

On the Permanence of Stored Information in the Human Brain

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ABSTRACT: *Many people believe that information that is stored in long-term memory is permanent, citing examples of "retrieval techniques" that are alleged to uncover previously forgotten information. Such techniques include hypnosis, psychoanalytic procedures, methods for eliciting spontaneous and other conscious recoveries, and—perhaps most important—the electrical stimulation of the brain reported by Wilder Penfield and his associates. In this article we first evaluate the evidence and conclude that, contrary to apparent popular belief, the evidence in no way confirms the view that all memories are permanent and thus potentially recoverable. We then describe some failures that resulted from attempts to elicit retrieval of previously stored information and conjecture what circumstances might cause information stored in memory to be irrevocably destroyed.*

Few would deny the existence of a phenomenon called "forgetting," which is evident in the common observation that information becomes less available as the interval increases between the time of the information's initial acquisition and the time of its attempted retrieval.

Despite the prevalence of the phenomenon, the factors that underlie forgetting have proved to be rather elusive, and the literature abounds with hypothesized mechanisms to account for the observed data. In this article we shall focus our attention on what is perhaps the fundamental issue concerning forgetting: Does forgetting consist of an actual loss of stored information, or does it result from a loss of access to information, which, once stored, remains forever?

It should be noted at the outset that this question may be impossible to resolve in an absolute sense. Consider the following thought experiment. A person (call him Geoffrey) observes some event, say a traffic accident. During the period of observation, a movie camera strapped to Geoffrey's head records the event as Geoffrey experiences it. Some time later, Geoffrey attempts to recall and

describe the event with the aid of some retrieval technique (e.g., hypnosis or brain stimulation), which is alleged to allow recovery of any information stored in his brain. While Geoffrey describes the event, a second person (Elizabeth) watches the movie that has been made of the event. Suppose, now, that Elizabeth is unable to decide whether Geoffrey is describing his memory or the movie—in other words, memory and movie are indistinguishable. Such a finding would constitute rather impressive support for the position held by many people that the mind registers an accurate representation of reality and that this information is stored permanently.

But suppose, on the other hand, that Geoffrey's report—even with the aid of the miraculous retrieval technique—is incomplete, sketchy, and inaccurate, and furthermore, suppose that the accuracy of his report deteriorates over time. Such a finding, though consistent with the view that forgetting consists of information loss, would still be inconclusive, because it could be argued that the retrieval technique—no matter what it was—was simply not good enough to disgorge the information, which remained buried somewhere in the recesses of Geoffrey's brain.

Thus, the question of information loss versus

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retrieval failure may be unanswerable in principle. Nonetheless it often becomes necessary to choose sides. In the scientific arena, for example, a theorist constructing a model of memory may—depending on the details of the model—be forced to adopt one position or the other. In fact, several leading theorists have suggested that although loss from short-term memory does occur, once material is registered in long-term memory, the information is never lost from the system, although it may normally be inaccessible (Shiffrin & Atkinson, 1969; Tulving, 1974). The idea is not new, however. Two hundred years earlier, the German philosopher Johann Nicolas Tetens (1777) wrote: "Each idea does not only leave a trace or a consequent of that trace somewhere in the body, but each of them can be stimulated—even if it is not possible to demonstrate this in a given situation" (p. 751). He was explicit about his belief that certain ideas may seem to be forgotten, but that actually they are only enveloped by other ideas and, in truth, are "always with us" (p. 733).

Apart from theoretical interest, the position one takes on the permanence of memory traces has important practical consequences. It therefore makes sense to air the issue from time to time, which is what we shall do here.

The purpose of this paper is threefold. We shall first report some data bearing on people's beliefs about the question of information loss versus retrieval failure. To anticipate our findings, our survey revealed that a substantial number of the individuals queried take the position that stored information is permanent—or in other words, that all forgetting results from retrieval failure. In support of their answers, people typically cited data from some variant of the thought experiment described above, that is, they described currently available retrieval techniques that are alleged to uncover previously forgotten information. Such techniques include hypnosis, psychoanalytic procedures (e.g., free association), and—most important—the electrical stimulation of the brain reported by Wilder Penfield and his associates (Penfield, 1969; Penfield & Perot, 1963; Penfield & Roberts, 1959).

The results of our survey lead to the second purpose of this paper, which is to evaluate this evidence. Finally, we shall describe some interesting failures that have resulted from attempts to elicit retrieval of previously stored information. These failures lend support to the contrary view

that some memories are apparently modifiable, and that consequently they are probably unrecoverable.

Beliefs About Memory

In an informal survey, 169 individuals from various parts of the U.S. were asked to give their views about how memory works. Of these, 75 had formal graduate training in psychology, while the remaining 94 did not. The nonpsychologists had varied occupations. For example, lawyers, secretaries, taxicab drivers, physicians, philosophers, fire investigators, and even an 11-year-old child participated. They were given this question:

Which of these statements best reflects your view on how human memory works?

