Reconstructive Memory, Psychology of

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Abstract

Memories are reconstructions of past events, not perfect recordings. These reconstructions can be accurate, but may also contain errors. Since the early 1900s, researchers have investigated memory processes in the laboratory and have demonstrated that reconstructions occur regardless of whether memories are retrieved after short or long periods. Reconstructive errors in memory retrieval have been shown in memory for basic objects (e.g., words, prose, pictures) and naturalistic materials (e.g., scenes, events). The implication is that understanding how memories are recollected requires considering the complex interaction of individuals' preexisting knowledge, beliefs, experiences, and goals.

Cognitive processes are active. When we perceive and encode events in the world, we construct (rather than copy) the outside world as we comprehend the events. If perceiving is a construction, then remembering the original experience involves a reconstruction. *Reconstructive memory* refers to the idea that remembering the past requires an attempt to reconstruct the events experienced previously. These efforts are based partly on traces of past events, but also on our general knowledge, our expectations, and our assumptions about what must have happened. As such, recollections may be filled with errors when our assumptions and inferences, rather than traces of the original events, determine them. Errors – false memories – constitute the prime evidence for reconstructive processes in remembering. Several different sources of error (inferences during encoding, information we receive about an event after its occurrence, our perspective during retrieval) exist. Contrary to popular belief, memory does not work like a video recorder, faithfully capturing the past to be played back unerringly at a later time. Rather, even when our memories are accurate, we have reconstructed events from the past.

In sum, reconstructive memory refers to the idea that retrieval of memories does not occur in some completely accurate form, as a video might replay a scene, but rather that recollection of memories involves a process of trying to reconstruct past events. Although the reconstruction can be quite accurate, the processes responsible can also introduce errors during retrieval. In fact, systematic errors in memory are the primary evidence for its reconstructive nature. This article provides an overview of the evidence that remembering is reconstructive.

Background

The hypothesis that remembering should be viewed as reconstructive dates to an important book by Sir Frederic Bartlett (1932). Bartlett contrasted veridical, rote forms of memory, such as reproducing a telephone number – which he called *reproductive memory* – with reconstructive memory and argued that the latter was a more typical use of memory outside laboratory and educational circumstances. That is, we are rarely faced with the task of remembering something exactly the way it happened; more frequently, we need only to get the essence of the event right. If a friend asks, "What did Kathleen say last night?" the request is not for a literal rendering of last night's conversation, but rather for the gist of what she said.

Bartlett argued that perceiving and comprehending events do not simply happen automatically, but that every event of comprehension involves the mental construction of one's understanding of the event in the world. In cases of ambiguous or difficult events, we can struggle with an "effort after meaning" in comprehending (as when you overhear a puzzling conversation and have to retrieve some relevant context to understand it). If encoding or perceiving is a construction, then when one wants to recall the events later, the attempt requires the reconstruction of the event.

Bartlett argued that remembering is guided by schemas, or general organizing structures, which aid encoding and guide retrieval. If you see a scene at the beach and are asked to recall it later, you might recall seeing a beach umbrella even if none was present in the actual scene itself, because an umbrella is consistent with the general schema of items that belong in a beach scene. Therefore, although schemas can aid encoding and guide retrieval, they can also lead to errors.

According to the standard textbook account, certain forms of remembering are reconstructive (remembering your time in the sixth grade) whereas others are reproductive (remembering a phone number or your favorite poem). However, a large amount of research is consistent with the idea that nearly all remembering is reconstructive. In fact, reconstructive memory appears to occur even when the reconstruction is quite accurate (Gallo, 2006; Roediger and McDermott, 1995). This article considers various forms of memory as they are experimentally studied and discusses evidence for reconstructive processes at work.

Sensory and Short-Term Memory

The greatest challenge to the claim in the previous paragraph, that all remembering is reconstructive, may come from studies of sensory memory, defined as the borderline between perceiving and remembering. Many theorists have argued that perceiving is itself a constructive activity, with the fascinating phenomena of visual and auditory illusions used as evidence

for this claim (see Hoffman, 1998; among many others). Sensory memory refers to the temporary persistence of information that has struck the senses, which lingers briefly as it is being comprehended. Visual persistence is called iconic memory and auditory persistence is labeled echoic memory. It would seem that iconic memory – essentially a fleeting afterimage of the scene from the outside world – would surely be a form of reproductive memory. Yet even in these situations errors arise, showing that the retrieval processes from this type of memory involve reconstruction. For example, in Sperling's (1967) studies of iconic memory, in which people had to report letters that they had briefly seen on a screen, a common error when people missed a letter was to report another letter that either looked like or sounded like the original letter. This type of error indicates that people may code even such simple items as single letters into visual patterns and associated sounds. When people miss a *b* in these experiments, they may substitute a *v* (which sounds like *b*) or a *p* or *d*, which share both similar appearance (a long line and a curve) and similar sound (the letters rhyme with *b*). In sum, even reports from iconic memory may show reconstructive tendencies.

