

# 6

## CHAPTER

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### Why Retrieval Is the Key Process in Understanding Human Memory

In a 1991 interview, Endel Tulving remarked that "The key process in memory is retrieval." This chapter takes that thesis as its starting point and details a variety of ways in which it is true. Calling attention to the relatively neglected stage of retrieval and bringing the topic into sharp focus were perhaps the main thrusts of Tulving's research in the 1970s and 1980s. Now he studies the neural underpinnings of retrieval, among other topics, and other writers in this volume will explore these fascinating recent discoveries. The purpose of my chapter is to elucidate and defend the thesis that Tulving outlined in his 1991 interview. Although retrieval is not now a neglected stage of the learning/memory process, as it was when Tulving began his career, it still seems safe to say that most writers and thinkers still assume that encoding and storage are the primary stages of the learning and memory process, with retrieval functioning merely to express the changed state of the nervous system from prior experience. This accepted view, as we shall see, is wrong.

The chapter is divided into several sections. I first consider a few historical points about distinguishing among encoding, storage, and retrieval. After that, I consider why retrieval might be considered the most critical process of the learning/memory sequence on logical grounds. Finally, the main part of the chapter is a list of five phenomena that document the centrality of retrieval processes to the study of human memory. Obvi-

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This chapter benefited from the comments of David A. Gallo, Kathleen B. McDermott, and Endel Tulving.

ously, the other stages in the learning and memory process cannot be ignored and they are intertwined with retrieval, but retrieval—utilization of stored information—is the critical mystery of memory.

## □ Encoding, Storage, and Retrieval

The tripartite delineation of the learning/memory process into stages of acquisition, storage, and retrieval in the modern era is usually credited to an important paper by Melton (1963).<sup>1</sup> However, another man, one born and raised in Estonia during the early years of his life, had previously made nearly the same distinctions that Melton (1963) explicated somewhat later. I refer to Wolfgang Köhler, whose lucid description occurs at the beginning of Chapter IX ("Recall") of his great book on *Gestalt Psychology* (1947):

Psychology investigates three main topics in the field of memory: (1) learning and the formation of the traces which later enable us to recall, (2) the fate of these traces in the time between learning and recall, and (3) the process of recall itself. To be sure, recall plays a part in the investigation of *all* these problems, because the study of the laws of learning and those of retention involves recall as much as does the study of recall as such. But when interested in the problems of learning, we can keep conditions constant with regard to retention and recall, so that only the conditions of learning are varied. If our problem refers to retention, the conditions of learning and those of recall are kept constant, while those concerning the interval between learning and recall will be varied. In the study of recall there will be variation only of the circumstances which concerns this event. Thus the three classes of problem are actually separable. (Köhler, 1947, p. 279)

Despite the fact that Köhler so eloquently distinguished these stages and even laid out the general experimental logic by which they could be studied, the clean separation he described was not really implemented for many years. It took another Estonian (and Zena Pearlstone) to perform a large experiment in 1966 to separate storage from retrieval processes in the way Köhler had suggested, by holding study and retention conditions constant and manipulating only retrieval conditions. Tulving and Pearlstone (1966) gave subjects categorized word lists and tested them

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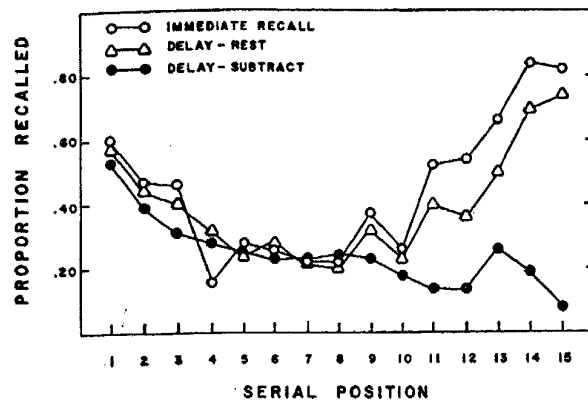
<sup>1</sup> Retrieval was, of course, explicitly discussed before the mid-1900s. Sir William Hamilton (1859) used the term, but more or less as a synonym for recall. Hamilton also distinguished explicitly among acquisition, retention and reproduction, by which he meant encoding, storage, and retrieval (Schacter, 1982, p. 167). More importantly, the biologist Richard Semon (1859–1918) was the first to argue strongly that retrieval processes were critical to the understanding of human memory. Schacter et al. (1978) reintroduced Semon's ideas to modern psychology, and Schacter (1982) provided a treatise on the man and his ideas.

under conditions of free recall or recall cued by category names. Subjects generally recalled more words under cued recall than under free recall, leading Tulving and Pearlstone to distinguish the information *available* in memory from that which is *accessible*. Free recall, cued recall, recognition, or any other test provides only an estimate of what information is accessible on a test under a particular set of retrieval conditions. Memory tests provide no magic window as to what information is stored (or available); rather, we experimental psychologists must always content ourselves with assessing the information accessible using one test or another. Cleanly separating encoding from storage is perhaps even more difficult than separating storage from retrieval (Watkins, 1990).

### ☐ Neglect of Retrieval Processes

The statements in the previous section may seem like truisms as a new century dawns, but it was not so many years ago that researchers interested in human memory believed differently. They either implicitly or explicitly rejected the idea that retrieval processes mattered. Four cases provide examples.