1. Everything we learn is permanently stored in the mind, although sometimes particular details are not accessible. With hypnosis, or other special techniques, these inaccessible details could eventually be recovered.

2. Some details that we learn may be permanently lost from memory. Such details would never be able to be recovered by hypnosis, or any other special technique, because these details are simply no longer there.

Please elaborate briefly or give any reasons you may have for your view.

We found that 84% of the psychologists chose Position 1, that is, they indicated a belief that all information in long-term memory is there, even though much of it cannot be retrieved; 14% chose Position 2, and 2% gave some other answer. A somewhat smaller percentage, 69%, of the nonpsychologists indicated a belief in Position 1; 23% chose Position 2, while 8% did not make a clear choice.

What reasons did people give for their belief? The most common reason for choosing Position 1 was based on personal experience and involved the occasional recovery of an idea that the person had not thought about for quite some time. For example, one person wrote: "I've experienced and heard too many descriptions of spontaneous recoveries of ostensibly quite trivial memories, which seem to have been triggered by just the right set of a person's experiences." A second reason for a belief in Position 1, commonly given by persons trained in psychology, was knowledge of the work of Wilder Penfield. One psychologist wrote: "Even though Statement 1 is untestable, I think that evidence, weak though it is, such as Penfield's work, strongly suggests it may be correct." Occasionally respondents offered a comment about

hypnosis, and more rarely about psychoanalysis and repression, sodium pentothal, or even reincarnation, to support their belief in the permanence of memory.

Admittedly, the survey was informally conducted, the respondents were not selected randomly, and the question itself may have pressured people to take sides when their true belief may have been a position in between. Nevertheless, the results suggest a widespread belief in the permanence of memories and give us some idea of the reasons people offer in support of this belief.

EVIDENCE PEOPLE USE

Brain stimulation. The most impressive evidence for the notion of permanent storage seems to come from the reports that events long forgotten are vividly recalled during electrical stimulation of certain regions of the human cortex. Wilder Penfield, who is best known for this work, was operating on epileptic patients during the 1940s, removing the damaged areas in their brains (Penfield, 1969; Penfield & Perot, 1963; Penfield & Roberts, 1959). To guide himself in pinpointing the damage, Penfield stimulated the surface of the brain with a weak electric current in the hope of discovering, in each of his patients, the particular area in the brain that was related to the epileptic attacks. During this electrical invasion of their brains, Penfield discovered that certain placements of the stimulating electrode apparently caused some of the patients to re-experience events from their past.

If one looks at accounts of Penfield's work written by others, one gets a clear impression of a phenomenon that is extremely vivid and rather widespread. For example, the following remarks are found in popular textbooks of introductory psychology:

Dr. Wilder Penfield, a Canadian brain surgeon, has reported that he was able to produce vivid memories in some of his patients by stimulating certain areas of the temporal lobes with weak electric currents. One patient reported hearing a song; in his words, ". . . it was not as though I were imagining the tune to myself. I actually heard it." Other patients suddenly relived long-forgotten childhood experiences. Stimulation of the same cerebral area always produced the same episode. (Kendler, 1968, p. 185)

We are in the operating room of the Montreal Neurological Institute observing brain surgery on Buddy, a young man with uncontrollable epileptic seizures. The surgeon wants to operate to remove a tumor, but first

he must discover what the consequences will be of removing various portions of the brain tissue surrounding the tumor. . . . Suddenly, an unexpected response occurs. The patient is grinning; he is smiling; eyes opening when that area is stimulated. "Buddy, what happened, what did you just experience?" "Doc, I heard a song, or rather a part of a song, a melody." "Buddy, have you ever heard it before?" "Yes, I remember having heard it a long time ago, but I can't remember the name of the tune." When another brain site is stimulated, the patient recalls in vivid detail a thrilling childhood experience.

In a similar operation, a woman patient "relived" the experience she had during the delivery of her baby. As if by pushing an electronic memory button, the surgeon, Dr. Wilder Penfield, has touched memories stored silently for years in the recesses of his patient's brains. (Zimbaro & Ruch, 1975, pp. 48-49)

Acceptance of the power of Penfield's stimulating electrode has reached a far wider audience than the students of introductory psychology courses. The following example appeared in an article that reached millions of Americans—through the *New York Times*—just a couple of years ago:

One of Penfield's patients was a young woman. As the stimulating electrode touched a spot on her temporal lobe, she cried out: "I think I heard a mother calling her little boy somewhere. It seemed to be something that happened years ago . . . in the neighborhood where I live." Then the electrode was moved a little and she said, "I hear voices. It is late at night, around the carnival somewhere—some sort of traveling circus. I just saw lots of big wagons that they use to haul animals in."

