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- Steven Rose

What a maddening thing a memory can be, dodging away from you when you're trying desperately to snag it, descending around you like a collapsing tent when you most want to forget it.

- Los Angeles Times

Forgetting is not a defect, it is a normal function. Forgetting serves to filter out information that exceeds our needs or that is no longer needed. Sometimes, forgetting serves the very useful purpose of moving on in life, leaving painful memories behind. However, many of these memories may still exist, lying dormant until the right set of cues uncovers them.

We have all heard of people with near-death experiences. Typically, when they recover they claim that "their whole life flashed before them." They became overwhelmed with memories, many of which had been forgotten for years, even decades. Nobody knows what it is about near-death experience that unleashes all these buried memories, but clearly such memory exists - it just needs an assist in retrieval.

Have you ever heard the saying that the brain holds all the memories of everything you ever learned? The idea here is that the problem of memory is not that it deteriorates over time but that it can't be recalled. Few scientists believe this fable, but there is a large amount of truth in the notion that retrieval is a separate memory process that is obviously important to the recall process.

What is really irritating is to fail to recall something that you know you know. Everyone can cite personal experiences of not being able to recall something that you know you know. Students taking a quiz commonly complain that they know the answers to questions they missed, and in fact often recall the answers after they turn in the exam.

Picture this scene: you go to a fancy dinner party and spot this drop-dead gorgeous lady standing in the corner talking to a group of male admirers. You know her! She was one of the runners in the 10 K run last Spring. Now, here she is, high-heeled, long-legged, flat stomached, in a black velvet dress that looks as if it were glued in place. Her upswept hair-do exudes the elegance of caviar and champagne. And you can't remember her name. You are so excited, you are lucky to remember *your* name. You wanted to go over and say, "Hi, ..., remember me? We met when we ran in the 10 K at Andover last Spring." Without her name, you don't have nerve to break into her group. On the way home, after the party of course, it suddenly hits you - "Janice Hopkins! Where was that name when I needed it?"

Why was that so hard to remember? Actually you did remember it, you just could not recall it on demand. There are two reasons for failed recall here: 1) The context was different. She wasn't sweating and wearing baggy running clothes. 2) The second reason was stress and anxiety. You pressured yourself to recall. The subconscious mind that you have to call on to surface memories does not appreciate having demands made. Nor does it like to be pushed and rushed.

Recognition is a form of memory that is much easier to achieve than recall. Think of all the times you said, or heard others say, "I'd recognize it if I saw it." Multiple choice questions on student examinations are a good case in point. It is much harder for a student to generate an answer than to pick one from a list of choices where the correct answer is recognized once the student sees it. My many years of teaching have shown me that students will score some 10-40 points lower on the same exam when the questions are converted from multiple choice to short answer or fill-in-the-blank questions.

Recall requires digging up of the memory, and that often needs the assistance of cues that were associated with the memory at the time it was first registered. For example, when you meet a new person, remembering their name is facilitated if you make visual or verbal associations of the name with certain obvious characteristics of the person. If "John" is bald, you might think of a commode (john) with hair growing on the seat. Or if "Mary" is always smiling and laughing you might associate her name with being "merrie." Now the hairy commode seat and the merry girl serve as cues to help you dredge up the name.

Another example of cuing uses the technique of "acrostics." Here, a phrase is constructed in which the first letter of each word serves as a cue for the item to be remembered. Students of neuroanatomy learn the phrase, "On Old Olympus' Towering Tops A Famous Vocal German Viewed Some Hops." This stands for the names, in order, of the twelve cranial nerves: olfactory (I), optic (II), oculomotor (III), trochlear (IV), trigeminal (V), abducens (VI), facial (VII), vestibulocochlear (VIII), glossopharyngeal, vagus (X), spinal accessory (XI), and hypoglossal (XII).

You can also create an acronym, preferably a meaningful word, in

which each letter represents what you want to remember. We discussed this retrieval device earlier in the chapter, "Memories Hang Out With The Right Crowd."

Buried in the Unconscious

Robert Baker has written a book, *Hidden Memories*,[1] that argues that many memories lie buried in our brain and are only brought to the surface under certain, often extreme, conditions. Much of the early evidence comes from the many studies of Freud, who used hypnosis to uncover buried memories of early childhood. Then there are also the modern studies of the neurosurgeon, Wilder Penfield, who evoked memories from neurosurgical patients by electrically stimulating certain parts of the cerebral cortex (note that neurosurgery is often done without anesthesia, because no pain sensors exist in brain itself and because the patient needs to be conscious to be certain that no unnecessary damage is done). These memories had been dormant for years or decades and were only "released" to conscious recall by the electrical stimulation. This is a good place to remember discussions in the first chapter of this book about the ability that everyone has to learn certain things implicitly, without conscious awareness.

Baker points out that "accurate records of many objects and events will enter our minds completely unaware and can show up in the form of intuition, likes and dislikes of which we are totally ignorant of their origin." He reminds us of procedural memories that have become unconscious and automatic. The corollary is that we know much more than we realize and that it may affect our behavior in unrecognized ways.