During the 1960s, proponents of the two-store model of human memory argued for the difference between short-term and long-term memory by reference to the single trial free recall serial position curve, examples of which are shown in Figure 6.1. These data arose from part of an experiment by Roediger and Crowder (1975) in which immediate recall was compared to recall after a 30 sec interval filled with demanding arithmetic problems. In another condition, subjects had recall delayed for 30 seconds, but they rested (and presumably rehearsed the list). A positive recency effect occurred in immediate recall and a negative recency effect appeared in 30-sec delayed recall with arithmetic. However, of interest for current purposes is the preresency effect—the general similarity in performance in the two conditions for items 1–10. Proponents of two store theories (e.g., Glanzer, 1972; Waugh & Norman, 1965) argued that this flat portion of the serial position curve measured the contents of long term storage (in part, because this part of the curve was unaffected by delay). Many variables that affected the preresency portion of the serial position curve were thought to affect transfer of information from short- to long-term store; to put it another way, the preresency part of the curve was believed to reflect directly the contents of long-term store. The familiar equations used to estimate the information “in” both stores depended heavily on the assumption that the flat part of the single-trial free recall serial position curve accurately reflected the contents of the long-term store. However, it is almost a thought experiment to show that various



**FIGURE 6.1.** The serial position curve of a single trial free recall. Free recall of 15-word lists either immediately or after a 30-sec delay filled with arithmetic or unfilled (rest). Data are from Roediger and Crowder (1975, Experiment 1).

cued recall techniques or recognition tests would greatly change the estimate of available information. Differences could as easily arise from retrieval as from storage—especially in free recall—but nonetheless the attribution made in this classic work from the 1960s was that serial position effects directly reflected storage differences. As Glanzer and Cunitz (1966) put it in the first sentence of the abstract of their famous paper, “Two experiments were carried out to test the hypothesis that the bimodal serial position curve in free recall is produced by output from two storage mechanisms—short term and long term” (p. 351). They concluded their results confirmed the hypothesis, as did many later researchers.

A second example comes from free recall work reported by Paivio (e.g., Paivio, 1969; Paivio & Csapo, 1969), who was interested in why concrete materials were better recalled than abstract materials. For example, pictures are better recalled than words on free recall tests and concrete words are better recalled than abstract words, especially when subjects are instructed to use mental imagery (Paivio & Csapo, 1969). According to dual coding theory, pictures and (to some extent) concrete words activate two codes (one verbal and one pictorial/imaginal), whereas abstract words activate only a verbal code. Representation in two codes is assumed to support retention better than only a single code. The dual coding theory appealed directly to storage differences as the locus of interesting effects in retention of various materials, especially on tests of free recall. Once again, the critical determinant of recall was deemed to be processes in storage, with recall reflecting faithfully what was stored. The idea that retrieval processes might be involved was not considered very strongly, except in paired

associate learning where the imageability of the stimulus was known to affect recall of the response (concrete stimuli led to better recall than abstract stimuli; Paivio, 1969). Of course, encoding/storage differences in retention of verbal and nonverbal stimuli are important; the point here is simply that retrieval processes should not be neglected.

A third example comes from recognition tests, especially yes/no or free choice tests. After subjects see a long series of items during a study phase, on the test they examine a series of both studied and nonstudied items, deciding "yes" if an item is old or was studied and "no" if it is new or was not studied. Because old test items are copies of the events perceived during study, some have proposed that retrieval processes are avoided in recognition tests. Thus, recognition tests are believed to bypass the retrieval stage and to provide pure measures of what is stored in memory. Murdock (1968) was interested in modality differences in short-term memory and whether they should be attributed to encoding, storage or retrieval. He performed two experiments showing that auditory presentation yielded better performance than visual presentation in several tests. He argued that in recall tests the auditory superiority could be due to either storage or retrieval differences. However, he argued "that the types of recognition memory tests used here obviated the need for retrieval of the item," and could therefore be attributed to encoding or storage processes (p. 85). For other reasons, Murdock argued that storage (rather than encoding) was the locus of the effect, but for present purposes the interesting point is that recognition tests were argued to "obviate" the need for retrieval. However, he changed his mind, and a few years later, Ratcliff and Murdock (1976) wrote a paper entitled "Retrieval processes in recognition memory."

These examples from the not-too-distant past show that, whereas scholars such as Köhler (1947) and Melton (1963) may have emphasized the importance of retrieval processes, their thinking did not permeate the field. This was true even after the experiments by Tulving and Pearlstone (1966) distinguished availability from accessibility. In fact, some denied the distinction. Freund and Underwood (1969) performed an experiment comparing cued to free recall and found that, under their conditions, no difference existed. They concluded that their "data are quite in accord with . . . Cofer's (1967) conclusion that the usual free recall procedures exhaust the storage, i.e., there would seem to be no storage-retrieval discrepancy" (p. 52). If everything stored can be recalled, as they assumed, then obviously one need not worry about retrieval processes and how they might affect measures of memory. In addition, there is no reason to study cued recall, recognition, or other measures. Free recall, to Freund and Underwood (1969), provides the perfect window to what information is stored in memory.

These four examples could be multiplied. They demonstrate that retrieval processes have been frequently ignored or minimized. And these attitudes are ingrained and difficult to alter, especially in neurobiological approaches to memory, where emphasis is on changes in the nervous system as a function of experience. Even today in cognitive psychology, one can find the statement that recognition seems to provide a direct window on the storage (or the availability) of information in memory relative to recall. Recall may involve different, and arguably more complex, retrieval processes, but even the simplest recognition situation involves search or retrieval processes, as Sternberg (1966, 1969) showed long ago. But showing that retrieval has been neglected is not the same as defending the proposition that retrieval is the most critical process. The next section provides this defense.