There can be little doubt that Wilder Penfield's electrodes were arousing activity in the hippocampus, within the temporal lobe, jerking out distant and intimate memories from the patient's stream of consciousness. (Blake-more, 1977/1978, p. 88)

It is of interest to examine Penfield's own writings. In his 1969 work, he expressed a belief in the relatively permanent nature of memory:

It is clear that the neuronal action that accompanies each succeeding state of consciousness leaves its permanent imprint on the brain. The imprint, or record, is a trail of facilitation of neuronal connections that can be followed again by an electric current many years later with no loss of detail, as though a tape recorder had been receiving it all.

Consider now what happens in normal life. For a short time, a man can recall all the detail of his previous awareness. In minutes, some of it has faded beyond the reach of his command. In weeks, all of it seems to have disappeared, as far as voluntary recall is concerned, except what seemed to him important or awakened in him emotion. But the detail is not really lost. During the subconscious interpretation of later contemporary experience, that detail is still available. This is a part of what we may call perception. (p. 165)

On what did Penfield base these conclusions? Apparently on his observation of "flashback" responses.

The flashback responds to electrical stimulation . . . bear no relation to present experience in the operating room. Consciousness for the moment is doubled, and the patient can discuss the phenomenon. If he is hearing music, he can hum in time to it. *The astonishing aspect of the phenomenon is that suddenly he is aware of all that was in his mind during an earlier strip of time.* It is the stream of a former consciousness flowing again. If music is heard, it may be orchestra or voice or piano. Sometimes he is aware of all he was seeing at the moment; sometimes he is aware only of the music. It stops when the electrode is lifted. It may be repeated (even many times) if the electrode is replaced without too long a delay. This electrical recall is completely at random. Most often, the event was neither significant nor important. (Penfield, 1969, p. 152; emphasis ours)

In sum; Penfield concluded that memories are highly stable, that the brain contains a complete record of past experience that preserves an individual's past perceptions in astonishing detail. In this conclusion, he has provided the strongest version of a memory-permanence hypothesis—a view that might be dubbed the “videorecorder model.” The videorecorder concept is clearly an exciting one, and the science-fiction quality of Penfield's findings seems to have engendered a remarkable degree of excitement over the past 20 years.

Hypnosis. Hypnosis is also viewed as a retrieval technique that is capable of reactivating detailed memories that have lain dormant in a person for many years. The technique enjoys sufficient popular credibility for various U.S. law agencies to have used hypnosis as an aid to criminal investigation since the early 1960s. Many of the apparent successes deriving from hypnosis have been reported in a recent book by Eugene Block (1976) called *Hypnosis: A New Tool in Crime Detection*. There, for example, the reader will learn how hypnosis was used by the Israeli National Police Force in solving scores of cases. Also in Block's book are descriptions of the successful role that hypnosis played in other investigations, for example, in the case of the Boston Strangler, of the San Francisco cable-car nymphomaniac, and of Cleveland's Dr. Sam Sheppard, accused of killing his pregnant wife, Marilyn.

If one looks at what the “experts” are saying about hypnosis, one gets a clear impression that some of them believe it works because of the permanence of memory. For example, two hypnotherapists, Cheek and LeCron (1968), wrote in their book *Clinical Hypnotherapy*,

It seems that everything that happens to us is stored in memory in complete detail. Conscious recall is limited

to a very tiny part of total memory. Regression under hypnosis can bring out completely forgotten memories. It is also possible to bring them out merely by suggesting that they will be recalled. In this situation the patient remembers but doesn't relive the event. (p. 54)

Acceptance of the power of hypnosis has reached an audience far wider than that made up of researchers in the field. An example is an article that found its way into the homes of millions of Americans—through the *TV Guide* (Stump, 1975). There readers learned of the case of a 38-year-old woman whose boyfriend had been murdered. She saw it happen, but the shock—and heavy drinking—almost totally blocked her memory. She was brought to the police station, where a hypnotist, speaking soothingly, explained to her that the mind is like a videotape machine. What we observe is recorded, stored in the subconscious, and available for recall through hypnosis. Information that she provided, previously unreported, helped crack the case.

The article went on to report the enormous success that the Los Angeles police department has had with hypnosis. One spokesman said it had provided valuable leads and evidence in an impressive 65% of the cases. He further said,

Frequently when someone is shot, raped, beaten or otherwise attacked, he or she performs a defensive maneuver. They throw up a guard against fright, anxiety, and other traumas. Acting on survival instinct, they hide the hurt. Through hypnosis, we make the conscious mind passive and communicate with the subconscious to release what's buried there. (Stump, 1975, p. 34)

In sum, many proponents of hypnosis have used successful memory recoveries to support a version of a memory-permanence hypothesis. These views, along with widely publicized examples in which hypnosis was apparently successful, have been passed on to laypersons through the popular press.

