., & Rips, L. J. (1998). A year's memories: The calendar effect in autobiographical recall. *Memory & Cognition*, 26, 532-552.
- Landauer, T. K., & Bjork, R. A. (1978). Optimum rehearsal patterns and name learning. In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory* (pp. 625-632). London: Academic Press.
- Light, L. L., Kayra-Stuart, F., & Hollander, S. (1979). Recognition memory for typical and unusual faces. *Journal of Experimental Psychology: Human Learning and Memory*, 5, 212-228.
- Linton, M. (1975). Memory for real-world events. In D. A. Norman & D. E. Rumelhart (Eds.), *Explorations in cognition* (pp. 376-404). San Francisco: W. H. Freeman.
- Linton, M. (1978). Real world memory after six years: An *in vivo* of very long term memory. In M. M. Gruneberg, P. E. Morris, & R. N. Skyes (Eds.), *Practical aspects of memory* (pp. 69-76). London: Academic Press.
- Linton, M. (1982). Transformations of memory in everyday life. In U. Neisser (Ed.), *Memory observed: Remembering in natural contexts* (pp. 77-91). New York: W. H. Freeman.
- Loftus, E. F. (1993). The reality of repressed memories. *American Psychologist*, 48, 518-537.
- Loftus, E. F., & Marburger, W. (1983). Since the eruption of Mt. St. Helens, has anyone beaten you up? Improving the accuracy of retrospective reports with landmark events. *Memory & Cognition*, 11, 114-120.
- Loftus, E. F., Miller, D. G., & Burns, H. J. (1978). Semantic integration of verbal information into a visual memory. *Journal of Experimental Psychology: Human Learning and Memory*, 4, 19-31.
- Loftus, E. F., & Palmer, J. C. (1974). Reconstruction of automobile destruction: An example of interaction between language and memory. *Journal of Verbal Learning and Verbal Behavior*, 13, 585-589.
- Lyubomirsky, S., Caldwell, N. D., & Nolen-Hoeksema, S. (1998). Effects of ruminative and distracting responses to depressed mood on retrieval of autobiographical memories. *Journal of Personality and Social Psychology*, 75, 166-177.

- Mandler, G. (1980). Recognizing: The judgment of previous occurrence. *Psychological Review*, *87*, 252-271.
- Marsh, E. J., & Tversky, B. (2002). *Spinning the stories of our lives*. Unpublished manuscript.
- McDaniel, M. A., Dunay, P. K., Lyman, B. J., & Kerwin, M. L. (1988). Effects of elaboration and relational distinctiveness of sentence memory. *American Journal of Psychology*, *101*, 357-369.
- McDaniel, M. A., Waddill, P. J., & Einstein, G. O. (1988). A contextual account of the generation effect: A three-factor theory. *Journal of Memory and Language*, *27*, 521-536.
- McGaugh, J. L., & Gold, P. E. (1992). Memory consolidation. In L. R. Squire (Ed.), *Encyclopedia of learning and memory* (pp. 395-398). New York: Macmillan.
- McGeoch, J. A. (1932). Forgetting and the law of disuse. *Psychological Review*, *39*, 352-370.
- Melton, A. W. (1963). Implications of short-term memory for a general theory of memory. *Journal of Verbal Learning and Verbal Behavior*, *2*, 1-21.
- Melton, A. W. (1970). The situation with respect to the spacing of repetitions and memory. *Journal of Verbal Learning and Verbal Behavior*, *9*, 596-606.
- Miller, G. A. (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. *Psychological Review*, *63*, 81-97.
- Moffitt, K. H., Singer, J. A., Nelligan, D. W., & Carlson, M. A. (1994). Depression and memory narrative type. *Journal of Abnormal Psychology*, *103*, 581-583.
- Morris, C. D., Bransford, J. D., & Franks, J. J. (1977). Levels of processing versus transfer appropriate processing. *Journal of Verbal Learning and Verbal Behavior*, *16*, 519-533.
- Nelson, K. (1993). The psychological and social origins of autobiographical memory. *Psychological Science*, *4*, 7-14.
- Neisser, U., & Harsch, N. (1993). Phantom flashbulbs: False recollections of hearing the news about Challenger. In E. Winograd & U. Neisser (Eds.), *Affect and accuracy in recall: Studies of "flashbulb" memories* (pp. 9-31). New York: Cambridge University Press.