## □ Retrieval as the Most Critical Process

Encoding (accurately perceiving) an event is normally a prerequisite to remembering it. Therefore, encoding is a crucial stage in the learning/memory process. Similarly, retention of information over time until its expression is required is also critical. The changes in the nervous system during and after the encoding of an event—the formation and maintenance of memory traces—remain poorly understood. Yet retrieval is also a critical process, as argued above. Why consider retrieval the most important process, when all three stages (encoding, storage and retrieval) are clearly important?

The answer to this question can be made by analogy to the study of perception. Psychologists have a venerable history of thinking more clearly about remembering by analogy to perceiving (Bartlett, 1932; Craik, 1983; Neisser, 1967), and the same holds true in this case. If we consider visual perception, we may think of the events in the outside world as affording the opportunity for our perceiving them. Light strikes the objects and is available for a sentient being to perceive. However, without such a person or animal in the vicinity, the reflected light will not be perceived.

Retrieval functions in the learning/memory process much the way the perceiver operates in visual perception. Encoding and storage processes have been applied to practically all the experiences of our lives, with the residue of these experiences somehow stored in our brains. The result is a tremendous amount of available information about the past, like the reflected light in visual perception. However, the critical process in remembering is retrieval, our ability to access the residue of past experience and (in some cases) convert it into conscious experience. Without this process, remembering cannot take place. Experiences that are encoded and

stored but never retrieved are like reflected light that is never perceived—the information is available but of no use. Therefore, encoding and storage are necessary but certainly not sufficient conditions for remembering; retrieval processes are critical to convert these latent traces to conscious mental experience of the past.

One idea about retrieval that should be firmly put to rest is what Neisser (1967) called the *reappearance hypothesis*. The hypothesis is that encoding and storage leave traces that are pale representations of our actual experiences and that later retrieval processes cause these representations to appear, in great fidelity, before us to be recalled. This idea has been lambasted by succeeding generations of thinkers (James, 1890; Bartlett, 1932; Neisser, 1967; Loftus, 1979; and Tulving, 1983, to mention some), but hangs on and can be found, in one form, or another, in many modern treatments. Towards the end of his book, Bartlett (1932) wrote that “If there is one thing upon which I have insisted more than another throughout all the discussions of this book, it is that the description of memories as “fixed and lifeless” is merely an unpleasant fiction. That views implying this are still very common is evidence of the astonishing way in which many psychologists, even the most deservedly eminent, often appear to decide what are the characteristic marks of the process they set out to study, before they begin actually to study it” (pp. 311–312).

Neisser (1967) argued against the reappearance hypothesis and for what he called the utilization hypothesis, again by analogy to perceiving: “The analogy being offered asserts only that the role which stored information plays in recall is like the role which stimulus information plays in perception . . . One does not see objects ‘simply because they are there,’ but after an elaborate process of construction (which usually is designed to make use of the relevant stimulus information). Similarly, one does not recall objects or responses simply because traces of them exist in the mind, but after an elaborate process of *reconstruction* (which usually makes use of relevant stored information) . . . What is the information . . . on which reconstruction is based? The only plausible possibility is that it consists of traces of prior processes of construction. There are no stored copies of finished mental events, like images or sentences, but only traces of earlier constructive activity” (1967, p. 285).

All these quotes reveal the importance of retrieval processes in reconstructing past events. The encoded and stored information play the same role in remembering that stimulus information does in perceiving, and we use that information in constructing past events. Retrieval is then the critical process, the one without which remembering would be impossible. Indeed, as discussed below, it is perfectly possible to have the full-blown experience of remembering an event when the event never occurred at all in perceptual experience.

Although many neuroscientists are engaged in the quest for “finding the engram” or the underlying neural correlates of “trace storage,” Tulving (1991) remarked that “even if you could somehow identify the total pattern of physical/chemical *aftereffects* of an experienced event, in all its intricate and elaborate detail and full-blown complexity, you would have no way of knowing or predicting what kind of a “memory” (in the sense of experience) that engram is going to produce: that depends on the retrieval process, and that process has not yet occurred” (p. 93).

## □ Critical Factors in the Study of Retrieval

Endel Tulving has probably done more to emphasize the importance of retrieval processes in the study of memory than anyone else, and his research has illuminated many aspects of the problem (see Tulving, 1983, chapters 9–14 for a review). At the conference in Tallinn, I discussed ten reasons and phenomena to document why retrieval processes are so critical to the study of remembering. The preceding section provides the logical reasons to believe this, so the phenomena showing retrieval to be critical are, in some ways, just afterthoughts. Still, data have a way of driving home points to experimental psychologists where logic may not prevail. Therefore, in the remainder of this chapter, I will review logical distinctions, ways of approaching the study of retrieval (and therefore, of memory), and some interesting phenomena arising from study of retrieval processes. Here I consider only five reasons/factors relevant to the argument. Roediger and Gynn (1996) cover much of this material in more depth, as well as ideas and data that were included in my Tallinn presentation but are omitted here.

### 1. Conceptual Distinctions

The distinction between information available in memory and that which is accessible, reviewed above, is fundamental. Psychologists should never lose sight of the fact that what is retrieved may only reflect part of what is stored. In some of the conditions of Tulving and Pearlstone (1966), subjects recalled nearly twice as many words under cued recall conditions than they did under free recall conditions, showing that free recall hardly “exhausted the memory store.” And, of course, cued recall may also underestimate what could be remembered under other conditions with more powerful cues.

A second important conceptual tool that Tulving (1983, pp. 219–222) developed in his research, but named much later, is the *encoding/retrieval*



*paradigm*. The basic idea is represented in Figure 6.2. At a minimum, two encoding conditions (A and B) are crossed with two retrieval conditions (X and Y). If one considers only a single column (say, X), then one has an encoding experiment: encoding conditions are manipulated and retrieval conditions are held constant. In the history of experimental psychology, probably 80% of the experiments conducted on memory are pure encoding experiments. One or more independent variables are manipulated, and their effects are examined on a single type of memory test.