Spontaneous and prompted recoveries. The phenomenon of spontaneous recovery, namely, the fact that some items that seem to have been forgotten can and do reappear spontaneously, is well documented (Crowder, 1976). A spontaneous recovery can be a striking phenomenon that would be desirable to study in the laboratory. However, because that would be very difficult to do—the experimenter might be forced to wait all week for a spontaneous recovery to emerge—psychologists have tended to do experiments in which particular cues are provided in an attempt to recover certain memories. For example, Tulving and

Pearlstone (1966) discovered that in a categorized free-recall situation, providing category cues elicited words that had not been recalled in the absence of the cues. Thus, prior to being given the cues, the subjects must have had stored in memory words that were available but not accessible. This experiment, together with others that followed it (e.g., Tulving & Thomson, 1971, 1973), indicates that retrieval cues are instrumental in eliciting a desired item from memory.

A different body of evidence suggests that initially unreported elements of a stimulus tend to emerge in subsequent dreams, daydreams, doodles, free associations, and other fantasy activities. Furthermore, recollections following certain fantasy activities yield a similar recovery of initially unreported stimulus elements (Erdelyi, 1970). Such recoveries, whether spontaneous or prompted, are offered as evidence for the notion that memories are stored permanently.

Psychoanalysis. Psychotherapists use various techniques to help their patients bring their anxieties and conflicts into the open in order to determine where they came from and how to deal with them. Psychoanalysis is a type of psychotherapy that concentrates on dreams, fantasies, and other material from the unconscious that patients reveal through free association. This sort of treatment has apparently enjoyed some success in treating repression of traumatic events. Repression is characterized by a curious forgetfulness. The amnesia that results from repression is curious because "the affect surrounding the idea remains in consciousness and because the repressed idea has an uncanny way of returning—albeit in disguised form" (Vaillant, 1977, p. 128).

The purpose of psychoanalysis is to help the patients dig under the layer of repression, develop new insights into their behavior, and find more flexible ways to cope with their anxiety. It is premised on the idea that some emotional experiences in childhood are so traumatic that to allow them to enter into consciousness many years after they occurred would cause one to be totally overwhelmed by anxiety. It is thought that such traumatic experiences are stored in the unconscious, or repressed, but that with proper therapeutic techniques they can be unleashed. Repression is thus conceptualized in terms of a retrieval failure, with access to the critical memories being temporarily blocked.

The primary evidence for repression comes from

clinical patients, and numerous reports exist in the literature. Often recoveries from amnesias of unbearable memories occur through the use of therapy, hypnosis, or drugs (see Erdelyi & Goldberg, 1979). Patients have, through interventions of this sort, recovered memories of such experiences as being accidentally buried alive or surviving an airplane crash, about which they had been hitherto amnesic. The vividness with which these memories are reported can indeed be impressive.

EVALUATION OF THE EVIDENCE

These phenomena seem to offer impressive support for the belief that information is permanently stored. However, careful evaluation of the evidence in each case raises rather substantial doubts. As we shall see, reports of "memories" that occur either spontaneously or as a result of memory probes, such as electrical stimulation, hypnosis, or psychotherapy, may not involve memories of actual past events at all. Rather, there is good reason to believe that such reports may result from reconstruction of fragments of past experience or from constructions created at the time of report that bear little or no resemblance to past experience. Furthermore, secondary sources and popular accounts tend to distort the evidence so as to lend more credence to the notion of memory permanence than is really warranted.

Brain stimulation. As noted, the work of Penfield captured the imagination of psychologists and has provided perhaps the most widely cited support for the contention that memories are permanent. But let us look more closely at what Penfield actually found. Penfield began with 1,132 patients, and by his own admission, the patient responses that might have indicated a memory recovery occurred in only 40 cases out of the total of 1,132 cases surveyed, or only 3.5% of the time (Penfield, 1969, p. 154). (In an earlier publication, however, Penfield and Perot, 1963, noted that electrical stimulation produced what they labeled "experiential responses" only when the electrodes were applied to the cortex of the temporal lobe. This region was explored in 520 of the patients; thus the 40 patients exhibiting experiential responses constituted 7.7% of this group.) But in any event, production of these responses by the stimulating electrode was relatively rare to begin with.

In their 1963 article in *Brain*, Penfield and Perot

reviewed all 40 cases in which stimulation of the cortex of conscious patients produced experiential responses. Of the 40 patients, 24 claimed to have had an auditory experiential response; that is, they heard a voice, voices, music, or a meaningful sound. For example, upon stimulation, one patient (Case 9) said in a subdued voice, "Oh, a kind of sound in the distance like people singing." When asked what they were singing, she replied, "I don't know. It was like a bunch of old folks in the background, probably some hymns." Nineteen patients claimed to have a visual experiential response, seeing a person or a group of people, a scene, or a recognizable object. For example, one patient (Case 19) claimed to have seen a familiar man grabbing a stick. Twelve patients reported combined visual and auditory experiential responses; that is, they experienced scenes with appropriate sounds. Penfield and Perot (1963) seemed to be most impressed with the 22 responses observed in these 12 people, for they argued that many of the responses "consisted of an experience which the patient could easily recognize and identify as having been part of a previous experience" (p. 672). Finally, five patients made responses that were described vaguely; for example, patients referred to having had "a thought," "a memory," "a flash-back," or they may have said "that reminded me of something."