Baker extends his argument to claim that dreaming, hallucinations, and psychotic episodes are driven by hidden memories. What Baker does not do is acknowledge that these hidden memories are almost certainly distortions from the original memories (see the chapter on "Memories That Lie"). There is also the unacknowledged possibility that the brain can construct new memories "on the fly" by creative

imagination. For example, you may dream of taking a trip to Mars in a spaceship. You certainly have no memory of you or anybody else doing that, but your brain knows enough about spaceships and Mars to create a detailed story line for your dream.

Baker also discusses the fact that we have memories that we do not recognize as belonging to us. Sometimes, for example, what we thought was an original idea or phrase, was actually a buried memory. The *déjà vu* phenomenon may also reflect a past memory of an actual event that we have forgotten.

Hypnotic recall of hidden memories may provide clues for memory retrieval. Many scientists now believe that hypnosis is not a distinct state of consciousness. Rather, it is viewed as role playing, where subjects voluntarily agree to become compliant and responsive to suggestion. How this loosens the bonds that tie up hidden memories is not known. Apparently, when we allow our mind to be more responsive to suggestion, we become supersensitive to retrieval cues. There is also the probability that misleading suggestions can dredge up memories that are falsely reconstructed during the retrieval.

While neuroscientists are currently arguing about "conscious" and "unconscious" mind, let us retain the traditional, common sense understanding as a matter of convenience. The classical problem of memory retrieval is that conscious and unconscious minds may not be working well with each other. As students or former students, we all remember those rare times when answers to questions do pop up in time to be used during an examination. Imagine the communication that might occur between conscious mind and unconscious brain when a problem in memory recall is overcome.

> *Conscious mind*, calling down to *subconscious mind*: "Hey partner, I see we are having a little trouble with this question. What's the hold-up down there?"
>
> *Sub-conscious mind*: "Yea, boss. I know I put that stuff in here somewhere, but I haven't found it yet. It is in here somewhere."

> *Conscious mind*: "Don't worry. I know you have it on file. Take your time. I know you will find it. While you are rummaging around, feel free to interrupt whenever you come across the answer to the current question."

Note that effective recall requires the conscious and unconscious mind to work as equal partners. The sub-conscious balks at being pushed around. Also note that the importance of confidence (see the chapter on emotions). The subconscious mind is reassured when it is repeatedly told that it knows what it is doing and that it can be trusted to do its memory tasks.

Retrieval processes are among the least understood aspects of memory. In fact, one theoretician[2] argued that memory recall is not a retrieval process but rather one of reconstruction. The features and cues of the original experience are supposedly reconstructed during recall. While this view is not widely held, it does help explain several things. During a reconstruction process, the original event can be colored by subsequent experiences and rationalizations introduced under the spur of emotion. Details may be added or removed. Such a process would explain false memory.

Explicit memories have to be retrieved or reconstructed from the unconscious mind into consciousness. We don't know that much about the unconscious mind. Sigmund Freud showed us that the unconscious mind was important because of its huge storehouse of buried memories, although many neuroscientists disagree with the details of many of Freud's interpretations.

It is also possible that the unconscious mind uses its store of unexpressed memories to influence our attitudes, feelings, thinking, decisions, and behavior - both conscious and unconsciousness. The French philosopher Jean Paul Sartre persuaded many scholars to accept the notion that there is a seamless connection between consciousness and unconsciousness. Sartre also believed that we are our unconscious mind. Our individual essence and human responsibility do not stop at the edge of consciousness.

In the book, "Between the Lines,"[3] Robert Haskell's central premise is that the unconsciousness memories and thinking routinely

get expressed as "subliteral" meanings in human communication. In other words, much of what we say not only has an obvious literal meaning, but also a less obvious, and sometimes very different, unconscious meaning. This idea applies to body language, of course, but Haskell extends it to encoded talk. The idea is related to such euphemisms as "political correctness," "double-speak," and of course, reading "between the lines."

Accessing the Hard Drive

Even casual computer users know the distinction between "memory" or RAM, the electronic workspace where current material is held for processing, and "storage," the hard drive, floppy disk, or CD on which that work is saved for future access. Of course, the brain does not work the way a computer does, but the analogy might still be useful to make the point that memory retrieval may be a "hard drive" access problem.