Short-term and working memories last longer than sensory memories do, but people are still ordinarily accurate in retrieving information from short-term stores if no interference occurs. Does this accuracy reflect a rote, reproductive process? The answer seems to be no, because when the short-term memory system is challenged by having people operate under, for example, fast rates of presentation, errors occur. Errors are often (but not always) phonological in nature. That is, if someone tries to recall letter strings and misses a letter, similar sounding letters are confused (Conrad, 1964). In the case of words, those that share visual and phonemic (sound-based) features are confused (Crowder, 1976; Chapter 4). Therefore, even though short-term memory processes are often considered quite accurate (and they can be), recall in these situations typically occurs under conditions that make for accurate reconstructions (e.g., with short unfilled delays between study and test). Stress these systems by presenting material quickly, or by creating interference, and the characteristic error pattern indicative of a reconstructive process appears.

Long-Term Memory

By far the greatest amount of research on reconstructive memory has occurred in the domain of long-term, episodic memory. Many different kinds of experiments have been conducted and we will consider some of the main types here, which have used a wide variety of materials: word lists, pictures and scenes, sentences, prose passages, and videos. Research with all these materials reveals remembrance to be quite prone to error and filling in the gaps.

Word Lists

Roediger and McDermott (1995) developed a paradigm in which people heard lists of 15 words that were generated as associates to another word, which was not itself presented.

For example, subjects heard the list "hot, snow, warm, winter, ice, wet, frigid, chilly, heat, weather, freeze, air, shiver, Arctic, frost." All these words are associated to the word 'cold,' which was the word that generated the list (all the items in it were associates to 'cold'), but 'cold' was not presented. Immediately after hearing the list, subjects were asked to recall the items and were urged to be sure that the words they recalled had been presented in the list. Despite this warning not to guess, Roediger and McDermott found that their subjects recalled missing words like 'cold' at very high levels; in fact, the probability of recalling the critical item often equaled the probability of recall of the list items. After recall of many lists, subjects received a recognition test in which they were instructed to pick out only items that had actually appeared earlier in the experiment. The test included words from the lists (winter, chilly), completely unrelated words (automobile), and the critical words such as 'cold.' Subjects examined each word and, if they judged it to be old (i.e., studied), they were asked to make a remember/know judgment. This judgment (Tulving, 1985) asks people to report if they can remember the moment of the item's occurrence in the study list (a remember judgment) or if they just know it was on the list but cannot remember its moment of occurrence (a know judgment).

The recognition results are shown in Figure 1, where it can be seen that subjects were good at distinguishing studied words from unrelated lures or distracters. However, the critical lures such as 'cold' were recognized with the same likelihood as were the words in the list, about 80% of the time. In other words, people were just as likely to recognize the related but non-studied words as they were items in the list. In addition, subjects claimed to remember the moment of occurrence (as measured by remember judgments) of the critical words (that, of course, were not actually presented) at the same level as for the words that were actually studied. In short, in this paradigm subjects were just as likely to recall, recognize, and claim to remember the occurrence of words that were never presented as words that really were presented, which provides a compelling demonstration of illusory memory. The implication is that subjects reconstruct the list using their general knowledge and insert a specific memory – they remember 'cold' as having occurred – because it fits with the general theme or schema of the list.