When we eliminate the patients who heard only music or voices and those whose responses were too vague to classify, we find that less than 3% of the patients contributed the lifelike experiential responses for which Penfield's work is so famous. And a detailed examination of even these patient protocols leaves one with the distinct feeling that they are reconstructions or inferences rather than actual memories. For example, one patient (Case 1) said upon stimulation that she suddenly saw herself as she had appeared in childbirth, and that she felt as if she were reliving the experience. Another (Case 36) said, "I think I heard a mother calling her little boy somewhere. It seemed to be something that happened years ago." She said it was "somebody in the neighborhood where I live." When the same spot was stimulated 18 minutes later, she said, "Yes, I hear the same familiar sounds, it seems to be a woman calling. The same lady. That was not in the neighborhood. It seemed to be at the lumberyard." She added that she had never in her life been around a lumberyard. When a patient under stimulation sees her-

self from the sidelines engaged in a particular act, or experiences people in locations in which she has never been, there is clear indication that the individual is not "reliving" the experience but rather is reconstructing it. A similar interpretation of brain-stimulation work has been offered by Neisser (1967):

In short, the content of these experiences is not surprising in any way. It seems entirely comparable to the content of dreams, which are generally admitted to be synthetic constructions and not literal recalls. Penfield's work tells us nothing new about memory. (p. 169)

In sum, Penfield would have us believe that stimulation of the brain "causes previous experience to return to the mind of a conscious patient" and that "there is within the adult brain a remarkable record of the stream of each individual's awareness or consciousness" (Penfield & Perot, 1963, p. 692). But these conclusions (and the video-recorder model), based as they are on the dubious protocols of a handful of patients, seem unwarranted. A reconstruction or construction hypothesis seems much more viable. A hint as to what is likely to go into such reconstructions was provided by Mahl, Rothenberg, Delgado, and Hamlin (1964) in their examination of a 27-year-old housewife who underwent brain stimulation; they concluded that a strong determinant of the content of these "memories" is "the patient's 'mental content' at the time of stimulation" (p. 358). These so-called memories, then, appear to consist merely of the thoughts and ideas that happened to exist just prior to and during the stimulation.

Hypnosis. Despite apparent successes in using hypnosis to recover memories, the technique is subject to a variety of criticisms. First, when it does work to revive a temporarily inaccessible memory, hypnosis does not necessarily involve the awesome, mysterious power that many apparently attribute to it. Rather, it may simply be that hypnosis encourages people to relax more, to cooperate more, or to concentrate more than they otherwise would. Put another way, the argument is that hypnosis is best understood in terms of the interpersonal relationship existing between hypnotist and subject. A good relationship results in the subject's behaving in a way that is pleasing to the hypnotist, that is, in a way in which the subject perceives a good hypnotic subject should behave (Hilgard, 1977; Evans & Kihlstrom, Note 1).

The net result may well be simply a *criterion shift* rather than improved access to stored information. That is, rather than being more able, the subject may simply be more willing to report information in the hypnosis setting than under ordinary circumstances.

In support of this criterion-shift hypothesis is the fact that although hypnotized subjects who are asked to recall or relive former experiences often produce a wealth of recollections, much of this material is fabricated. There exists no evidence to support the view that recall during a state of hypnosis is any more accurate or complete than recall under ordinary waking conditions (Barber, 1965; Neisser, 1967). Even more dramatic, several experiments have shown that subjects under hypnosis will confidently recall events not only from the past but from the future as well (Kline, 1958; Rubenstein & Newman, 1954). In response to this somewhat muddled state of affairs, many researchers have voiced strong objections to the use of hypnosis in the legal arena. An article in the *American Bar Association Journal* recently argued:

People can flat-out lie under hypnosis, and the examiner is no better equipped to detect the hypnotic lie than any other kind. Even more serious, a willing hypnotic subject is more pliable than he normally would be, more anxious to please his questioner. Knowing even a few details of an event, often supplied in early contacts with police, may provide the subject with enough basis to create a highly detailed "memory" of what transpired, whether he was there or not. ("Hypnotized Man Remembers Too Much," 1978, p. 187)

Spontaneous and prompted recoveries. The recovery of items that appear to have been forgotten certainly does happen, but this does not, of course, constitute evidence that all or even many memories are recoverable. If we traveled to Holland and saw one yellow tulip, that obviously would not provide evidence that all tulips are yellow. Even after seeing an acre of yellow tulips, we would not be surprised to walk a mile down the road and find a field of tulips that were red. Similarly, in the case of memory, the existence of examples of successful recoveries should not imply that all memories are potentially recoverable.