Naya and colleagues[4] found that the temporal cortexes of monkeys performing a visual pair-association task exhibited two distinct signals: a perceptual signal that propagated in the normal forward direction in the brain, and a backward-projecting signal that likely represented retrieval of object information from "storage" in long-term memory. A month later, deFockert and colleagues[5] shifted the focus to the brain's analog of RAM: working memory, in which the brain temporarily holds information used in reasoning and planning. The subjects performed a selective attention task in which they had to classify famous written names as pop stars or politicians while ignoring distractor faces that were superimposed on the names. The ability to resist distraction was tested under conditions wherein subjects had to hold in working memory a series of digits. If the digits were in the same order for each trial, the working memory load was considered low, compared with the greater load imposed when the digits to be held in working memory were in a different order on each trial. The high-load condition resulted in greater interference effects from the

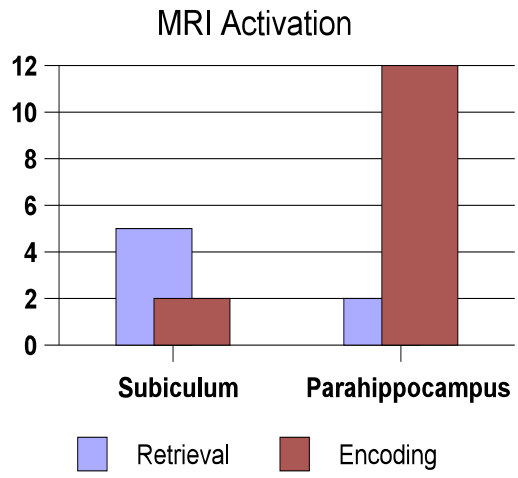
distractor faces. In other words, recall was disrupted when working memory had demands placed on it. This is a case where trying to do two things at the same time doesn't work well. The processing of memory about names and the corresponding career category needs working-memory space. Tying up working memory with difficult tasks makes it unavailable for memory processes that need that space. Another way to look at this is that working memory space is needed to process all the associations and cues related to a memory.

Getting Your Memory Into RAM

Recall depends enormously on how well the information was encoded in the first place. That is, information has to be encoded into RAM, so to speak, in order to be available for retrieval. It also obviously has to be encoded in your working memory to have a chance to be learned permanently.

Retrieval of already-learned information is a distinctly different process than encoding the information during learning. Even different parts of the brain are used.[6] A group of researchers at Stanford compared MRI images of brain oxygen consumption and showed that different parts of the medial temporal lobe were activated during encoding and during retrieval.

This difference can be illustrated in the graph below on MRI activation, in which the percentage of activated pixels (digitized points) in a MRI scan that were activated during retrieval and encoding tasks. It is clear that during encoding, much greater activation occurs in the parahippocampus, a cortical region adjacent to the hippocampus. Opposite effects are seen during retrieval, where the greater activity occurs in a nearby area known as the subiculum.



Degree of activation in two memory processing parts of the brain. During retrieval, activation in the subiculum is much greater than during encoding of the same memory. The opposite relationship occurs in the parahippocampus.

One aspect of getting memory items "into RAM" from the brain's hard storage is the serial position of each item. It is well known that when presented a list to memorize, people are most likely to remember the last few items presented. Obviously, you have to work harder to remember the earlier items in a list. As you might expect, if items to be learned have some logical sequence, and they are studied in that order, memorization will be more effective than if the items were presented in random order. The reason is that the logical relationships help build associations.

Priming the Recall Pump

When we recall an explicit memory, we are recalling something that we were consciously aware of when the memory was formed. This is not true, of course, for implicit memories, which can be both learned and recalled without conscious awareness.

Amnesic patients who have selective damage to the inner regions of the temporal lobes have difficulty in recognizing or recalling recently presented information that they were explicitly aware of when the information was first presented. But on implicit memory tests, these same patients perform normally. These and other observations indicate that awareness is a key element in the recall of explicit memories. In other words, if amnesic patients could make themselves aware of the circumstances surrounding the original learning, the association of the cues with the learning objects would increase the chances of recall.

This insight about recall has come from recent studies that we discussed elsewhere on the different results between a normal-delay eyeblink conditioning where the cue stimulus (tone) and the unlearned stimulus (air puff) overlap in time and in "trace" conditioning in which there is an interval between the cue tone and the air puff. Amnesic patients do not develop trace conditioning, but do condition to the same situation when the cue tone stays on while the air puff is delivered. There is something about the delay interval that amnesic patients can't handle.

New light on this enigma has emerged from a recent study by R. E. Clark and Larry Squire[7]. They found that the delay in trace conditioning could also produce a memory deficit in healthy volunteers when these subjects did not consciously realize the contingency between the cue tone and the air puff. Thus, we now see that amnesic patients fail at trace conditioning, because they cannot sustain an explicit awareness of the cue-air puff relationship.