If one considers a single row in Figure 6.2 (say, the A row), then the result is a retrieval experiment: conditions of encoding are held constant and retrieval or test conditions are varied. The Tulving and Pearlstone (1966) experiment, contrasting free with cued recall, represents such an experiment. There are others of this ilk (e.g., Roediger & Tulving, 1979), but not too many. I would guess that fewer than 5% of the experiments in the field are pure retrieval experiments.

A third type of study is probably the most performed study in the history of psychology: the standardized test. Retrieval conditions are held constant and the interest is in seeing how people differ on a standard test of memory (like the Wechsler Memory Scale) or of reasoning and knowledge (like the Scholastic Assessment Test). Although prevalent, such a study does not represent a true experiment; no independent variable is manipulated.

For memory theory, the most critical type of study employs the entire encoding/retrieval design: encoding conditions are manipulated simulta-

		Retrieval	
		X	Y
Encoding	A	AX	AY
	B	BX	BY

**FIGURE 6.2.** The encoding/retrieval paradigm. Encoding conditions A and B are crossed with retrieval conditions X and Y. Each column represents an encoding experiment and each row a retrieval experiment. A single cell constitutes a standardized memory test. The entire 2 × 2 arrangement provides a minimal example of the encoding/retrieval paradigm. After Tulving (1983, p. 220).

neously with retrieval conditions. (Again, the 2 X 2 configuration shown in Figure 6.2 is the minimum required. Wider variations are possible. For example, Rajaram and Roediger (1993) reported a 3 X 5 encoding/retrieval experiment.) The encoding/retrieval experiment permits one to answer the question of specificity or generality of effects. For example, if an encoding manipulation has a certain effect on free recall, will it have the same effect on cued recall? On recognition? On an implicit memory test? The encoding/retrieval paradigm was employed in many experiments designed to explore the encoding specificity hypothesis and related ideas. Perhaps 15% of experiments in recent years have used this logic.

## 2. Encoding Specificity and Transfer Appropriate Processing

When the encoding/retrieval paradigm is employed, strong interactions are often obtained. Effects of encoding manipulations do not generalize across various retrieval conditions, or vice versa. This type of experiment dates at least to Tulving and Osler (1968), and a study reported by Thomson and Tulving (1970) can serve here as a useful reference experiment. Subjects learned two lists of paired associates consisting of weakly associated items (e.g., glue-CHAIR) and retrieval of the capitalized target word was later cued with the word in lower case letters. These first two lists got subjects used to the procedure and encouraged them to encode the capitalized target with respect to its lower case neighbor. The critical list was the third one. Now subjects studied target words such as FLOWER either with a weak associate (fruit-FLOWER) or by itself (FLOWER) to instantiate two encoding conditions. These encoding conditions were crossed with three retrieval conditions in which subjects were to recall the capitalized target items: no cues (free recall), cued recall with the weak associates from study (fruit), or cued recall with strong associates that had not been studied (bloom).

The proportions of words recalled in these six conditions are shown in Table 6.1 and reveal a strong interaction. Consider first the top row, where target items were presented alone at study. Recall was best with strong associates as cues, next best under free recall, and worst with weak associates. However, when the weak associates had been presented during study (the second row), recall was best with the same weak associates as cues, next best under free recall conditions, and worst with strong associates as cues—the opposite pattern! In short, the effectiveness of retrieval cues is not determined solely by their own properties, but in relation to how events were encoded. The strong associates were most effective cues under one set of encoding conditions and the least effective in the other set. The same statement holds true for weak associates as cues, but of course for the opposite set of conditions.

**TABLE 6.1. Recall of target words (e.g., CHAIR) that had been encoded either alone or in the context of a weak associate when tested with no cues, weak associate cues, or strong associate cues.**

	Retrieval Cues		
	None (Free recall)	Weak (Fruit)	Strong (Bloom)
List context			
None	.49	.43	.68
Weak Associate (fruit)	.30	.82	.23

Data area from Thomson and Tulving (1970, Experiment ).

Results such as those in Table 6.1 led to the *encoding specificity hypothesis* (or principle): retrieval cues are effective to the extent that information extracted from the cues matches, complements, or overlaps the encoded information. The cues permit better construction of the original event under these matching conditions. The results shown in Table 6.1 were considered controversial for a while, but have been replicated (directly and conceptually) many times in the intervening 30 years. Even the surprising finding that strong associates as cues can lead to worse recall than free recall (following certain encoding conditions) has been replicated (Roediger & Adelson, 1980; Roediger & Payne, 1983).

Similar types of results have been published under the banner of transfer appropriate processing approaches (e.g., Morris, Bransford, & Franks, 1977; Roediger, Weldon, & Challis, 1989). The original aim of Morris et al. (1977) was to challenge the levels of processing framework, which in its earliest statements did not include consideration of retrieval processes ( Craik & Lockhart, 1972). Encoding was considered to proceed through various stages from shallow (analysis of physical features) to deep (consideration of meaning), with deep processing leading to better retention than shallow processing. Dozens of experiments published both before and after Craik and Lockhart's (1972) seminal paper bore out this proposition. However, Morris et al. (1977) pointed out that consideration of retrieval conditions is critical too, and drove home the point with a clever experiment. They had subjects encode the same word (e.g., eagle) under one of two conditions designed to effect either a shallow or a deep level of processing. Subjects answered questions such as "Eagle rhymes with legal" or "Eagle is a large bird" with the answer being "yes" for half the questions and "no" for the other half. This manipulation is typical of levels of processing experiments. Morris et al. used two types of test. In a standard recognition test they intermixed studied words (EAGLE) with new words (BEAVER) and asked subjects to pick out words they had seen

in the prior encoding phase of the experiment. They assumed that subjects in such tests primarily consider meaning in making their decisions. In a different type of recognition test, a rhyme recognition test, they showed subjects a list of words at test, but with instructions to pick out words that rhymed with words given during the study phase. That is, none of the words on this test had actually appeared in the study phase, but some words rhymed with those that did (BEAGLE), whereas others did not (BEAVER).

