CHAPTER 17

Episodic and Autobiographical Memory

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EPISODIC AND AUTOBIOGRAPHICAL MEMORY

When most people think about human memory, they think about their personal memories, and how they remember and forget the events of their lives. One's autobiographical memories might include important events such as weddings, graduations, and funerals, as well as more mundane breakfasts and meetings with colleagues. However, most experiments on episodic memory ask people to remember carefully controlled stimuli such as lists of words or pictures presented in the laboratory. This chapter tackles the relationship between these two forms of memory. Of interest is how people encode, store, and retrieve episodic and autobiographical memories. Some researchers have treated these terms as synonyms, writing about "episodic or autobiographical memory." Although these concepts are related, we believe there are good reasons to treat them separately, because they refer to distinct psychological constructs and typically have been investigated using different methods. Moreover, the two research traditions have often focused on different issues and, as such, have yielded unique insights into the workings of memory. Entire books have been written about these topics (e.g., Conway, 1990; Rubin, 1999; 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, with the requirement that one is retrieving information from a specific time and place (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 memory (we will consider these tasks shortly). In 1972, episodic memory was primarily contrasted to *semantic memory,* the general store of knowledge that a person has (Tulving, 1972). The definition of the word *elephant,* the meaning of H_20, 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 retrieve this knowledge—hence the notion that these are general or generic memories.

In the past 20 years, the concept of episodic memory has not only been treated as a psychological construct useful for heuristic and descriptive purposes, but it has also been used to refer to a specialized mind-brain system (see Szpunar & McDermott, 2009, for a recent treatment of the concept). Tulving (2002) provided a compelling case that episodic memory represents a unique mind-brain system that is (probably) unique to humans and that permits us to travel backward mentally in time to reexperience 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). Understanding how people think about the future is currently a major direction of research in the field (see Szpunar, 2010, for a recent review), but for purposes of this chapter we concentrate on the more traditional study of episodic memory in the laboratory.

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 includes both one's knowledge of oneself as well as the memories that surround 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 include other types of information, such as *procedural learning* (knowing that we know how to drive, to play tennis, and so on). Therefore, autobiographical remembering often recruits additional brain areas beyond the episodic memory network (Cabeza et al., 2004; see also McDermott, Szpunar, & Christ, 2009), as it involves a variety of different types of memory all directed to the self.

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

Successful remembering requires completion of three stages, regardless of whether the target is an episodic memory or an autobiographical memory. Information must be acquired, it must be retained across time, and it must be retrieved when needed. These phases are referred to as *encoding, storage,* and *retrieval* (Melton, 1963). Encoding refers to accurate perception in the most minimal case, and the process of encoding changes the nervous system as memory traces are created. 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 words did you study 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.

To better understand the issue at hand, imagine a situation in which subjects are asked to learn 50 unrelated words, presented at a rate of 5 s per word, and then are tested 24 hours later. Subjects are asked 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 can we say about the forgotten words? Is there a way to pinpoint at what stage or stages the breakdown occurred?

It can be very difficult to separate encoding, storage, and retrieval processes (Roediger & Guynn, 1996; Watkins, 1990). In our example, the first possibility is that some words were not encoded; for example, the subject might have closed her eyes briefly and missed two words entirely, meaning that these words were never encoded. However, this cause of poor performance would be unlikely in most experiments, as researchers try to present information under optimal conditions. Still, encoding could be impaired with fast presentation rates or distraction, although we would not refer to this as forgetting (encoding is a necessary condition for a later failure to be deemed forgetting).

Even assuming all the words were perceived accurately, another possibility is that the words were 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 Nairne and Neath, this volume).

Alternatively, the experience may have been stored, but the distributed trace became disorganized or decayed over the 24 hrs; that is, it was "lost" from storage. A further possibility is that the trace was perfectly intact after 24 hrs, but could not be retrieved. Evidence for this last possibility comes from experiments that show the recovery of seemingly forgotten information. For example, subjects in our hypothetical experiment might be able to recognize some of the 34 words that they were unable to recall, since a recognition test would provide strong retrieval cues (Tulving & Pearlstone, 1966). That is, many experiments support 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 assess the availability of information, but any test shows only what information is accessible under a particular set of retrieval conditions (Tulving & Pearlstone, 1966; Weiner, 1966).