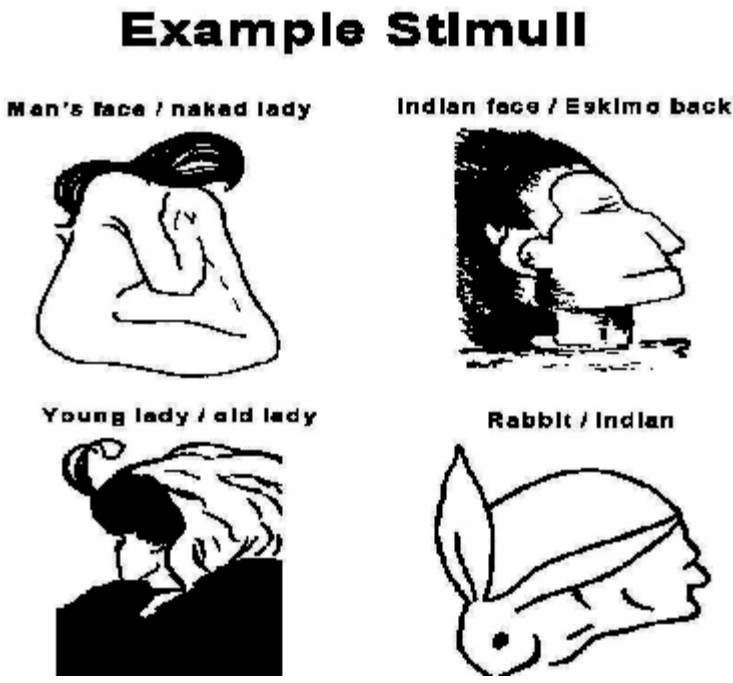
This idea has been confirmed in word-stem completion tests of priming. Implicit learning benefits from priming. In typical priming tests, subjects are asked to complete fragmented words or identify a word or a picture after a brief exposure. Priming is evident when the subjects can complete or identify items that they recently saw or heard faster or more accurately than items for which there had been no prior exposure. Healthy volunteers exhibit priming of new associations in a word-stem completion test only when they are aware that they are producing words from a study list to which they were previously exposed.

Just to avoid confusion over what is implicit and explicit, we need

to emphasize that it is the learning process that is implicit. Although words are explicit, the priming process is creating learning unbeknownst to the subject. But apparently the implicit learning process is augmented if the subject explicitly knows in general what is going on.

Research on priming can be done with either words or picture.[8] Experimental subjects are asked to name or to complete a fragmented word form. For instance, they may be expected to complete the word fragment, (ele.....) after having been primed by looking at pictures that included one of an elephant. With picture priming, subjects may be primed with brief glimpses of a set of pictures and then be asked to name them or to name pictures with missing elements that are gradually re-introduced.

Another approach is to use picture-fragment naming, using so-called ambiguous figures. Novices who have never seen these pictures before have trouble recognizing (remembering) the hidden image in the figure. A large segment of the general population has difficulty in extracting hidden images, while other people do it with ease. The operative mechanism seems to be the ability of the brain to respond to priming cues. The hidden images contain certain lines and shapes that serve as cues for retrieval of memory of the full image. The brain has remembered the image, or enough of the image elements that allow it to be constructed. Eventually the viewer will recall the hidden object, although for some subjects, a great deal of verbal prompting and help may be needed. Although at first experience, subjects may struggle with recognizing the hidden image, upon later testing the recall is usually instantaneous, signifying that they have memorized the linkage between the cues in the picture and the hidden image of the picture. Incidentally, I performed a brain-wave study in humans that revealed a correlation of specific frequencies over wide areas of cortex when hidden images were recalled into consciousness.[9] Thus, rather profound things are happening in the brain as it links priming cues to the recall of memories into conscious recognition. Another phenomenon that interested me was that each person has a default preference. For example, in the rabbit/Indian figure below, I see the rabbit readily and may have to struggle to see the Indian. Others can have the opposite response.



Sample ambiguous figures that can be interpreted in two distinctly different ways. The titles for each picture indicate the two alternative images.

Patients who are amnesic for explicit memory may perform perfectly well on implicit tasks. This has been interpreted to indicate that there is a separate memory mechanism involved in implicit learning.

So what is the practical point? First, if there are two separate mechanisms for memory, you ought to try to get them to work together and reinforce each other. If you need to memorize something, it helps to have repeated exposures to the material and to realize during recall attempts that you have seen this material before. Maybe this only

applies to implicit learning, such as learning to play the piano. A teacher hits a key (cue) and you hear the sound. The next time the teacher hits the key, you may recall that sound in your mind's ear better if you realize that you have been exposed to this pair of stimuli before. You know that you are supposed to know.

This priming effect may be a factor in the "total immersion" approach to learning a foreign language. Even though at first you do not remember all the foreign words swirling around in your head, having heard them before makes it easier to remember them as the need becomes more compelling.

One of the well-established things about priming is that pre-exposure to visual stimuli is sufficient to establish a subsequent preference, even when the previous exposure is subliminal. In other words, subliminal stimuli can be recalled in the form of a preference of which you are unaware. The mechanism for this effect has recently been elucidated by Rebecca Elliott and Raymond Dolan in London.[10] They used an MRI imaging technique with volunteer subjects who chose between a pair of abstract stimuli on the basis of whether they preferred the stimulus or remembered having seen the stimulus. They were tested under two conditions: one where one or the other stimulus had been previously presented subliminally and the other condition when both stimuli were novel. Judgments based on memory were associated with MRI activation of two specific regions of cortex, whereas preference judgments were associated with activation of two different zones of cortex. If a stimulus had been presented subliminally, the implicit memory of it was signaled by activation of yet another frontal cortex area.