Some of the results are provided in Table 6.2 and show another strong interaction, like that in Table 6.1. The typical levels of processing effect, with semantic encoding producing better recognition than phonemic encoding, occurred on the standard (meaning-based) recognition test. However, on the rhyme recognition test, the opposite pattern held: now rhyme encoding produced better recognition than semantic encoding. The general point that Morris et al. made is that there are no inherently deep and shallow orienting tasks or types of test. Rather, study experiences may be more or less appropriate to transfer on a test, depending on the nature of the test. Prior attention to the sound quality of words leads to better performance than does attention to meaning if the test taps knowledge of such phonemic qualities. To return to Neisser's (1967) ideas, when the constructive activity engaged during retrieval matches the initial construction of events during perception, the retrieval construction becomes more accurate. (Others published results similar to those of Morris et al. [1977] at about the same time, such as Fisher & Craik [1977], Jacoby [1975], and McDaniel, Friedman, & Bourne [1978], but in their types of test, usually phonemic and semantic encoding produced equivalent retention rather than an actual reversal of the pattern.)

Experimental designs to study the ideas of encoding specificity and transfer appropriate processing both employ Tulving's encoding/retrieval paradigm, and both bodies of work drive home the point of the relativity of memory tests. There are few cases (and perhaps no cases) in which "main

**TABLE 6.2. Results of Morris et al. (1997) Experiment 1: recall of target words (e.g., EAGLE) that had been encoded in terms of meaningful properties or phonemic properties and tested on either a standard (meaning-based) recognition test or a rhyme (phonemic-based) recognition. Recognition was enhanced when encoded properties appropriately matched the requirements of the test.**

		Test Conditions	
		Standard recognition semantic	Rhyme recognition phonemic
Encoding	Semantic	.84	.33
Condition	Phonemic	.63	.49

effect" generalizations hold true across a broad array of memory tests. Although psychologists may typically employ only a handful of memory tasks in their work—and some devote whole careers to studying one type of test—retention can be tested in a myriad of ways. A variable (such as type of orienting task in the levels of processing paradigm) that produces a powerful effect on one set of tests may have no effect or even a reverse effect on other tests. This conclusion again shows the critical importance of retrieval processes in understanding memory: we cannot make general claims about what is encoded and stored, only about what can be retrieved.

### 3. Retrieval Mode Matters

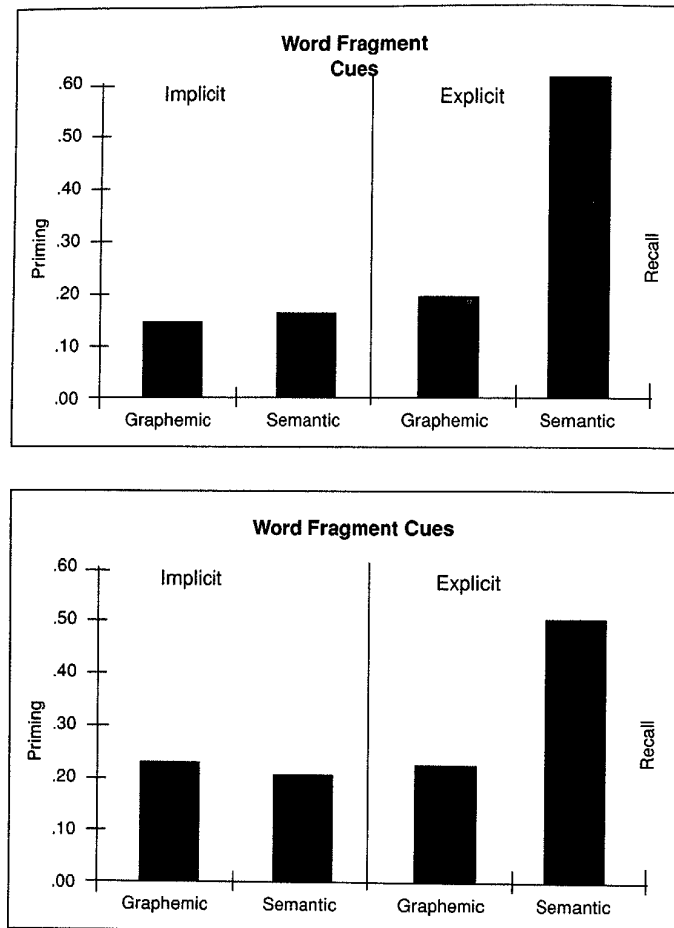
Tulving (1983) referred to the concept of retrieval modes in discussing the issue of the conditions of cue effectiveness. In order for episodic retrieval to occur, two conditions must be met: the cognitive system must be in the retrieval mode, and an appropriate cue must exist. (The cue can be external or internal.) To take an example, I see chalkboards (now dry erase boards) every time I walk in a classroom or a seminar room and they do not remind me of anything. But if I were given the cue "chalkboard" and asked to retrieve an event from my life, I would immediately remember the time, about 1963, when I was in my American history class at Riverside Military Academy, in high school. We had recently been assigned to learn all the capitals of the 50 states by our teacher, Lieutenant Jerome Vinger, and the class had just performed dismally on a test that straightforwardly assessed our knowledge (or lack thereof) on this topic. Vinger checked our work and discovered blank spaces on most tests. He grew red in the face, began shouting at us, and suddenly wheeled around and smashed the blackboard into many pieces with both fists, leaving us in stunned silence as the pieces tinkled to the floor and he left the room. So, although seeing chalkboards normally reminds me of nothing in particular, if put into the retrieval mode I can vividly remember a day from military school in the early 1960s.