The previous example demonstrates how reconstructive memories can be demonstrated with associative lists, but these memories can also be shown for semantic categories, as well. A chapter by Roediger et al. (2012) discusses work by Roediger and colleagues (Meade and Roediger, 2006, 2009; Roediger and DeSoto, 2013), who had subjects study category members belonging to different semantic categories (e.g., vegetables). Subjects studied 15 members from each category that were neither the most typical members of the category (e.g., carrot, lettuce, etc.) nor atypical (e.g., 'artichoke'). They were words like 'corn,' 'spinach,' and others. On a subsequent recognition test, however, subjects were highly likely to recognize highly typical category members that were never presented (e.g., carrot). These false memories were often accompanied by extremely high confidence – subjects were extremely certain that the highly typical category members were presented, even though they never were. Like the Roediger and
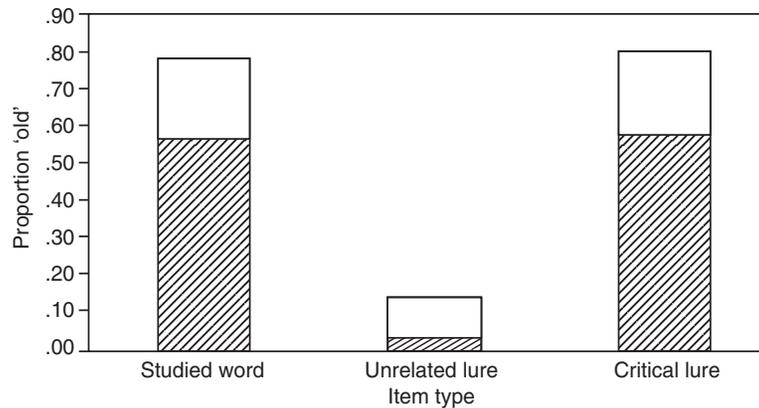
Figure 1 False recognition and false remembering. Mean probability of recognizing (total bar) and remembering (cross-hatched bar) studied words and lures. Unrelated lures were rarely recognized, but critical lures were recognized and remembered at about the same levels as studied words. People remember the occurrence of the critical items at the same level as words that were actually studied. Data reproduced from Roediger, H.L., McDermott, K.B., 1995. Creating false memories: remembering words not presented in lists. Journal of Experimental Psychology: Learning, Memory, and Cognition 21, 803–814 (Experiment 2).

McDermott (1995) study, this research provides evidence that semantic knowledge and schemas guide reconstructive processes that occur during remembering.

Prose Recall

A large body of research demonstrating reconstructive processes in retrieval has been carried out in prose recall. Brewer and colleagues (Brewer, 1977; Brewer and Sampaio, 2006; Brewer et al., 2005; Sampaio and Brewer, 2009) examined pragmatic implications in retention of sentences. A pragmatic implication is made when the person reading or hearing a sentence infers something that is neither explicitly stated nor logically implied by the sentence. For example, "The karate champion hit the cinder block" implies that the block was broken. However, this is a pragmatic implication; it is perfectly possible that the block was struck but not broken. After people studied sentences of this type mixed with other sentences, they were given the first parts of the sentences as cues to recall the entire sentence. Brewer (1977) showed that in recall of sentences with pragmatic inferences, people were more likely to recall the implied verb than the verb actually used in the sentence. When reconstructing the action, they remembered the champion as breaking the cinder block, not just hitting it. This result reflects a kind of inferential momentum, with people going beyond the literal truth of a statement to infer the events that probably occurred next. Often such inferences may be correct, but they are not necessarily so. When the inference is strongly made, but false, it can generate a false memory.

Sulin and Dooling (1974) also studied people's remembrance of implications as facts. In one case, they presented subjects with short paragraphs about a troubled girl and later tested for recognition both of ideas from the paragraph and of other ideas that had not been presented but that were either consistent or inconsistent with the theme of the passage. The paragraphs studied by two groups of

subjects were identical, with the exception of the name above the story. In one case it was Helen Keller and in the other case it was Carol Harris. One item on the recognition test asked subjects if the following sentence had appeared in the narrative: "She was deaf, dumb, and blind." Students who had read the story about Helen Keller frequently made the error of saying that this sentence had appeared in the passage, whereas those reading about Carol Harris almost never made this error. In trying to reconstruct whether the sentence may have been in the story, the knowledge about Helen Keller caused subjects to fill in what "must have been" in the story and led subjects erroneously to conclude that the sentence was there.

Sometimes people remember the sentences that were in a prose passage no better than sentences they have never read before, so long as the new sentences are consistent with the material that was actually presented. Bransford and Franks (1971) gave subjects short sentences such as "The rock rolled down the hill" or "The rock crushed the hut." There were four simple ideas like this that, when put together, would make up the complex sentence: "The rock rolled down the hill and crushed the tiny hut." The experimenters gave their subjects various sentences to build up the complex idea unit. They later tested subjects by asking them to pick out sentences they had actually studied from among other sentences. Two types of distractor sentences were used: some were consistent with the idea unit but had not been studied, whereas other sentences were unrelated to the idea unit. The test sentences themselves could vary in the number of idea units present, from one to four. Subjects rated their belief that the sentences had been previously studied on a 10-point scale, from −5 (sure the sentence was new or nonstudied) to +5 (sure the sentence was old or studied).