Thus the vast evidence that fantasy activities can result in the emergence of initially unreported elements of a stimulus does not imply that all memories are potentially recoverable. In fact, from a thoughtful application of signal-detection analysis, Erdelyi (1970) concluded that fantasy

activities did nothing to intensify the memory for the stimulus but, rather, affected the response rates: "While fantasy generation increases the extent to which information is outputted from memory storage, the input traces in memory storage do not themselves become intensified" (p. 111). Fantasy activities apparently induce people to adopt a less stringent criterion for reporting, so that low-confidence memory items are recalled when otherwise they might not have been reported.

Psychoanalysis. Our remarks on the subject of memory recovery also apply to psychoanalysis. In fact, Erdelyi's (1970) conclusions were based largely on work involving free-association techniques, one of the principal methods used in psychoanalysis.

In terms of the recovery of repressed memories, even some of those who believe in the concept of repression have argued that it is possible that subjects purportedly recovering lost memories are in fact generating not memories of true events but fanciful guesses, fantasies, or plain confabulations (Erdelyi & Goldberg, 1979). The major methodological problem is that for the most part, independent verification of the accuracy of the "memory" produced by the subject can never be obtained. In reviewing the available evidence, Neisser (1967) has flatly stated that these recoveries are "not a fully accurate copy of earlier experience" (p. 169).

Some Retrieval Failures

Our emphasis thus far has been on the use of different techniques designed to produce recovery of memories that have at one time or another been temporarily unavailable. What we have tried to illustrate is that the results of these techniques must be viewed with a highly jaundiced eye. They do not, contrary to popular belief, provide support for anything like a videorecorder memory.

On the other side of the coin, we cannot deny that successful recoveries can and do occur. Our argument is with the contention that all memories are potentially recoverable. In this section, we shall offer some speculations about the circumstances under which a particular memory trace may be altered or obliterated.

MEMORY DISTORTION IN THE LABORATORY

One of us (EL) has, over the past several years, been investigating circumstances under which re-

ports of real-world, complex events can undergo systematic and predictable distortions (Loftus, 1975, 1977, 1979a, 1979b; Loftus & Palmer, 1974). To get an idea of the flavor of this research, consider the following experiment reported by Loftus, Miller, and Burns (1978). The subjects viewed a series of 30 color slides depicting successive stages in an auto-pedestrian accident. The auto was a red Datsun seen traveling along a side street toward an intersection with a stop sign for half of the subjects, and toward an intersection with a yield sign for the remaining subjects. The remaining slides show the Datsun turning right and knocking down a pedestrian who is crossing at the crosswalk. Immediately after viewing the slides, the subjects answered a series of 20 questions. For half of the subjects, Question 17 was "Did another car pass the red Datsun while it was stopped at the stop sign?" The remaining subjects were asked the same question with the words "stop sign" replaced by "yield sign." The assignment of subjects to conditions produced a factorial design in which half of the subjects received consistent or correct information, whereas the other half received misleading or incorrect information. After a short filler activity, a two-forced-choice recognition test was administered. Two slide projectors were used to present 15 pairs of slides, each pair being presented for about 8 seconds. For each pair of slides, the subjects were asked to select the slide they had seen earlier. The critical pair consisted of a slide depicting a red Datsun at a stop sign and another slide, nearly identical, except that it depicted the Datsun at a yield sign. The results showed that when the intervening question contained misleading information, recognition performance was hindered. In one condition, for example, over 80% of the subjects who received misleading information responded incorrectly on the forced-choice recognition test. They indicated that they had seen the slide that corresponded to what they had been told rather than the slide that they had actually seen.

A major thrust of this and related research has been a practical one: It provides a warning, for example, that eyewitness accounts occurring in such situations as courtroom trials and insurance investigations can be highly suspect. Of interest in the present essay, however, is the relation between the eyewitness report and the memorial information that underlies it. Three hypotheses

seem viable. The first, relatively uninteresting, might be termed a "supplementation of nothing" hypothesis. According to this hypothesis, many subjects simply fail to store information about the critical object (say the stop sign) at the time of original viewing. The postperceptual (misleading) information (corresponding to the yield sign in this example) is then added to the memory representation of the event and thereby forms the basis for the subsequent report.

A variety of data allow us to reject this possibility. First, when given no misleading information, and when tested immediately after the incident, over 90% of the subjects correctly identified the sign they had seen. This result suggests that the information did register itself in long-term memory. Second, one group of subjects viewed the incident and then filled in a diagram with all the details they could remember; more than half of them drew in the correct sign. This finding suggests that at least half of the subjects encoded the sign to the point of including it in their diagram. In fact, it underestimates the actual number who encoded the sign, since others may have encoded it but not bothered to draw it in their diagram (Loftus, Miller, & Burns, 1978). Taken together, these results indicate that at least some of those subjects whose recollection changed as a result of misleading information actually did store the critical information in the first place.