We used an episodic memory task (remembering a list of words) to illustrate how problems could arise at each stage of the learning and memory process. However, 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 relayed by the professor at the same time.

Even though it is difficult to cleanly separate encoding, storage, and retrieval processes, these distinctions are still important as they keep us aware of what kinds of conclusions we can draw from our experimental procedures. As shown in Figure 17.1, in the prototypical experiment, 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 and testing (storage); and (d) during the test itself (retrieval). In the following sections, we briefly deal with each phase

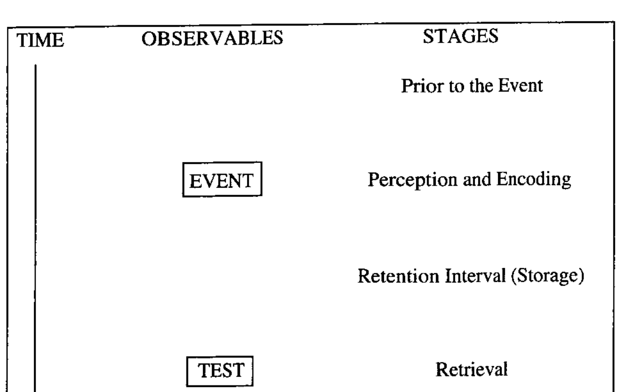

Figure 17.1 The four stages of the learning-memory process that are relevant to understanding how an event is remembered.

in turn, beginning with episodic memory before turning to 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 retrieving such memories requires that 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—recall of stories, 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 each requires 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.

Free recall. The person is exposed to words, pictures, or other material and is asked to recall them in any order after a brief delay with no retrieval cues. In a variant, the words or pictures can be presented repeatedly with a test after each presentation trial. Then the task is called multiple-trial (multitrial) free recall rather than single-trial free recall.

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.

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.

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 an example of a cued recall task, with the retrieval cue item being *intralist*, or coming from within the list itself.

Recognition. This test requires one 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 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. 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.

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 has to judge how many times he or she studied each item. The task can also be converted for relative frequency judgments. Two items are given during the test, and the subject must judge which one was presented more frequently during the study phase.

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 between events in time.

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 speaker). At test the subject is given each item and asked to identify the source—spoken or written? Male or female?

Metamemory judgments. People can be asked to judge different features of their episodic memories. For example, a subject might rate how confident she is that an event occurred, from 1 (certain it did not) to 7 (certain it did). For items recalled or recognized, people can also indicate whether they remember specific details about an item's presentation (e.g., how it appeared or sounded, any thoughts they had during its presentation, etc.) or rather only know that it was presented without remembering the moment of actual occurrence (Tulving, 1985). People can also rate the more specific sensory, emotional, and contextual characteristics of each memory (e.g., using the Memory Characteristics Questionnaire created 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, performance on episodic (or explicit) memory tests does *not* necessarily reflect "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. Collecting remember-know judgments is one way to obtain a measure that is thought to reflect more purely episodic memory, since Remember judgments involve mentally traveling back in time and re-experiencing the past (Gardiner, 1988; Rajaram, 1993; Tulving, 1985). Jacoby has also developed a procedure for separating conscious recollection from more automatic, nonconscious uses of memory (Jacoby, 1991; Jacoby, Toth, & Yonelinas, 1993).

