Tricks of Memory

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Abstract

Remembering an episode from even the recent past may involve a blend of fiction and fact. We discuss a straightforward laboratory paradigm that is proving useful in the study of false memories of simple episodes. In this paradigm, subjects study lists of 15 related words (*bed*, *rest*, *awake* . . .) that are all related to a critical word that is not presented (*sleep*). Later, subjects recall and recognize the critical missing word with about the same probability that they remember words from the list. This memory illusion is resistant to people's attempts to avoid it. We argue that similar memory errors are commonplace and are a natural outcome of an intelligent cognitive system, which makes inferences about incoming information. Therefore, memory illusions, like perceptual illusions, are a consequence of normal human information processing and offer a window for examining basic cognitive processes.

Keywords

memory; false memory; memory illusions; illusions; associative errors

There are two fundamental errors of remembering: forgetting events that occurred previously and remembering those that did not occur (or remembering them differently from the way in which they occurred). The first error, forgetting, hardly needs documentation; the experience is embarrassingly familiar to everyone. The other major class of memory errors, errors of commission, strikes most people as a curious one: How could a memory that seems vivid and clear be anything but accurate?

This article focuses on these tricks of memory. Sources of error can arise at several stages in the encoding-storage-retrieval sequence. People can perceive (and therefore encode) events differently from the way they occur; stored memories can be influenced by intervening events; and conditions during the retrieval stage can lead to reports that bear little relation to the original occurrences.

We believe that distortions of memory provide a fertile ground for studying interesting and important psychological phenomena. The experimental techniques used to induce illusory memories have typically involved the presentation of complex material (e.g., prose or videotapes), the introduction of misleading information between the time when the material is first presented (the study phase) and the time when memory is tested (the test phase), and the use of long delays between study and test (see Roediger, 1996). The work described here provides a new procedure for inducing illusory memories. This procedure differs from typical ones used in false memory research in that it uses a standard list-learning paradigm, no misleading information, immediate testing, and warnings to subjects to be cautious and accurate. Despite these features, the illusory memories obtained are among the strongest ever reported in the literature on human memory.

AN ASSOCIATIVE MEMORY ILLUSION

In our first studies (Roediger & McDermott, 1995), we created illusory memories by adapting a procedure used by Deese (1959) for other purposes. In our typical experiment, subjects hear lists of 15 words presented at the rate of 1 word every 1.5 s. Each list consists of a set of words associated to a single word that is not itself presented. For example, subjects may hear *bed*, *rest*, *awake*, *tired*, *dream*, *wake*, *snooze*, *blanket*, *doze*, *slumber*, *snore*, *nap*, *peace*, *yawn*, and *drowsy*; immediately afterward, they are asked to recall the list. The subjects are instructed not to guess—to be certain that they recall only items that were actually on the list. In this example, the list words are all associates of *sleep*, which does not appear on the list. The results from one experiment (averaged over 24

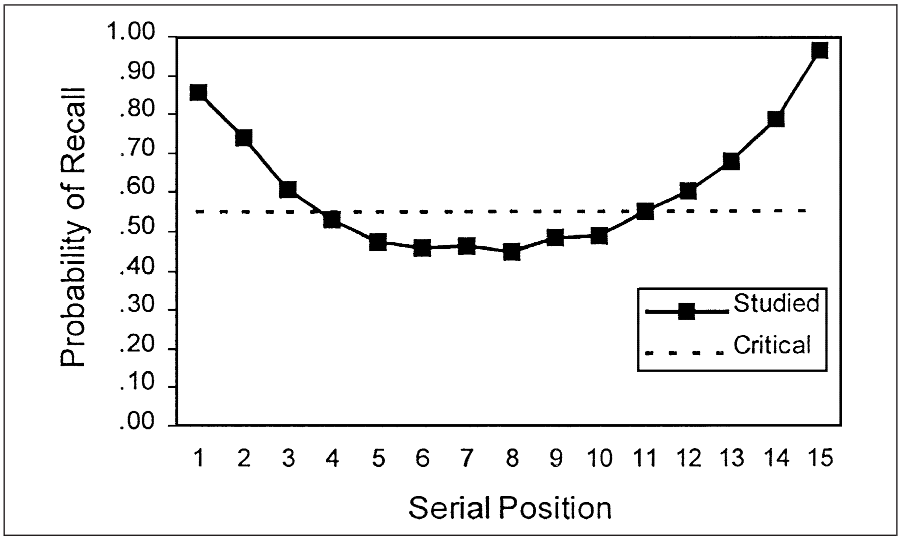

Fig. 1. Example of results from an experiment testing recall of semantically associated words presented in lists. The probability of accurate recall is graphed as a function of serial position in the list (solid line). The dashed line shows the probability that a nonpresented word associated with the list words was falsely recalled (from Roediger & McDermott, 1995, Experiment 2).

such associative lists) are shown in Figure 1. The graph shows strong primacy and recency effects, or high probabilities of recall of words from the beginning and the end of the lists. However, the most striking finding is represented by the dashed line, which indicates the level of recall for the critical nonpresented words (e.g., *sleep*) from which the lists were derived. The probability of recall of these missing words was somewhat greater than the probability of recall of words that actually had been presented in the middle of the lists!