Is there a practical application for this phenomenon of "mere exposure effect?" I am not aware of anyone studying the matter from this perspective. Perhaps if you wanted your kids to appreciate classical music, or jazz or whatever, you should expose them to it when they are young. It is well established that if kids are exposed to a home in which parents read and in which parents read to the kids, the children are more likely to grow up appreciating books.

Don't count on priming effects to be the same for all kinds of learning. There is evidence from patients with memory deficits that

different brain systems support procedural learning and other forms of learning. W. C. Heindel and colleagues at the San Diego VA Medical Center[11] compared memory performance in three groups of patients: Alzheimers (AD), Huntington disease (HD), and Parkinson's disease (PD) (subdivided into patients with dementia and those without). Two implicit memory priming tasks were evaluated, one that engaged procedural (motor) memory and the other that engaged declarative (explicit) memory. HD patients were impaired on the motor learning priming but not on the verbal priming task. AD patients revealed the opposite relationship. The demented, but not the non-demented PD patients were impaired on both implicit priming tasks. In both HD and PD patients, the deficits on the motor learning task correlated with the severity of dementia but not with the level of movement dysfunction independent of memory. Thus, in normal people, it is possible that priming effects that work for motor memory might not work for verbal memory, and vice versa, because these two kinds of learning are mediated by different neural systems.

The Sound of Blocked Retrieval

Failure of retrieval under "tip-of-the-tongue" (TOT) conditions is thought to result because something is blocking retrieval. One leading theory is that words of similar meaning or sound "blocked" the path of the word you were looking for. Recent research by Lori E. James, Ph.D., and Deborah M. Burke, Ph.D., report evidence that TOT experiences have to do with weak connections among word sounds represented in memory.[12] The idea is that language retrieval depends on memory of both a word's meaning and its sound. Retrieval supposedly depends on the strength of connections within a network that includes conceptual and phonological levels.

So, James and Burke tested the theory that remembering sound is as important as meaning in being able to retrieve a word by asking 114 questions to 108 research participants. General-knowledge questions

were used to evoke target words that are known to provoke a high rate of TOTs. For example, people were asked, "What word means to formally renounce a throne?" Target words-in this case, "abdicate," included proper names and other seldom-used words.

For some of the trials, participants heard ten priming words before the question. Half of the priming words shared at least one phonological feature of the target word. For example, when "abdicate" was the target word, "abstract" was used as one of the prime words. When participants pronounced words that sounded similar to the target word, more correct responses occurred and there were fewer TOT experiences.

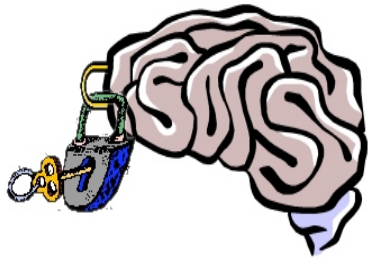
This research may explain why, after a person is not able to remember a particular word, it suddenly comes to mind. These pop-ups may occur when you have recently heard a word that shares a similar phonology. That is, retrieval can improve when the recall task is accompanied by phonologically related words. The experimenters found this to be true for both older and younger study participants.

They also found that the TOT experiences are a function of weak connections among memory representations. The weak connections are strengthened by processing the phonology of a TOT target. But this enhancement of retrieval works best in younger subjects than in old.

So, as a practical matter, how can people keep their memory recall process from getting rusty? Use it, as Dr. James suggests. "People should keep using language, keep reading, keep doing crosswords. The more you use your language and encounter new words, the better your chances are going to be of maintaining those words, both in comprehension and in production, as you get older."

The Key Is In the Cue

"Oh yea, now I remember!" How many times have we done that after being given some reminder cue for a memory that we had but could not recall? The memory is there all along, but we need cues to bring them to the surface of consciousness. Why is a cue needed? First, recall that association is a key element in memory, and cues generally remind us of the original associations we used to create the memory.



Unlock Those Memories With Cues

All sorts of things can serve as cues for recall. One perhaps unexpected source of cuing is odor. Odors may have a priming effect. David Smith at Bishop's University in Canada, compared learning in subjects that smelled either jasmine or a perfume while learning long word lists.[13] They were re-tested some time later, and one or the other odor was present during the recall testing. Best results occurred when the odor during re-test was the same as the odor during learning. The effect of odor is one example of the so-called "state-dependent learning" that I have described in the chapter, "Memories Hang Out With the Right Crowd." Here we see how specific this effect is. It is not just having any odor present when trying to elicit recall of items learned in the presence of odor, but that the best results occur when the odor is the same in both conditions.