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 remembering 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, young adults perform better on episodic memory tests than do 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 and your friend would encode and remember it very differently. 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 (Van Overschelde & Healy, 2001). However, expertise can also have costs, as demonstrated in a recent experiment (Castel, McCabe, Roediger, & Heitman, 2007) in which people with high and low knowledge about football were asked to remember two lists of words, one involving animals that also happened to be the names of professional football teams (e.g., *dolphins, broncos, falcons, colts* . . .) and the other involving body parts (e.g., *knee, eyes, arm, mouth* . . .). People with a lot of knowledge about football remembered more of the animals than did people without football knowledge, but they were also more likely to falsely recall team names that weren't actually presented in the list (e.g., *eagles, panthers, cardinals*). The two groups showed comparable memory for the list of body parts, a domain for which they had similar expertise. However, the group with the football knowledge likely encoded the animal list differently, realizing that it was a list of football teams, and then also used that knowledge to reconstruct the list. In short, background knowledge (expertise) can change the way events are encoded and reconstructed, sometimes with benefits to memory and sometimes with costs. More generally, 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 is extended in time, even if it simply involves seeing a word or picture presented in a list. 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 last word presented in a list, however, and the experimenter asks for recall of the last word immediately after its presentation, is the experimenter testing perception or memory? The two processes blend 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 Nairne & Neath, 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; see Gallo, 2006, 2010 for reviews). False memories represent the extreme, but in general, what is encoded does not match exactly what is available for perception. A critically important concept is the distinction between nominal and functional stimuli (Underwood, 1963). The *nominal stimulus* is the event as it happened in the world, and includes 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. For the understanding of learning and memory, it is the functional stimulus that is critical, not the nominal stimulus (Underwood, 1963). 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 process refers to the conversion of the nominal stimulus of the world into the functional stimulus that can be potentially remembered (Miller, 1956). People typically recode information from the world into a form that the cognitive system can more easily handle 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; why do some people 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 it 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.

One of the most famous demonstrations of the power of recoding comes from the voluminous literature on levels of processing. Craik and Lockhart (1972) proposed that encoding is a byproduct of perception and that perception occurs in a series of stages. For words, they proposed that processing includes an analysis of each word's visual or orthographic features, followed by analysis of the word's phonemic (sound) properties, and culminating with analysis of the word's meaning. This set of stages can be considered as occurring at 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 memorial consequences of different levels of processing. People are asked questions before they see words, and the questions are meant to direct attention to a particular level of analysis (see the right side of Figure 17.2). 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, 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 all the questions and words carefully.

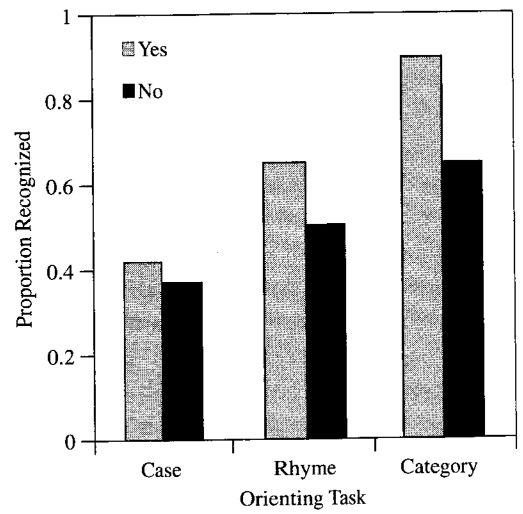

Figure 17.3 The levels-of-processing (LOP) effect. Mean proportion of words recognized as a function of orienting task and type of response to the question (*yes* or *no*). Adapted from Craik and Tulving (1975, Experiment 9B).

Later, subjects were given a recognition test that intermixed the studied words 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 the levels of processing manipulation. When people answered a question about the word's visual appearance, performance was barely better than chance. When they answered a question about its meaning, performance was nearly perfect (at least when the answer was *yes*). Therefore, levels of processing strongly determined later recognition, an outcome that has been replicated many times, although there are still unanswered questions involving the effect (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 was the same—single words presented at slow rates. Many variables known to affect memory were held constant, such as the type of materials, the knowledge that a test would be given, the individuals tested, and so on. The questions caused the words to be recoded differently, with some types of processing providing for much better recognition than others, even though all the questions were easy ones that could be answered in a fraction of a second. Nonetheless, this split-second difference in encoding