In 1983, Tulving would write that "We know next to nothing about retrieval mode, other than it constitutes a necessary condition for retrieval" (p. 169). However, I think we have learned at least some things in the meantime from the manipulation of mode of retrieval during testing. I refer to the large literature contrasting explicit and implicit tests of memory. This distinction, first made by Graf and Schacter (1985; see Schacter, 1987) is between tests in which subjects are required to think back and retrieve experiences from their recent past (explicit tests) and other tests in which instructions are simply to perform as well as possible and any memory effects are inferred from priming (better performance from recently studied items than from comparable items that were not studied).

Roediger and Blaxton (1987) analyzed the explicit and implicit memory distinction in terms of different retrieval modes being employed on the two types of tests. Briefly, on explicit tests subjects are instructed to be in what Tulving (1983) called the retrieval mode (for episodic memory tests)—examine the cue and try to recollect a past event. Implicit tests orient subjects to a different mode of responding, one characterized by various writers as reflecting automatic or even unconscious responding. Subjects are typically told to produce the first response that comes to mind when they see the cue. Jacoby (1984) and Roediger and McDermott (1993) argued that the distinction between intentional and incidental retrieval captured the explicit/implicit distinction reasonably well. Just as experimental psychologists have long distinguished between intentional and incidental learning when subjects are or are not, respectively, warned about an upcoming memory test before they are exposed to material, so too retrieval can be intentional or incidental (with respect to instructions about the study episode).

In many of the early experiments comparing explicit and implicit memory tests, retrieval mode was confounded with many other factors, such as type of cue. For example, free recall was compared with primed word fragment completion (e.g., Weldon & Roediger, 1987) or recognition memory was contrasted with word identification (Jacoby, 1983). Graf and Mandler (1984, Experiment 3) performed the first experiment in which retrieval mode per se was manipulated and all other study and test factors were held constant, a situation that Schacter, Bowers, & Booker, (1989) later christened as satisfying the retrieval intentionality criterion (because only the intention to retrieve was manipulated between conditions). Graf and Mandler (1984) showed that a standard levels of processing manipulation affected performance on an explicit cued recall test using word stems as cues, but did not affect priming on the implicit test of word stem completion. Roediger, Weldon, Stadler, and Riegler (1992) replicated this pattern in word stem tests and extended it to word fragment tests. As shown in Figure 6.3, the levels of processing manipulation greatly affected both explicit tests of word stem cued recall and word fragment cued recall. However, the same manipulation did not affect priming on the implicit tests of word stem completion or word fragment completion.

All the results cited in this section show the critical importance of retrieval mode or retrieval orientation to performance on memory tests, even with all other encoding, retention, and overt test conditions held constant. Again, consideration of retrieval factors—in this case, the manipulation of mode of retrieval through instructions—is critical to the study of memory. Simply having had relevant past experience and an overt cue does not guarantee conscious access to the past—one must be in the retrieval mode.



**FIGURE 6.3.** Variations in retrieval mode produce different patterns of effect. Manipulating levels of processing had marked effects on explicit tests using word fragments or word stems as cues, but there was no effect on priming on implicit tests. Data are from Roediger et al. (1992, Experiment 1).

#### 4. Retrieval Experience Matters

Retrieval mode affects retrieval experience, as just described. However, even when subjects are in the (explicit/episodic) retrieval mode, their recollections of the past may involve different retrieval experiences. Tulving (1985) initiated the study of a particular kind of retrieval experience by

introducing the *remember/know paradigm*. Briefly, he argued that there are two means of access to one's personal past. We can have the experience of mentally traveling back in time and re-experiencing, in a pale way, the events of the past. If you are reading these words at night and I ask you to recollect the events of the day, your retrieval experience would probably be one of remembering, as you traced your day's activities. On the other hand, we can know facts about our past history without being able to remember them, just as we can know facts about history. An obvious example is knowing when and where we were born. Less obviously, the same sort of impersonal knowledge can be expressed for salient events during our adult lives. To take one example for me, in the winter of 1973 (probably January) I know I flew from New Haven, CT to West Lafayette, IN, via Chicago (the only way to get there). Surely just after the flight I could have remembered all kinds of events about it: how I got to the airport, who I sat next to, what we talked about, the changeover in Chicago, and so on. But now, 27 years later, I know I made the trip, but I cannot remember anything whatsoever about it.<sup>2</sup>

Tulving (1985) argued that the remember/know distinction could be applied to all aspects of recollection, including the types of events studied in the laboratory. He developed a set of instructions to elicit remember/know judgments from subjects and applied them in some exploratory experiments. Gardiner (1988) refined the instructions and showed how subjects could provide reliable judgments across a variety of variables and many others have also profitably used the remember/know technique to ask interesting questions (e.g., Rajaram, 1993). Gardiner (Chapter 12) reviews some critical findings developed from this literature (see too Rajaram & Roediger, 1997).