- Paivio, A., & Begg, I. (1971). Imagery and comprehension latencies as a function of sentence concreteness and structure. *Perception and Psychophysics*, *10*, 408-412.
- Paivio, A., & Csapo, K. (1973). Picture superiority in free recall: Imagery or dual coding? *Cognitive Psychology*, *5*, 176-206.
- Paivio, A., Rogers, T. B., & Smythe, P. C. (1968). Why are pictures easier to recall than words? *Psychonomic Science*, *11*, 137-138.
- Paivio, A., Yuille, J. C., & Rogers, T. B. (1969). Noun imagery and meaningfulness in free and serial recall. *Journal of Experimental Psychology*, *79*, 509-514.
- Pezdek, K., Finger, K., & Hodge, D. (1997). Planting false childhood memories: The role of event plausibility. *Psychological Science*, *8*, 437-441.
- Pillemer, D. B., Goldsmith, L. R., Panter, A. T., & White, S. H. (1988). Very long-term memories of the first year in college. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *14*, 709-715.
- Pillemer, D. B., Rhinehart, E. D., & White, S. H. (1986). Memories of life transitions: The first year in college. *Human Learning: Journal of Practical Research and Applications*, *5*, 109-123.
- Rajaram, S. (1993). Remembering and knowing: Two means of access to the personal past. *Memory & Cognition*, *21*, 89-102.
- Robinson, J. A. (1976). Sampling autobiographical memory. *Cognitive Psychology*, *8*, 578-595.
- Roediger, H. L., III. (1978). Recall as a self-limiting process. *Memory & Cognition*, *6*, 54-63.
- Roediger, H. L., III. (1990). Implicit memory: Retention without remembering. *American Psychologist*, *45*, 1043-1056.
- Roediger, H. L., III. (2000). Why retrieval is the key process in understanding human memory. In E. Tulving (Ed.), *Memory, consciousness, and the brain: The Tallinn conference* (pp. 52-75). Philadelphia: Psychology Press/Taylor & Francis.
- Roediger, H. L., III, & Gallo, D. A. (2002). Levels of processing: Some unanswered questions. In M. Naveh-Benjamin, M. Moscovitch, & H. L. Roediger III (Eds.), *Perspectives on Human Memory and Cognitive Aging: Essays in Honour of Fergus Craik* (pp. 28-47). Philadelphia: Psychology Press.
- Roediger, H. L., III, & Guynn, M. J. (1996). Retrieval processes. In E. L. Bjork & R. A. Bjork (Eds.), *Memory* (pp. 197-236). San Diego, CA: Academic Press.
- Roediger, H. L., III, & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*, 803-814.
- Ross, M. (1989). Relation of implicit theories to the construction of personal histories. *Psychological Review*, *96*, 341-357.
- Ross, M., McFarland, C., & Fletcher, G. J. (1981). The effect of attitude on the recall of personal histories. *Journal of Personality and Social Psychology*, *40*, 627-634.
- Rubin, D. C. (1982). On the retention function for autobiographical memory. *Journal of Verbal Learning and Verbal Behavior*, *21*, 21-38.
- Rubin, D. C., & Kozin, M. (1984). Vivid memories. *Cognition*, *16*, 81-95.
- Rubin, D. C., & Schulkind, M. D. (1997). The distribution of autobiographical memories across the lifespan. *Memory & Cognition*, *25*, 859-866.
- Sanitioso, R., Kunda, Z., & Fong, G. T. (1990). Motivated recruitment of autobiographical memories. *Journal of Personality and Social Psychology*, *59*, 229-241.
- Schmidt, S. R. (1985). Encoding and retrieval processes in the memory for conceptually distinct events. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *11*, 565-578.

- Shum, M. S. (1998). The role of temporal landmarks in autobiographical memory processes. *Psychological Bulletin*, *124*, 423–442.
- Slamecka, N. J., & Graf, P. (1978). The generation effect: Delineation of a phenomenon. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *4*, 592–604.
- Slamecka, N. J., & Katsaiti, L. T. (1987). The generation effect as an artifact of selective displaced rehearsal. *Journal of Memory and Language*, *26*, 589–607.
- Suengas, A. G., & Johnson, M. K. (1988). Qualitative effects of rehearsal on memories for perceived and imagined complex events. *Journal of Experimental Psychology: General*, *117*, 377–389.