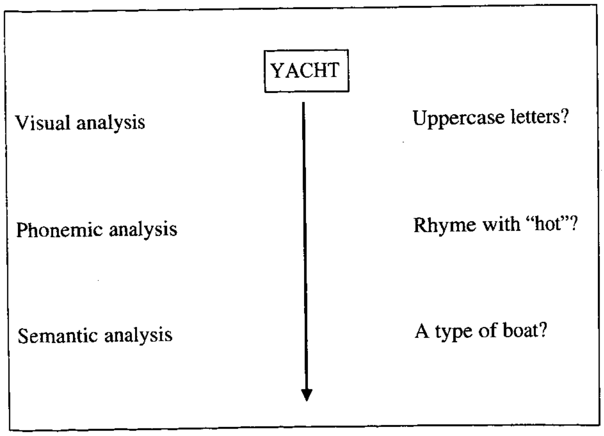

Figure 17.2 The levels-of-processing (LOP) procedure

of the words created huge differences in recognition. Of course, these effects are not limited to the particular tasks described here. Other shallow processing tasks include checking each word for the presence of the letter *e* or quickly estimating the number of letters each word contains (e.g., Hyde & Jenkins, 1969); neither of these tasks requires the subject to access the meaning of the words. Other deep processing tasks include deciding how pleasant each word is (e.g., Hyde & Jenkins, 1969) or classifying each word as abstract or concrete (e.g., Wagner et al., 1998); successful completion of both these tasks requires accessing the meaning of each word. Across tasks, retention is generally better following deep processing that taps meaning than following shallow processing. Recent research has focused on understanding the effectiveness of a particular deep processing task that yields especially large mnemonic benefits; specifically, asking subjects to process items for their survival value boosts memory (e.g., Nairne & Pandeirada, 2008). That is, deciding how much a "pencil" would help you to survive being stranded in the grasslands boosts later memory for that word more than does rating *pencil* for how pleasant it is or how easy it is to imagine (Nairne, Pandeirada, & Thompson, 2008). The exact mechanism underlying this effect is still under debate (e.g., Butler, Kang, & Roediger, 2009), but it highlights that one of the open questions involves understanding why some deep tasks boost memory more than others (Roediger & Gallo, 2002).

Many other factors during encoding affect episodic memory, although space will permit us to review just a subset in the next few sections. For example, active involvement in learning, such as generating information rather than reading it, promotes retention (Jacoby, 1978; Slamecka & Graf, 1978; for a recent review see Bertsch, Pesta, Wiscott, & McDaniel, 2007). 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 (see Slamecka & Graf, 1978, for similar results). 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).

Second, repetition also reliably affects episodic memory. 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., Dempster, 1988; Melton, 1970; for a review see Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006). This spacing or lag effect 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).

Third, concrete materials are generally better remembered on episodic memory tests than are abstract materials. For example, pictures are more likely to be recalled than words (the names of the pictures), a finding that is called the *picture superiority effect* (Paivio & Csapo, 1973; Paivio, Rogers, & Smythe, 1968). Also, words that refer to concrete objects (*umbrella, fingernail*) 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 advantage for concrete materials also holds true for prose (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) 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 (see Worthen & Hunt, 2011, for discussion of mnemonic techniques).

Finally, distinctive events are generally better remembered than are events 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, deep semantic processing of words may yield more distinctive encoding and retrieval cues than does 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 how different encoding conditions and processing can affect episodic memory performance. However, the fact that these phenomena occur 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

Events that happen between the 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 (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. Growing evidence suggests that one of the functions of sleep is to help consolidate memories (Rasch & Born, 2008).

Support for consolidation comes from work on retrograde amnesia, which refers to the forgetting of experiences from *before* a concussive event (the forgetting of events happening after the concussion is called anterograde amnesia). For example, sometimes victims of car accidents don't remember the events leading up to the accident. More generally, traumatic brain injury, anoxia, long-term substance abuse, and various neurodegenerative diseases (e.g., Pick's disease) can all yield amnesia of varying severity, sometimes with patients having difficulty remembering events from years before the onset of brain trauma. Retrograde amnesia implicates a consolidation process because the injury interrupts some process that is ongoing *after* the events in question have already occurred. Furthermore, retrograde amnesia occurs in a graded fashion, such that events immediately before the injury are remembered less well than older memories (presumably as the older memories are more consolidated). After a period of time following the injury, memories will sometimes gradually recover.

Of course, even without brain damage, it is normal for forgetting to occur as time passes. All other things being equal, as more time passes since the occurrence of events, fewer of the events will be retained. In the first experiments on long-term retention, Ebbinghaus (1885/1913) provided evidence for the decline of retention over time, and the function he discovered has been replicated 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.