The other two hypotheses about the relation between the eyewitness report and the underlying memorial information bear directly on the permanence issue. A coexistence (permanence) hypothesis would hold that the postperceptual information is added to the memory representation, where it coexists with the original information. The test report then rests on a choice between these two competing alternatives. A substitution hypothesis, on the other hand, would claim that the postperceptual information replaces the original information and that in the process, the original information is forever banished from the subject's memory.

EVIDENCE FOR SUBSTITUTION

Can we distinguish between these two hypotheses? As noted earlier, it is not possible to unequivocally reject the coexistence hypothesis, since failing to find a member of a supposedly coexisting pair does not logically imply that the elusive member does

not exist. We can, however, provide circumstantial evidence against the coexistence hypothesis by devising experiments that attempt, in as rigorous a way as possible, to uncover the original information. If such attempts fail, then we can conclude that the information may have vanished—and that for all practical purposes, it has vanished. What follows is a brief description of some rigorous attempts to recover the original information. None of them succeeded in finding it once it had been tampered with.

Testing method. As we have said, it is not at all difficult to take someone who has seen one object, say a stop sign, and cause him or her to recollect actually seeing another object, in this case a yield sign. The method of probing for a recollection seems to matter very little. We can ask, "Did you see a yield sign?" and obtain the response "yes." We can ask, "What type of traffic sign did you see?" and obtain the response "a yield sign." We can ask, "Was it a stop sign or a yield sign?" and obtain the answer "yield." And, what is most impressive, we can present, side by side, pictures of the two signs and find that the yield sign is the choice. This last recognition test is particularly compelling, for the subject rejects the stimulus that is identical to the one actually seen. If recognition were assumed to be a relatively passive process of matching stimuli to specific locations in a content-addressable storage system, one would expect that a representation of the actual and true scene would result in a match and that an alteration would fail to match. This does not occur.

Also relevant is the finding that warning people just prior to a test that some misinformation may have been presented earlier does not enable them to reject that misinformation in favor of their original memory. Put another way, once the misinformation has been incorporated into memory, a later warning is unable to help in the recovery of what was initially seen (Loftus, 1979a).

Demand characteristics. It is natural to ask whether these results are due to demand characteristics. Perhaps observant subjects discern the experimental hypothesis. Obliging subjects may then try to confirm that hypothesis. In the context of the stop sign/yield sign study, it is possible that some or all of the subjects not only remembered which traffic sign they had observed but also remembered what they had been "told" and then went along with what they believed to be the ex-

perimental hypothesis, choosing the sign that they had heard about rather than the one they had actually seen. Loftus, Miller, and Burns (1978, Experiment 2) devised a way to test this notion. Subjects who had participated in the sign-altering experiment were told, just before leaving the experiment, the exact purpose of the experiment. They were told that they had seen either a stop sign or a yield sign and that their questionnaire had presupposed the existence of one sign or the other. Their task was to guess which condition they had been in. In other words, this final debriefing activity gave the subjects the opportunity to be completely insightful about their condition in the experiment. Of those who had been given misleading sign information and had been fooled by it, nearly 90% still insisted they had seen the sign that corresponded to what they had been told.

Incentives. It could be argued that the reason so many people go along with misleading information is that they are not highly motivated to be accurate. If high incentive were provided for accurate responding, perhaps people would show evidence that their memories were accurate. For example, if subjects were offered \$1, or \$5, or even \$25 for correct responding, would their choice still be for the yield sign that they had read about over the stop sign that they had actually seen? Loftus (1979a) found the answer to be yes. When no reward was offered, 75% of the subjects chose the incorrect sign; with a \$1 reward, 80%, with a \$5 reward, 70%, and with a \$25 reward, 85% of the subjects rejected the true sign in favor of the incorrect alternative. In sum, subjects actually performed slightly less accurately when an incentive was provided.

Second guesses. A second-guess technique is particularly well suited for investigating whether original information and new information coexist in memory or whether original information is altered by what occurs subsequently. The logic of this technique is as follows: At the time subjects are asked for their recollections of an event, they first guess among fixed alternatives, and if they guess incorrectly, they choose among the remaining uncommitted alternatives; if they choose correctly on the second guess at a level higher than chance, then they must have had some information available about the correct response, in spite of the error on the first guess. A variation of this technique has been used successfully in the study of psychophysical thresholds (Swets, Tanner, &

Birdsall, 1961), tachistoscopic recognition (Bricker & Chapanis, 1953), and paired-associate learning (Bregman, 1966).

Loftus (1979a) performed a second-guess experiment using memory for colors. In one study, the subjects viewed a series of slides depicting a complex incident involving several people. Some subjects saw one slide that showed a man sitting down and reading a book with a green cover. Subsequently, these individuals were exposed to information indicating that the cover was a different color, say yellow. Later all the subjects were tested on their memory for the details of the slides; they picked colors that best represented their recollection of critical objects. For each object, they were also asked to indicate their second choice, assuming that the first choice was incorrect. In brief, the results showed that the subjects did not choose correctly on the second guess at a level higher than chance.