The sentences that were not consistent with the idea units were accurately rejected as not having been studied, but the results for the other two types of items (shown in Figure 2) reveal that the more idea units embedded in the test
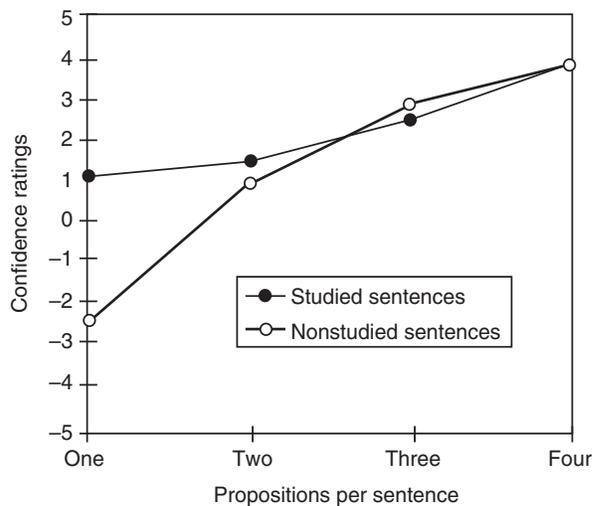
Figure 2 Mean recognition ratings for studied and nonstudied sentences as a function of number of propositions per sentence. Subjects could not distinguish sentences actually presented from those that had not been presented but that were consistent with the ideas. Data reproduced from Bransford, J.D., Franks, J.J., 1971. The abstraction of linguistic ideas. Cognitive Psychology 2, 331–350.

sentence, the higher the confidence rating that the sentence had been studied. Interestingly, this relation held both for sentences that had been studied and for new, nonstudied, sentences that were consistent with the overarching idea unit. Remarkably, except for sentences expressing only one idea, subjects were equally confident when recognizing the sentences that had not been presented in the study phase as when recognizing those that had been presented! Therefore, consistent with Bartlett's ideas, people seemed to retain the meaning of the sentences, but did not retain the literal wording of the sentences.

Bartlett (1932), who began this tradition of work, was interested in repeated recollection of material. He presented subjects with a Native American folktale, *The War of the Ghosts*, which he had them read twice. The story is a bit disjointed, has supernatural elements, and is rather difficult to understand. He found that subjects frequently made errors in recalling the story and that these errors increased over repeated retellings of the story. The stories got shorter, reflecting forgetting, but more importantly for present purposes, the story changed in systematic ways by subjects introducing errors that served to rationalize its bizarre elements. For example, people might have 'remembered' elements that had not been present to explain some of the unusual features in the story. Interestingly, this tendency to rationalize – to reconstruct the story more in line with the subject's own schema – seemed to grow over time and repeated retellings. Although Bartlett's original studies were rather informal, the work has been replicated under more systematic conditions (Bergman and Roediger, 1999).

Pictures and Scenes

Reconstructive memory has also been shown with common pictorial scenes (Miller and Gazzaniga, 1998;

Weinstein and Shanks, 2010). Miller and Gazzaniga (1998) developed a procedure that used scenes that had once been covers of the *Saturday Evening Post* magazine. They showed people the scenes with a critical object from the scene removed. To use our earlier example, people might view a beach scene with a beach umbrella either present in the scene or absent from it. Miller and Gazzaniga found that when people were given recognition tests on objects in the scene, they were very likely to recognize the object as having been present when in fact it was not. Again, in reconstructing the scene, the object was inserted and seemed part of the memory.

The Misinformation Paradigm

One of the most popular paradigms for studying reconstructive processes in memory was developed by Elizabeth Loftus and her colleagues (Loftus et al., 1978) and is called the *misinformation paradigm*. It is modeled after the events that an eyewitness to a crime might experience. In the lab, subjects view a set of slides or video depicting an event, then later read a narrative or answer questions about the event. In Loftus et al. (1978), subjects witnessed an automobile accident that occurred at an intersection where a car failed to stop at a stop sign. In the later series of questions, subjects were asked either one of three questions: "Did the car stop at the traffic sign?" (control condition), "Did the car stop at the stop sign?" (consistent information condition), or "Did the car stop at the yield sign?" (inconsistent or misleading information condition). This question served as the experimental manipulation for a question asked at a later point in time: "What kind of sign was at the intersection, stop or yield?"