Retroactive interference occurs when events that follow some critical event of interest inhibit recall of those earlier events. 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 learn competing associations (e.g., *dogwood-rhinoceros*). The control group either performs a distractor task during the

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

second phase of the experiment or learns completely unrelated pairs (*record-rhinoceros*). All subjects then take a memory test that provided the stimulus (left-hand) member of the first pair (*dogwood-*______), and the task is to recall the paired item (*giraffe*). However, subjects who learned the interfering association (*dogwood-rhinoceros*) perform worse than subjects in the control condition.

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 key question was whether the verbally presented misinformation would be incorporated into memory for the scene, causing 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. Relative to the neutral condition, seeing consistent information augmented later recognition of the correct sign, but having been exposed to the misleading information decreased correct recognition. This misinformation 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).

Of course some things that happen during the retention interval can improve memory, such as *repeated covert retrieval of information* (*rehearsal*), 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: 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 very effective when testing occurs shortly after learning. To implement this schedule when trying to learn the name of a new person, one would rehearse the name just after hearing it to make sure it is encoded. Then the person would 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. More recent research on this topic has found that on delayed tests, equally spaced retrieval practice is as good as or better than expanding practice (e.g., Karpicke & Roediger, 2007, 2010; Logan & Balota, 2008). The important point is that retrievals should be spaced out in time rather than occurring immediately after learning.

In short, what happens between encoding and retrieval can have powerful consequences for 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, 2000; Roediger & Guynn, 1996; Tulving, 1974).

Surprisingly, giving the same test repeatedly can increase recall. For example, if subjects study 60 pictures and then try to recall them, 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 pass 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 previously. This recovery of items is called reminiscence, and when the number of items recovered outweighs the number forgotten, to produce an overall increase across tests, the effect is called hypermnesia. This hypermnestic effect can continue to expand across a week after learning (Erdelyi & Kleinbard, 1978). The phenomenon of hypermnesia is not well understood theoretically, but shows that retrieval can be quite variable (especially on tests of free recall). Humans seem 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 often greatly increase the remembering of past events (Roediger & Guynn, 1996; Tulving & Pearlstone, 1966). The encoding specificity principle is the idea that guides 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 principle states that, all other things being equal, the more completely the features 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.

Often, recognition tests provide powerful retrieval cues because they provide copies of the to-be-remembered events. 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 still involves more than one type of retrieval process (Jacoby, 1991; Mandler, 1980). In fact, sometimes events can be recalled when they cannot be recognized!

In the classic demonstration of recognition failure of recallable words, Tulving and Thomson (1973) had subjects study weakly associated pairs of words (e.g., *glue-CHAIR*), with instructions to remember the capitalized words. Later, subjects took a free association test where they were given words like *table* and asked to produce up to six associates to each of a series of words; of course, they quite often wrote down *chair* as a response. In a third phase, 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 earlier list. Subjects 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 sometimes be greater than recognition, the encoding specificity principle 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.

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 similar cognitive operations as were engaged during learning. Tests may be more or less appropriate to tap the knowledge that was learned.

To explicate this idea, let us revisit the levels-of-processing effect shown 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 the 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 each 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 stimuli? 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 condition. 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 & Guynn, 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 act of retrieval is not a neutral event; it changes the way memories will be retrieved in the future. Correct retrieval of information increases the probability it will be recalled on a later test, relative to either no retrieval or to restudy of information (e.g., Carrier & Pashler, 1992). This *testing effect*, as it is called, seems to increase when tests are delayed, so the advantage of retrieval to restudy is greater when a test is given a week later rather than immediately (Roediger & Karpicke, 2006). Repeated retrieval increases the size of the effect (Wheeler & Roediger, 1992). On the other hand, if a person makes an error during retrieval, the error is also quite likely to be repeated (Roediger, Jacoby, & McDermott, 1996). In short, the act of retrieval itself can powerfully modify one's recollections in the future (Roediger & Butler, 2011).

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. We turn now to a somewhat different tradition of research, involving autobiographical memories, which also often involve remembering experiences (albeit personal ones). However, research on autobiographical memory tends not to use the laboratory methods that characterize the study of episodic memories.

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 romantic partner are all autobiographical to some extent. Some autobiographical memories also meet our definition for episodic memory; for example, memories of one's wedding are indeed easily labeled both memories of 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 it 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.

Historically, psychologists have made surprisingly few attempts to capture autobiographical memory. Galton (1879) first attempted to study personal memories; he retrieved and dated his own memories in response to each of a series of 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 of 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 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, 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.