Recall may be blocked by some kind of interfering or competing phenomena due to similar or confusing cues. Interference may occur before the memory is formed (proactive) or afterwards (retroactive).[14] The original studies of proactive interference used a design in which

three or four recall trials are given in rapid succession. Stimuli in each trial were similar (setting up the probability of interference). Each trial was separated by a distractor-filled interval. The material was hard to learn, but not if interference was reduced by using distinctive items on the last trial. A more real-world like demonstration was reported in a study in which subjects heard television news items while they viewed a videotape of the same events. Subjects heard three items during each trial and attempted to recall them after a 1-min delay. Four sets or trials of items were used. Control subjects received information on the same topic for all four trials. Subjects in the experimental group were treated the same except that on the last trial the items were on a different topic. In both groups, the percentage of correct responses declined over the first three trials, from about 85% correct on the first trial to 55% on the third trial. On the fourth trial, the percentage correct continued to decline (to 43%) in the controls, but increased sharply (to 74%) in the experimental group. The lesson seems to be that to remember well you must avoid interference at any time before, during, or shortly after a learning experience.

Retroactive interference occurs when new material, especially if it is similar to the material to be memorized, is introduced shortly after attempts to memorize. This is akin to interfering with consolidation, as I discussed earlier. But the interference with consolidation is magnified by similarities between the learned material and the post-learning distractors. Some interesting examples in studies of human infants have been reviewed.[15] These studies have shown, among other things, that infant memories are highly vulnerable to interfering information presented while the training memory is still active (that is, before consolidation), but are resistant to information after a reactivation treatment (after consolidation).

Recall interference can even occur with well-learned material. Most readers have experienced the following problem in a meeting or conversation: You have an "agenda item" that you plan to introduce. But you get so distracted by other pressing items in the conversation that you forget to bring up your agenda item. Sometimes the agenda

item was the main reason for the meeting or conversation in the first place.

An experimental psychologist, Endel Tulving at Yale, has clarified the idea that memories can be enduring, even when we cannot recall them at given moments. Tulving's explanation is that we fail to recall because a critical cue is missing. I would add the possibility that some element of the current situation could actively interfere with the recall, as just mentioned. In any case, the cue-dependent forgetting idea holds that we remember an event if and only if a trace of the event is left behind and if something reminds us of it. Given that definition, it would be just as easy to name this cue-dependent remembering, even though Tulving called it "cue-dependent forgetting.".

Tulving[16] and others have performed simple, but elegant, experiments that illustrate the point. For example, adult humans were presented a list of words and then required to recall as many as possible. While each word in the list is known to the subject, the appearance in a given list is a unique learning experience.

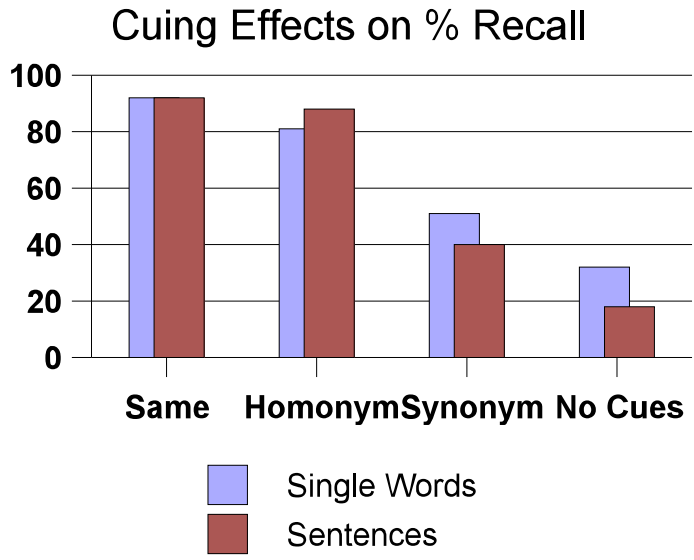
One experiment involved presenting words in pairs of closely related words (bark - dog; for example). Subjects were told that the right-hand members of each pair were the target words that they would be tested on during a recall test. After seeing a list, subjects were given two successive tests: 1) left-hand members were presented as retrieval cues, as in bark - ... Not surprisingly, subjects did quite well, averaging 74% of the target words. But results of the second recall test were most interesting. Here, the target words were cued with an associated word that had NOT appeared anywhere in the list. Thus, subjects would be given cues such as grog (rhymes with ....). Generally such cues failed to trigger recall of the same words that appeared in the original list. These results suggest is that recall depends on highly specific cues, even when the memory trace itself has not been lost.

Another interesting experiment that Tulving and colleagues conducted was one in which subjects were shown 28 five-letter words, and their recall was tested with cues of two, three, four, or five of the initial letters of these words or with no cue letters. For example, the

word grape on the list would be cued with gr ---, gra--, and grap-. In tests with no cues, subjects were asked to write, in any order, all the words that they remembered from the list. The results showed what could be expected: the more cue letters that were used, the higher the recall. With no cuing, subjects averaged only about 25% recall of words. But that performance rate was more than doubled with three-letter cuing. The information was there all the time. It just needed appropriate cuing.

Tulving cites another experiment of a contemporary in which subjects were presented a list of words and were required to recall the list with and without cues. The cue situations were varied so that cues were homonyms of target words, synonyms of target words, or cue words that were identical with target words. The results demonstrated a powerful impact of cuing. Similar results were obtained in other tests in which the words to be remembered were embedded in meaningful sentences.