Remembering may be seen as the purest manifestation of explicit or episodic memory. One implication to be drawn from this body of work is that tasks that used to be considered "episodic memory tasks" (because they met the formal definition of requiring subjects to retrieve information from a particular time and place in the past; Tulving, 1972) are no longer considered to be such. That is, even on ostensibly episodic tasks such as free recall, cued recall, or recognition, recollections may reflect some combination of remembering (thought to reflect episodic memory) and knowing (reflecting a contribution of semantic memory, within

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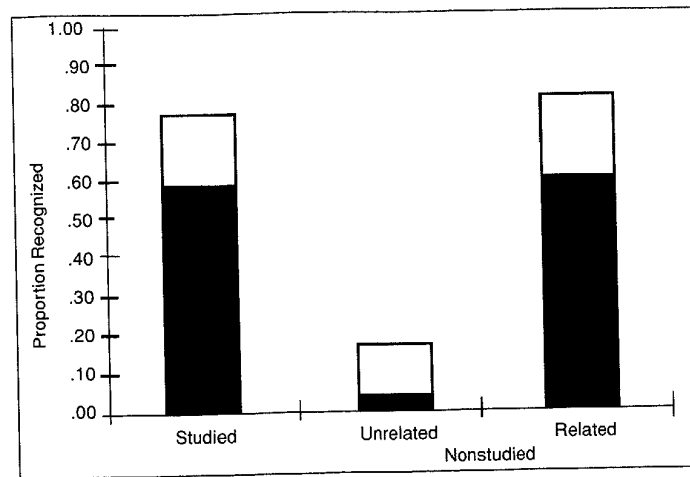
<sup>2</sup> My example here is fully in keeping with the original claims by Tulving (1985) about know responses as being a type of noetic (knowing) consciousness arising from semantic memory retrieval. However, researchers favoring dual process theories of recognition (e.g., Jacoby, Jones, & Dolan, 1998) interpret knowing in terms of familiarity or fluency, one of the two factors in such theories. *Know* responses in typical recognition memory experiments may be better captured in this latter sense, of familiarity. However, the issue of how best to characterize *know* responses is still being sorted out.



Tulving's [1985] framework). In recognition memory experiments, where the remember/know technique has been most commonly used, manipulation of many variables, such as levels of processing, that greatly affect overall recognition have been shown to have their effect on remembering, not knowing, for studied items (Gardiner, 1988).

In almost all standard experiments, distractors or lures about which subjects make false alarms are deemed to be known rather than remembered. That makes sense, because the items were not studied—how could one remember an event that had never happened? However, recent applications of the remember/know paradigm to a somewhat different situation have revealed exactly that: people remember events that never happened to them. Roediger and McDermott (1995) presented subjects with lists of 15 words. The 15 words in every list were semantic associates to one word (called the critical item for our purposes) that had not been presented. So, subjects might hear *door, glass, pane, shade, ledge, sill, house, open, curtain, frame, view, breeze, sash, screen* and *shutter*, all words produced as associates to the critical item *window*, but *window* was not presented in the list. Roediger and McDermott (1995) found that subjects frequently recalled *window* and indeed its probability of recall was about the same as (or even exceeded that of) words presented in the middle of the list, like *house* and *open* in the above example. This outcome of high recall for these lists replicated prior work by Deese (1959). However, in addition, Roediger and McDermott (1995) provided subjects with a later recognition test that included standard list words, control words unrelated to the list words, and the critical nonpresented items. Subjects were instructed to decide if each word were old (studied) or new (nonstudied) and, if old, to provide a remember/know judgment for the item: did they remember its occurrence in the list or just know that it occurred?

The results are presented in Figure 6.4, where the bars represent overall probability of calling the three types of items "old." The black part of the bar represents the proportion of remember judgments, whereas the white part reflects know judgments. Examining recognition of the list items, we see that the proportion called old was .79, with .57 judged as remembered and .22 as known. For unrelated lures, the false alarm rate was .14, with .03 remembered and .11 known, showing the usual pattern of subjects calling false alarms to unrelated lures as known rather than remembered. However, for the critical lures, the outcome was quite different. For words like *window* in the above example, the false alarm rate was .81, and remember judgments accounted for .58 of these false alarms, almost exactly the same values as for studied words. Thus, recognition of the critical lures approximated the level for studied items in the Roediger and McDermott (1995) paradigm. Although surprising, this result has been replicated in many other experiments (e.g., Payne, Elie, Blackwell &



**FIGURE 6.4.** False remembering. Subjects falsely recognized critical nonpresented items after studying lists of 15 associatively related words at the same level as for studied items. In addition, the *remembering* of these critical nonstudied words occurred at the same level as for studied items. Therefore, the full-blown experience of remembering an event can occur without its prior explicit encoding and storage. Data from Roediger and McDermott (1995, Experiment 2).

Neuschatz, 1996; Schacter, Verfaillie & Pradere, 1996). If the critical target is actually presented, it is better remembered than are other list items (McDermott, 1997), but when it is not presented, its recall and recognition approximates that of other list items.

The study of false recall and false recognition using the Roediger-McDermott paradigm has been intense, and this is not the place to review it (see Roediger, McDermott & Robinson, 1998). Two points are relevant for present purposes. First, much work in cognitive psychology has been directed at the study of false memories over the past 30 years, with the assumption being that people are remembering events that never happened (see Roediger, 1996, for an overview). However, if recollection can be accompanied by several types of retrieval experience (minimally, remembering and knowing), then to demonstrate false *remembering* researchers must show that subjects actually judge themselves to be remembering the events, not reporting that the events are familiar on some other basis. The high levels of remember judgments for the falsely recognized words in the Roediger-McDermott paradigm indicate that this requirement holds in this case, but as already noted, false alarms in other situations are usually judged to be known, not remembered. It is unclear whether false remembering will be shown in other paradigms creating memory illu-

sions, but Roediger, Jacoby and McDermott (1996) and Zaragoza and Mitchell (1996) have reported relatively high levels of *remember* responses in Loftus' misinformation paradigm (e.g., Loftus, 1991; this volume).