- *Diary studies*. The subject is asked to record events from her own life for some time period, and after a fixed interval is tested on her memories for what actually happened. Factors of interest include the time interval between recording and testing, the types of to-be-remembered events, and the types of retrieval cues provided at test. 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).
- *Galton word-cuing technique*. For each word in a series, the subject is asked to retrieve and record a personal life event; time to retrieve each memory can also be recorded. 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 (e.g., using the Autobiographical Memory Questionnaire; Rubin, Schrauf, & Greenberg, 2003).
- *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 hearing the news of an assassination or for one's first week of college.
- *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).
- *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 a woman in the laboratory, and later be asked to remember these episodes (e.g., Suengas & Johnson, 1988). Recent research has had rival basketball fans watch videos of old basketball games in the lab and later remember the outcomes of particular shots (Botzung, Rubin, Miles, Cabeza, & LaBar, 2010).

The same framework used to discuss episodic memory will be used for our discussion of autobiographical memory. We will consider factors (a) prior to the events or episodes to be remembered; (b) during the to-be-remembered event (encoding); (c) occurring in the interval between the event and later testing; and finally (d) 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 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, anterograde amnesics cannot 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 later remembered at lower rates than would be predicted from the prototypical forgetting curve; this phenomenon is called *childhood amnesia* (Nelson, 1993). Although there is some evidence that adults can remember important events (such as the birth of a sibling) from as early as age 2 (e.g., Eacott & Crawley, 1998), by most estimates the offset of childhood amnesia occurs sometime around the age of 4½ (e.g., Bruce, Dolan, & Phillips-Grant, 2000; Multhaup, Johnson, & Tetirick, 2005).

Individual differences among adults also affect the way people will encode, store, and retrieve memories. For example, there is evidence for gender differences in autobiographical memory, with women having more vivid memories than men (e.g., Ross & Holmberg, 1992). Another well-documented difference involves depressed individuals, who ruminate on negative thoughts and are biased toward retrieving sad life events. They also tend to recall fewer details of events, relying more on the "gist" (e.g., Moffitt, Singer, Nelligan, & 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 Forgas and Eich, this volume).

More generally speaking, prior events affect how and whether people remember a target event. 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. Just as studying related material in laboratory experiments causes interference (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., pictures are better remembered than words) and how some types of encoding tasks led to better memory (e.g., evaluating the meaning of a to-be-remembered item). 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 strongest 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, 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 semi-random 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 non-salient 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, and smells). Overall, the results from the two studies line up 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 (this is sometimes called the positivity bias or the Pollyanna Principle).

Although diary studies provide a rich source of autobiographical memories, such richness comes with methodological costs. Diary studies often involve only the experimenter as subject (or, at most, a small sample of individuals), the to-be-remembered events are not randomly selected, and the very act of recording the events may change the way they are encoded. To deal with the recording problem, Thompson (1982) conducted a diary study in which participants recorded events not only from their own lives but also from their roommates' lives. All 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 methodological advance, 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 forgotten events, 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 (Brewer, 1988a, 1988b).

We mention here only one of the many other studies that support the claim that life events that are unique, important, and emotional are the ones that tend to be vividly remembered. 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 cues (e.g., their own 13th birthdays). These cues naturally varied in their ability to elicit vivid memories; vivid memories tended to be associated with consequentiality, surprise, emotional change, and rehearsal.

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 always accurate ones. 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, assassinations, and the 9/11 attacks have confirmed that what characterizes flashbulb memories is the confidence with which they are held (e.g., Weaver, 1993) and the vividness of the memories (Talarico & Rubin, 2003), 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, and 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 repeatedly retrieved (either covertly or overtly). With autobiographical memories, it is particularly difficult to pin down the cause of memorability to one particular stage in the memory process. With that issue in mind, we turn now to discussing effects occurring during the retention interval.

Factors Occurring During the Retention Interval

This section will focus on how various characteristics of the retention interval (i.e., how long it is and what happens during it) can affect autobiographical memory.