One of Tulving's experiments tested the common idea of interference, which holds that memory is impaired by putting conflicting or distracting information between the time of learning and the recall test. In this test, subjects were presented lists of 24 words in each of 6 conceptual categories. For instance, one of the lists contained the words: hut, cottage, tent, hotel (category = housing type), Another list contained cliff, river, hill, volcano (CATEGORY = earth formations). Each list was shown three times, each time at the rate of one second per word. Then a non-cued recall test was given where subjects were to recall as many of the words as they could in a given category. Then the test was repeated with another category of words. After each category was presented and tested, subjects were asked to list all the words they had seen, without cuing. Immediately after this test, subjects were re-tested with cuing that consisted of giving them the names of the categories (housing types, earth formations, etc.). As you would expect, the amount of recall in the non-cued case declined precipitously with the

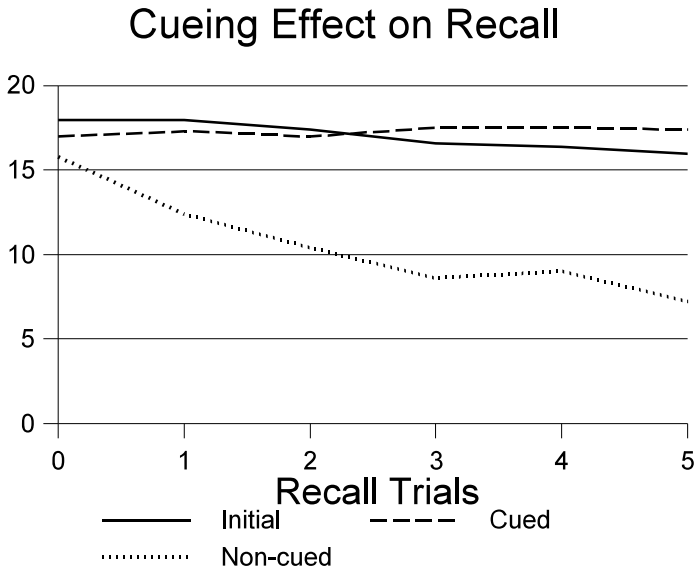


Results of experiments that tested cuing effects on a list of words to be memorized. Cues were either homonyms or synonyms of words in the original list to be memorized. Both single words and sentences were recalled more accurately when cues are presented.

number of lists that intervened between the first group of words and the last.

The next graph plots some of the data from one of Tulving's experiments that scored the average number of words recalled from a list of 24 words in three successive tests (original learning, non-cued recall, and cued recall). The graph shows the disruptive influence of presenting other lists learned between presentation of the original list

and the non-cued recall test.



Note that the degrading effect on performance was not seen when the recall was cued. What this shows is that the memory was there all along. It just needed appropriate cues to trigger recall. This viewpoint does not preclude that some forgetting is due to deterioration of a memory trace. The important thing to remember is that we remember much more than we think we do and that appropriate cuing will disclose that.

I have explained before "state-dependent learning," which is the phenomenon that recall is more effective if it is performed under the same conditions that were present during the initial learning. These "states" influence memory because they are full of cues that include not only physical settings (room, climate, scenery, etc.) but even emotional mood. Gordon Bower at Stanford,[17] for example, showed that memory retrieval is mood dependent. Bower asked his subjects, college students,

to keep week-long diaries of their emotions. In the laboratory, students were put through hypnotic and suggestion exercises that would increase the likelihood that they would achieve a good, happy mood, or a lousy, downer mood. After mood manipulation, students were tested on their ability to recall events from their diaries. Happy students remembered more of the pleasant incidents in their diary. Unhappy students remembered more of the sad and unpleasant incidents. Observations like these also illustrate why states of depression are so persistent - depression feeds upon unpleasant memories and thus intensifies the depression.

Extinction of a learned response is a useful model for evaluating contextual cues. In Pavlovian fear conditioning, for example, the fear can be extinguished if the conditioning stimuli are repeated but no longer paired with the aversive stimuli. For example, if a rat is trained to expect electric shock to its feet each time a light is flashed, that learned anxiety can be extinguished by eliminating the foot shock after each light flash. A recent study[18] has shown that this extinction is not simple habituation, but rather specific to the contextual cues present during the learning and extinction processes. The experimenters conditioned rats to fear two sound- conditioned stimuli, which they then extinguished in two different contexts. Rats exhibit fear by freeze behavior. When the freeze behavior was extinguished under a given context, re-testing showed that it tended to stay extinguished in the same context - but not when re-tested with the other sound conditioned stimulus.

There are important implications for treating conditioned fear and anxiety in humans. Although you can desensitize and extinguish learned anxiety reactions, the extinction may well be limited to one particular state or context. A different set of contextual cues may retrieve a buried learned anxiety or fear. This is a typical situation in "anxiety attacks," in which an overwhelming anxiety seems to "come out of the blue" with no rhyme or reason. Some cues in that context may have triggered the anxiety memory, which could no longer be suppressed because the context was not the same as the original situation in which the learned anxiety had been extinguished.