The same result was obtained in an experiment using memory for objects. The subjects looked at the stop/yield sequence, viewing either a stop sign or a yield sign. They returned to the laboratory after one week, at which time a questionnaire subtly told them that they had seen either a stop sign, a yield sign, or a no-parking sign. After a filler activity, they were tested. The critical test item asked them to indicate their recollection of the type of sign they had seen on the corner by choosing among fixed alternatives. They also indicated their second choice. Here, too, we found that when subjects were initially wrong, and 90% of them were, their second guesses showed basically chance performance. In short, the pattern of responses in these experiments suggests that the subjects had completely lost the original information about the correct alternative.

Hypnosis. Despite the fact that hypnosis can result in the "recollection" of facts that never occurred, there are those who are still impressed with its power to reveal original memory traces. To determine whether this technique could enable an individual whose memory had been altered to "return to the truth," Putnam (1979) conducted a study in which the subjects were first shown a videotape of an accident involving a car and a bicycle. After some delay, the subjects received a questionnaire that asked some objective questions and some that contained misleading information. Some of the subjects were questioned under hypnosis whereas others were not. The hypno-

tized subjects were told that "under hypnosis it would be possible for them to see the entire accident again just as clearly as they had seen it the first time, only this time they would be able to slow it down or zoom in on details if they chose to" (p. 442). Putnam found more errors were made by the subjects in the hypnosis condition, particularly on the leading questions. He interpreted these results to indicate that hypnosis does not reduce retrieval difficulties and allow subjects to retrieve a veridical memorial representation. Quite the contrary, subjects appear to be "more suggestible in the hypnotic state and are, therefore, more easily influenced by the leading questions" (p. 444). Suggesting the existence of a license plate, when in fact none had been visible at all, not only induced hypnotic subjects to say they had seen it but prompted them to offer partial descriptions of the license number. One subject said it was a California plate which began with W or V, and this obviously constructed information was not obtained under any duress. Suggesting that the major character's hair was blond, when actually it was black, caused hypnotized subjects to "remember" blond hair. Showing these subjects the videotape again caused some consternation. One subject said, "It's really strange because I still have the blond girl's face in my mind and it doesn't correspond to her (pointing to the woman on the videotape) . . . it was really weird" (p. 444).

IMPLICATIONS

The net result of these studies is a strong suspicion that substitution has occurred—that the misleading information has irrevocably replaced the original information in the subject's brain. The suggestion is that some aspects of the original representation of a complex event are fragile indeed. When the memory of an event is called to consciousness, there appears to be a potential for substitution to occur. It is reasonable to suppose that memory is not necessarily permanent.

What then of the coexistence possibility? Implicit in our remarks has been the notion that substitution and coexistence are not mutually exclusive mechanisms of the mind. Classical interference-theory experiments have certainly indicated that A-B and A-C responses can be simultaneously maintained in memory (cf. Crowder, 1976). And instances of coexistence are abundant

in everyday life; few have lost the information that Jacqueline Onassis was once Jacqueline Kennedy.

Assuming then that both substitution and coexistence are possible, a major question then confronts the memory theorist: Under what circumstances does one process rather than the other occur? As a start toward answering this question, we suggest that the mechanism responsible for updating memory both seeks efficiency and takes account of real-world constraints. In a situation that permits logical (real-world) coexistence, memorial coexistence is likewise allowed. Thus, the Stimulus A may be attached to both B and C, and similarly, to illustrate, allowance is made for the fact that the former First Lady may undergo a name change in accord with her marital status. Often, however, real-world coexistence is logically forbidden. The automobile that was involved in the accident that we recently experienced stopped either at a stop sign or at a yield sign, but it did not stop at both. The shirt worn by the thief was not simultaneously green and blue. In such instances, the most economical procedure may be to dismiss one memory in favor of the other, much as a computer programmer will irrevocably destroy an old program instruction when a new one is created.

The implication of the notion of nonpermanent memory is that it should give pause to all who rely on obtaining a "truthful" version of an event from someone who experienced that event in the past. Clinical psychologists, counselors, and psychiatrists who use the anamnestic interview to gain information about the prior events in someone's life typically do so to be able to make intelligent decisions about what kind of help should be given. Anthropologists, sociologists, and some experimental psychologists query people about their past in the course of studying some particular problem of interest to social science. It is important to realize that the statements made during such interviews may not be particularly accurate as reports of prior events. The contents of an interview may not reflect a person's earlier experiences and attitudes so much as his or her current picture of the past. It may not be possible, in some instances, to ever discover from interviewing someone what actually happened in that person's past. Not only might the originally acquired memory have departed from reality in some systematic way, but the memory may have been continually subject to change after it was initially stored.

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