As the retention interval increases, so does forgetting (Linton, 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 first and second years of life are almost nonexistent, and memories from the first 5 years 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 17.5, 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

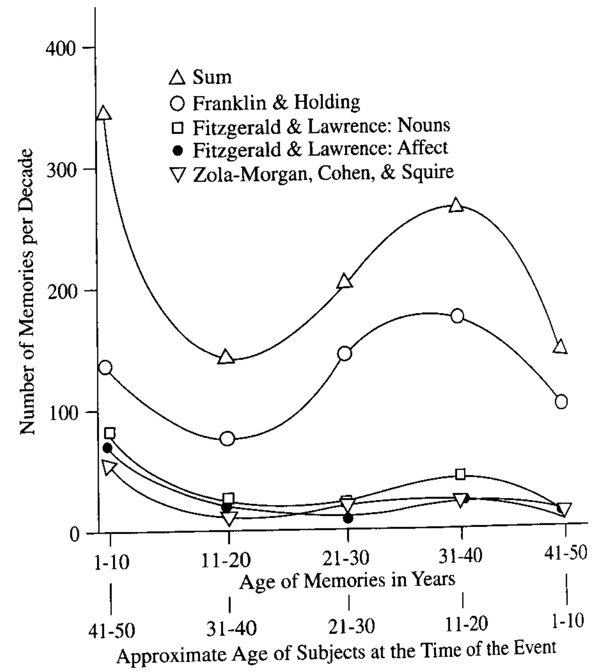

Figure 17.5 Distribution of autobiographical memories across the life span. In four studies, represented by the lower four curves in the figure, 50-year-old subjects remembered and dated life events in response to cue words. The top curve collapses over studies and sums over the lower four curves. Subjects recalled a disproportionate number of events from adolescence and early adulthood (reminiscence bump).

Source: From Rubin, Wetzler, & Nebes (1986) and reprinted with permission of Cambridge University Press.

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. Most of these explanations assume that bump events are differently encoded or rehearsed. A new explanation has recently been advanced, based on the finding that the reminiscence bump occurs for highly positive but not highly negative memories (Rubin & Bernsten, 2003). This valence difference is hard to fit with the explanations just described (e.g., both first kisses and first car crashes are important), and instead fits with the idea that people have a script for what happens in a particular life, and that script involves mainly positive events, many of which happen during the bump period. That is, undergraduates can tell you that most people will go to college, graduate, marry, and have kids, and they can tell you when these events happen (and they tend to fall during the bump period); but they don't predict that everyone will suffer from cancer or have a car crash at a particular age. When reconstructing memories from their lives, older adults use this script (a set of expectations about a typical life) to help remember, leading them to disproportionately sample the typical events that happen during the bump period. Recent data suggest that the bump is *not* due to differences in how memories are encoded, since children's narratives about their future lives also show a bump (Bohn & Bernsten, 2011). That is, if a child imagines the events of her hypothetical life, she includes more events that fall within the bump period. So one possibility is that both children and older adults have a script for a typical life, that children use to predict the future and older adults use to reconstruct the past. One important direction for future research is to understand the extent to which the bump reflects differences in autobiographical memory as opposed to resulting from general knowledge people have about typical lives. More generally, infantile amnesia and the reminiscence bump are interesting phenomena that never would have been discovered if researchers had stayed within the confines of standard experimental psychology (measuring memory for words and pictures), and both topics remain the focus of much research.

What happens during the retention interval is just as important as the length of that interval. 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, 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 this post-event information is often correct, it may also be incorrect. Just as in laboratory studies of episodic memory, misleading post-event information can affect how we conceptualize original events and impair our ability to retrieve the original events.

In one clever demonstration of this point, 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 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 post-event 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; unbeknown to the subject, one of the events had never occurred. Over a series of sessions, participants came 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).