A leading explanation for forgetting, at least for extinction of conditioned reflexes, is that extinction is promoted by feedback from behavior during trials in which the conditioning stimulus is withdrawn. This was recently demonstrated in eye-blink conditioning of rabbits that learned an association between a tone and an air puff to the eye.[19] Extinction did not occur when during extinction trials the eye blink was prevented by blocking the nerve circuits that cause blinking. Thus, it seems that the behavior (blinking without the presence of the air puff in this case) in the early extinction trials creates a new learning situation (learning to unlearn) that promotes forgetting. This idea has not been tested for practical application, but the implications could be profound.

Non-Memory Effects on Recall

Especially in the chapter on emotions ("We Get Emotional About Our Memories"), I made the point that memory can fail because of stress or unpleasant emotions. The extent to which such failure can be assigned specifically to a failure of retrieval is not known, but it seems reasonable to suspect that recall failure can be a major factor. Retrieval may also be influenced by such other non-memory influences involving confidence, credibility of interviewers and witnesses, social compliance, conformance, and lack of sleep.

Crutches

When all else fails, you can always use memory crutches. I hate to even suggest it, because if you do all the things that this book shows are helpful for memory you should not need many crutches. Nonetheless, memory crutches do help organize your life and reduce the number of things you have to remember, perhaps giving you more mental energy and will to memorize the things that are really important. Examples of useful memory crutches include:

- Put important items back in the same place each time, such as bills, car keys, purse, wallet, the daily mail, etc.
- Use lists, on scrap paper or your PDA if you have one.
- Put sticky note reminders in key places.
- Keep a calendar (but remember to check it each day).
- Get organized. Have a place for everything and put everything in its place. Get a file cabinet (or two or whatever it takes) and label the files in the most meaningful ways.
- Have a tote bag or briefcase that always has in it what you need for the day.

* * * * *

This chapter reinforces the idea that we remember much more than we think we do. We have many buried memories. Recall depends on appropriate cues. Recall is influenced by such things as distracting information, either immediately before or after learning, cues that were present during learning, relevant cues presented after learning, the way information is grouped or categorized, and emotional mood.

Picture cues are the most effective. Recall the chapter "Memories Hang Out With The Right Crowd." A main reason that pictures are such powerful reminders that the many cues contained therein. Perhaps you remember a school teacher who presented information by drawing diagrams on the board. Remembering the structure of a diagram, which is relatively easy, makes it easier to remember the content.

Recall is promoted when you have confidence in your memory and trust it to work when you need it most.

Key Ideas:

1. Don't pressure or rush your sub-conscious mind to come up with whatever you are trying to remember. Think about something else for a while.

2. Be confident about your memory. Tell your subconscious mind that you trust it to remember and will be patient waiting for the answer.

3. Don't try to remember things when you are stressed or anxious. If you are in a stressful situation, calm yourself down before expecting best memory recall.

4. Merely exposing yourself to things you need to remember will make it easier to learn it permanently when you seriously try to memorize it.

5. Make up an acronym for things you want to recall. Then make a mental image of the acronym.

6. Buried memories may get reconstructed in the process of retrieval. Be aware that the retrieved memory may not be entirely correct.

7. Retrieval of memory is impaired if working memory is saturated. Space for working memory is needed to process in real time the associations and cues related to a memory.

8. Serial position of items in a list is recalled best if the items are arranged in some logical order that helps to build associations and cues.

9. Implicit memories can be learned and recalled without conscious awareness. Conscious awareness of the relationship of cues to memory items does make recall easier and more effective during early stages of learning. Examples include conversion of explicit to implicit learning in typing.

10. Priming facilitates memory, especially when you are consciously aware of priming taking place. Examples include skimming a book before reading it, re-learning a foreign language, and "total immersion" learning of a foreign language.

11. Sounds of words are important cues to recalling the word. Even different words that have similar sounds can help retrieve a word memory.

12. Distracting or irrelevant cues will interfere with recall. This interference effect can occur either immediately before a memory is formed or immediately afterwards.

13. Cues for recall generally are highly specific.

14. If items to be learned are classified by categories, then recalling the name of the category helps the recall of items within that category.

15. Emotions affect recall. Pressure, anxiety, or fear often interfere with recall. Positive, happy emotions promote recall.

16. Emotional depression feeds upon itself, because when you are depressed the memories most likely to be recalled (and reinforced) are the ones that make you depressed.

17. Learning to forget unwanted memories is also dependent on specific cues.

18. "Anxiety attacks" are usually triggered unconsciously by cues that are associated with buried unpleasant memories. Discovery of the cues and rational exploration of the buried memory and its associated emotions are central to therapy.

19. "Memory crutches," such as to-do lists, sticky notes, and habitual patterns of behavior, are O.K. to use only if they help organize the clutter in your lifestyle. But crutches should not be used to keep you from exercising your memory. Neither should they be used as a substitute for proving to yourself that you have a good memory.

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