Perhaps a more important implication for the central argument of the present chapter is that encoding and storage of a specific event are unnecessary to experience its full-blown retrieval as being remembered. The fact that subjects in the Roediger-McDermott recognition paradigm remember the critical nonpresented items at the same level as studied items indicates that explicit encoding and storage of an event are not necessary conditions for remembering it. The retrieval process gives rise to the experience of remembering, even in absence of specific encoding and storage of the event. Of course, encoding and storage processes are not unimportant in this situation: subjects only falsely remember the nonpresented word after experiencing the appropriate list. (That is, people do not falsely remember window after presentation of 15 words associated to sleep). And all memory phenomena are the joint product of encoding and retrieval processes (Tulving, 1974). One idea used to explain the high levels of false recall and false remembering in the Roediger-McDermott paradigm is that the critical item might have been activated (consciously or unconsciously) during list presentation and that this implicit associative response (Underwood, 1965) is responsible for these false recall and false recognition effects. If so, the argument could be made that the list item was implicitly encoded, even if not explicitly presented. Still, overt presentation (leading to encoding and storage) are not necessary for recollection of the event. Retrieval experience determines the reality of what we remember, whether or not what we remember matches what actually occurred.

## 5. Repeated Retrieval Is the Key to Long-Lasting Memories

Retrieval processes are usually conceived as the endpoint in the learning and memory process. After encoding and storage of events, a retrieval query that engages a series of processes may lead to recollection (whether right or wrong) of the event. Psychologists' interest in the process often stop here, with the performance measure. However, many of life's important events are repeatedly retrieved. We may repeatedly recollect the important, exciting, embarrassing, or emotional events of our lives. Given this fact, we may ask what effect repeated retrieval has. To paint with a broad brush, repeatedly recollecting events can either aid or hinder their later retention. Effects of repeatedly retrieving from memory are complex (e.g., Roediger, McDermott & Goff, 1997): retrieval of specific events can

make their future recollection more likely, but can also impede recollection of related events (a process called output interference; Tulving & Arbuckle, 1963).

Bjork (1975) pointed out that retrieval of an event is not neutral but affects later recollection. In his phrase, retrieval is a *memory modifier*. Bjork emphasized the positive effects of retrieval: successful retrieval of an event often makes its future recollection more likely. This arena of study has often been referred to as the *testing effect*: successful recall or recognition of events typically makes them more likely to be recalled and recognized on later occasions (e.g., Glover, 1989; Spitzer, 1939; Wheeler & Roediger, 1992). This effect can be understood within the framework of transfer appropriate processing: retrieval of an event at one time transfers to its later retrieval. Of course, retrieval of an event leads to further encoding and storage, too.

Suppose errors creep into the retrieval process. Bartlett (1932) reported his famous studies of repeated reproduction in which he obtained increasing evidence of error (reflecting constructive processes) over repeated retellings of "The War of the Ghosts" and other materials (see Bergman & Roediger, in press, for a replication). Recollection of an error also has an enhancing effect on its later recall—a testing effect for errors (Roediger & McDermott, 1995; Roediger et al., 1996; Schooler, Foster & Loftus, 1988). Therefore, the act of retrieval can modify recollection for better or worse.

We can probably go further with our claims. It seems likely that retrieval effects are also critical for our most cherished and long-lasting memories. Researchers studying flashbulb memories have shown in several studies that "rehearsal" of the event is important. That is, after a striking event in one's life, such as being involved in an earthquake, there seems a powerful tendency to retrieve it repeatedly. Although rehearsal (or sometimes rumination) is the label often applied, these terms refer to repeated retrieval of the event in question, and development of vivid flashbulb memories has been shown to be correlated in some (but not all) studies (e.g., Neisser et al., 1996). It seems highly likely that events in our lives will be remembered over the long term to the extent that they are repeatedly retrieved. If the event is retrieved accurately, then its later veridical recollection will be enhanced. However, if errors creep in from hearing others' erroneous accounts, from schematic processes filling in what "must have happened," or from other sources, repeated retrieval can lead to increasing errors over time, much as Bartlett (1932) reported. Once again, retrieval processes are the keys to remembering. Probably all we remember of distant events are those specific instances that have been repeatedly retrieved in the interim.

## □ Summary and Conclusions

Although encoding, storage and retrieval are all important stages in the learning/memory process, retrieval is the key process. Retrieving is like perceiving for a sentient observer. Just as the environment holds a wealth of potential stimulation, only some of which may be perceived, the brain holds traces of myriad encoded experiences, most of which will never be brought back to consciousness. These engrams, like stimuli in the environment, may hold potential for remembering, but without being retrieved, they play no role in remembering. Encoding and storage are usually necessary for remembering, but retrieval processes must convert the potential into action—the act of remembering.

Data from numerous experiments point out the critical role of retrieval processes in remembering. First, there is the relativity of tests—no test directly measures “memory storage,” and probably every variable thought to affect “memory” really only affects performance on a subset of tests, all of which can be valid indicators of knowledge. Interactions between study conditions and test environments are ubiquitous. Further, even the “set” or “mode” of the cognitive system at retrieval is critical to the quantity and quality of memory recovered. If the system is not in the retrieval mode, episodic memories are unlikely to be elicited. And even when in the retrieval mode, retrieval experience can be of different types (e.g., remembering or knowing the past). Finally, due to the pre-eminence of retrieval processes, it may be possible to have a full-blown experience of remembering an event even when the specific event was never encoded or stored. Retrieval is the key process in human memory, but one that has been neglected and that probably still is not given due consideration in most theories and approaches today.

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