Results of this experiment are shown in Figure 3, where it can be seen that, relative to the control condition in which the question was posed in a neutral manner, wording of the question that was consistent with the original information improved recognition whereas the conflicting information reduced recognition. This last finding is the misinformation effect – incorrect information received after an event is often incorporated into one's memory for the event. This misinformation effect has been demonstrated in many experiments, although the magnitude of the effect depends on the exact nature of the test.

The general principle to arise from experiments on the misinformation effect is that memory for an event is not encapsulated in time the way the event itself is. Rather, information provided after the event can modify our memories for the event itself. Consistent information improves our later reconstruction, whereas conflicting or misleading information is harmful. When we try to reconstruct events from our past, we draw on all the information and resources at our disposal and the reported memory may include 'facts' that were not really part of the event, but incorporated into it later. Practically, if police or other people ask suggestive questions or embed erroneous information into questions asked of witnesses after the event, then the witnesses' later recollections and testimony might be tainted.
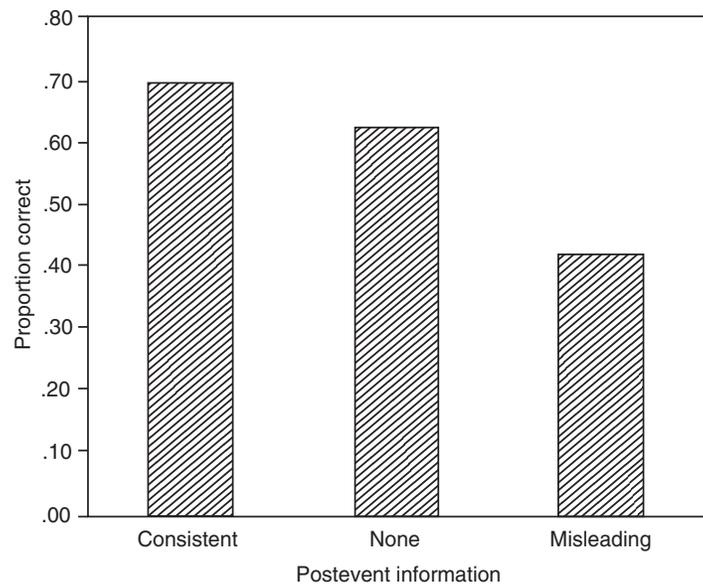
Figure 3   Probability correct (on a two-alternative forced choice recognition test) as a function of whether subjects had received information consistent with what they had previously seen, information inconsistent with what had been seen, or no specific postevent information. Misleading information after the event can reshape memory for the event. Data reproduced from Loftus, E.F., Miller, D.G., Burns, H.J., 1978. Semantic integration of verbal information into a visual memory. Journal of Experimental Psychology: Human Learning and Memory 4, 19–31 (Experiment 2).

Conclusion

This article has reviewed selectively some key evidence that permits us to draw the conclusion that remembering the past should be viewed as reconstructing it. To draw on a metaphor from Hebb (1949), we can think of the process of remembering the past as we conceive of paleontologists' reconstruction of a dinosaur from bone fragments and chips. The archeologist recovers a partial skeleton, but the finished product in a museum is shown as complete, with new bones added, old ones refinished or enhanced, and the entire skeleton reconstructed based on knowledge of what the animal probably looked like. Similarly, Hebb (1949) argued, remembering the past involves recollection of specific facts and details (the bones and bone chips) that are woven together into a complete story of the event (like the skeleton). However, the story about the event might involve considerable constructive activity on the part of the rememberer. A person's present knowledge and goals may shape and determine how he or she remembers the past. A quote from Bartlett captures the essence of this reconstructive approach:

> … the one overwhelming impression produced by this more 'realistic' type of memory experiment is that human remembering is normally exceedingly subject to error. It looks as if what is said to be reproduced is, far more generally than is commonly admitted, really a construction, serving to justify whatever impression may have been left by the original. It is this 'impression,' rarely defined as with much exactitude, which most readily persists. So long as the details which can be built up around it are such that they would give it a 'reasonable' setting, most of us are fairly content, and we are apt to think that what we have built we have literally retained. (Bartlett, 1932: pp. 175–176)

See also: Episodic Memory; Eyewitness Testimony; False Memories; Recognition; Retrieval; Source Monitoring; Visual Memory, Psychology of; Working Memory, Psychology of.

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