In the examples just described, participants' acceptance of the post-event information meant that they came to have vivid memories that contained errors. In other words, participants falsely recollected the target events. However, not all memory errors involve false recollection; consider the phenomena of déjà vu, whereby one believes one has experienced something (an event, a place, a conversation) previously, but cannot recollect the details of that prior experience, resulting in a surprising sense of familiarity. One possibility is that people have experienced part of a scene or event before (e.g., you previously saw photos of the gardens you are now visiting for the first time), but fail to recognize this connection, resulting in familiarity that cannot be attributed to a particular source. To test this idea in the lab, participants were exposed to scenes from college campuses that they had never visited in real life (they also saw many other photos to camouflage the target photos). They processed the photos shallowly, searching each for a cross embedded in the scene. One or three weeks later, they returned to the lab for an autobiographical memory task, where they judged whether they had visited each of a series of locations in real life. Photos that had been seen in Phase I of the experiment were judged as more likely to have been visited in real life, as compared to new photos from the never-visited campus (Brown & Marsh, 2008). Surprisingly, about half the subjects in this study reported experiencing déjà vu during it, even though déjà vu is a relatively rare experience in real life.

Thus far, our discussion of post-event experiences has focused on information coming from external sources; however, the rememberer herself can do things during the retention interval that will have consequences for memory. Specifically, 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, such 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 diary study of people's retellings of events from their own lives, people reported telling "inaccurate" stories almost two thirds of the time! Reports of inaccuracies were frequent, even though subjects likely underestimated how inaccurate they were in storytelling, both because of the social desirability of truth telling and because they were likely unaware of some the inaccuracies due to faulty memories (Marsh & Tversky, 2004). 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 (see Marsh, 2007, for a review of this work). In the section on episodic memory, we mentioned studies showing that the act of retrieval can greatly alter how events will be remembered in the future (for better or worse). The same principles apply in retrieval of autobiographical memories.

More generally, biased or distorted rehearsals can lead to the creation of false memories for entire events. In the earlier section on post-event information, we described how a suggestion from a trusted source might yield a false memory. A key part of memory implantation typically involves rehearsal of the suggestion; the subject comes to believe the false memory as she repeatedly retrieves and thinks about it (Roediger et al., 1996). Similarly, repeatedly imagining an event initially believed not to have happened increases 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. In short, we all think, ruminate, and daydream about our lives and what might have happened; such processes may lead to memory distortion.

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 utilized. So even though diary studies suggest little forgetting of life events, this is probably because they typically provide subjects with excellent retrieval cues, 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 non-experienced events. A study by Barclay and Wellman (1986) makes this point nicely. In that study, students made old-new judgments for 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 contrast, retrieval times for remembering autobiographical events tend to be slow and variable, suggesting that remembered events are reconstructed (as first proposed by Bartlett, 1932). We have already reviewed several ways that inaccuracies might be introduced during the retention phase, including exposure to post-event information and distorted retelling of an event. We now review the literature on reconstructing autobiographical memories at retrieval, beginning with the example of how people date autobiographical memories. Generally speaking, temporal cues are not very useful for recollecting events (Wagenaar, 1988), probably because people do not normally explicitly encode dates of events. For example, try to answer the following questions: On what date did you hear that U.S. forces attacked Libya? 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, even though you likely remember these events. 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 0.88; N. R. Brown et al., 1985). Due to space constraints, we will describe here only a few of the strategies people use to reconstruct when events occurred, which make use of what little temporal information was encoded originally. At least two types of information appear relevant: the temporal cycles that regularly occur in people's lives and temporal landmarks. First, natural *temporal cycles* 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 Shum, 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.

Of course, people's errors when remembering their personal pasts are not limited to temporal errors. For example, 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 their past beliefs with their present ones. 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, 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).

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 how knowledge of norms affected subjects' self-reported frequencies of health-threatening behaviors (e.g., 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 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 retrieved memories for each of a series of trait dimensions, including *shy-outgoing*. Of interest was whether subjects listed an extraverted or 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 extraversion (or in another condition, introversion) led to success as a police officer; the second phase remained the same. As shown in the right-hand panel of Table 17.1, subjects in this version of the experiment no longer recruited trait-relevant memories first. Thus, motivated retrieval 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).

TABLE 17.1 Motivated Retrieval of Autobiographical Memories

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

Source: Adapted from Sanitioso el 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.

In short, the research just reviewed highlights how autobiographical memories can be distorted and how these distortions may enter the system during encoding, storage, and retrieval. Just as important as memory accuracy, however, are the qualities of our autobiographical memories; the ones that matter most to our life stories tend to be vivid ones that are more easily retrieved.

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 about how memory works. For example, the principle that unusual events are well remembered describes 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 retrieval cues can bring back both autobiographical and episodic 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 instance, 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.

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