- Thompson, C. P. (1982). Memory for unique personal events: The roommate study. *Memory & Cognition*, *10*, 324–332.
- Tulving, E. (1967). The effects of presentation and recall of material in free-recall learning. *Journal of Verbal Learning and Verbal Behavior*, *6*, 175–184.
- Tulving, E. (1972). Episodic and semantic memory. In E. Tulving & W. Donaldson (Eds.), *Organization of memory* (pp. 381–403). New York: Academic Press.
- Tulving, E. (1974). Cue-dependent forgetting. *American Scientist*, *62*, 74–82.
- Tulving, E. (1983). *Elements of episodic memory*. New York: Oxford University Press.
- Tulving, E. (1985). Memory and consciousness. *Canadian Journal of Psychology*, *26*, 1–12.
- Tulving, E. (1993). What is episodic memory? *Current Directions in Psychological Science*, *2*, 67–70.
- Tulving, E. (1999). On the uniqueness of episodic memory. In L.-G. Nilsson & H. J. Markowitsch (Eds.), *Cognitive neuroscience of memory* (pp. 11–42). Seattle: Hogrefe & Huber.
- Tulving, E. (2000). Concepts of memory. In E. Tulving & F. I. M. Craik (Eds.), *The Oxford handbook of memory* (pp. 33–43). New York: Oxford University Press.
- Tulving, E. (2002). Episodic memory: From mind to brain. *Annual Review of Psychology*, *54*, 1–25.
- Tulving, E., & Pearlstone, Z. (1966). Availability versus accessibility of information in memory for words. *Journal of Verbal Learning and Verbal Behavior*, *5*, 381–391.
- Tulving, E., & Thomson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review*, *80*, 359–380.
- Tversky, B., & Marsh, E. J. (2000). Biased retellings of events yield biased memories. *Cognitive Psychology*, *40*, 1–38.
- Underwood, B. J. (1957). Interference and forgetting. *Psychological Review*, *64*, 49–60.
- Underwood, B. J. (1963). Stimulus selection in verbal learning. In C. N. Cofer & B. J. Musgrave (Eds.), *Verbal behavior and learning: Problems and processes* (pp. 33–48). New York: McGraw-Hill.
- Wade, E., & Clark, H. H. (1993). Reproduction and demonstration in quotations. *Journal of Memory and Language*, *32*, 805–819.
- Wagenaar, W. A. (1986). My memory: A study of autobiographical memory over six years. *Cognitive Psychology*, *18*, 225–252.
- Wagenaar, W. A. (1988). People and places in my memory: A study on cue specificity and retrieval from autobiographical memory. In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory: Current research and issues* (pp. 228–233). New York: Wiley.
- Watkins, M. J. (1990). Mediationism and the obfuscation of memory. *American Psychologist*, *45*, 328–335.
- Weaver, C. A., III. (1993). Do you need a “flash” to form a flashbulb memory? *Journal of Experimental Psychology: General*, *122*, 39–46.
- Weiner, B. (1966). Motivation and memory. *Psychological Monographs: General and Applied*, *80*, 22.
- Wetzler, S. E., & Sweeney, J. A. (1986). Childhood amnesia: An empirical demonstration. In D. C. Rubin (Ed.), *Autobiographical memory* (pp. 191–201). Cambridge, UK: Cambridge University Press.
- Wheeler, M. A. (2000). Episodic memory and auto-noetic awareness. In E. Tulving & F. I. M. Craik (Eds.), *The Oxford handbook of memory* (pp. 597–608). New York: Oxford University Press.
- White, R. T. (1982). Memory for personal events. *Human Learning*, *1*, 171–183.
- Wills, T. A. (1981). Downward social comparison principles in social psychology. *Psychological Bulletin*, *90*, 245–271.
- Wilson, B. A., & Wearing, D. (1995). Prisoner of consciousness: A state of just awakening following Herpes Simplex Encephalitis. In R. Campbell & M. A. Conway (Eds.), *Broken memories: Case studies in memory impairment* (pp. 15–30). Cambridge, UK: Blackwell.
- Yarney, A. D., & Bull, M. P., III. (1978). Where were you when President Kennedy was assassinated? *Bulletin of the Psychonomic Society*, *11*, 133–135.