After subjects had studied and recalled numerous lists, they were given a recognition test in which studied items were mixed with two types of nonstudied words (often called lures or distractors): the critical items (e.g., *sleep*) and unrelated distractors (e.g., *spider*). Subjects classified each word as *old* (studied) or *new* (nonstudied). If they classified a test word as old, they made a further judgment: whether they remembered or just knew the item had been studied (Tulving, 1985). That is, if they could recollect something specific about the moment of occurrence of the word during list presentation, they were to assign a *remember* judgment to the test word. If they knew the word had been in the list but could not recollect its exact moment of occurrence, they were to assign a *know* judgment.

Results for the three types of items (studied, unrelated nonstudied, and critical nonstudied) are shown in Figure 2. Examining the two left-most bars reveals no surprises: About 80% of the studied words were recognized, and most of these words were deemed to be remembered (the shaded part of the bar) rather than known (the white part). For unrelated lures, the false alarm rate (i.e., the frequency of recognizing them even though they were not presented) was low, and most of these falsely recognized words were deemed to be known, not remembered. This latter result makes intuitive sense in that there was no original event to be remembered. The right-most bar shows recognition of critical items like *sleep*; the false alarm rate for these words approximated the hit rate (i.e., rate of correct recognition) for studied items (i.e., about .80). In addition, subjects claimed to remember (i.e., to vividly recollect) the presentation of these words as frequently as they did items that had been studied! This procedure demonstrates robust false remembering because subjects are saying not simply that a critical word seems familiar, but that they actually remember some specific aspect about the moment of its occurrence.

MANIPULATING THE FALSE MEMORY EFFECT

How robust is the illusion? If subjects are informed about the effect, can they prevent its occurrence? The instructions we used in the original experiments, widely adopted by other researchers, caution subjects to be accurate. However, we and other researchers have subsequently gone further and fully informed subjects as to the nature of the false memory phenomenon, even giving a sample trial. In a recent study (McDermott & Roediger, 1998), we gave such instructions and then tested recognition when the critical items (like *sleep*) were sometimes present in the list and sometimes not. Subjects who were informed about the nature of the false memory phenomenon and instructed to attempt to avoid it did reduce both their hit rates and their false alarm rates (i.e., they became generally more cautious). However, the decrease in the false alarm rate was somewhat greater than the decrease in the hit rate, which indicates that subjects (to some extent) can selectively attenuate the effect. Nonetheless, informing subjects about the nature of the effect and asking them to avoid false recognition does not come close to eliminating the effect.

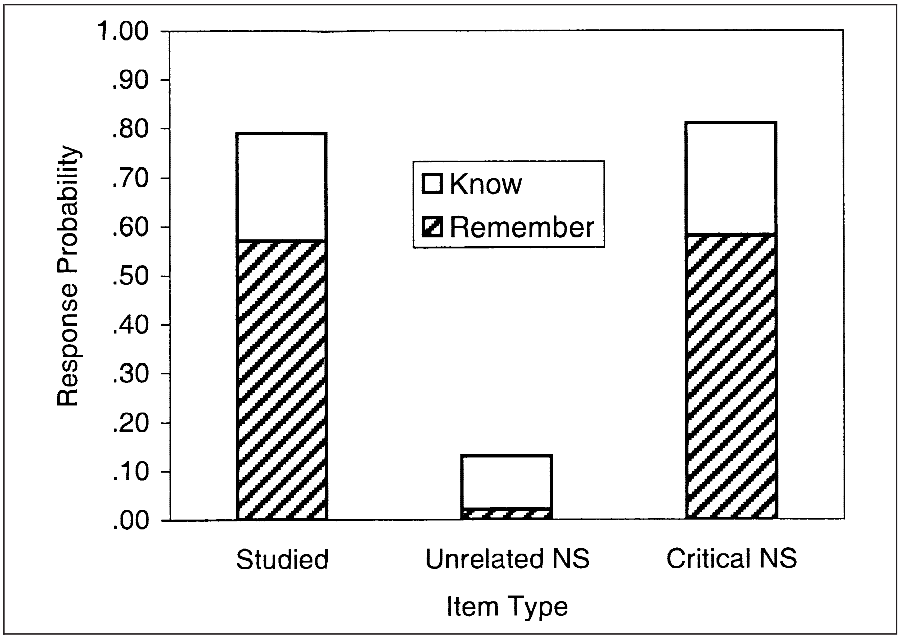

Fig. 2. Recognition performance for studied words, unrelated nonstudied (NS) words, and critical nonstudied (NS) words (from Roediger & McDermott, 1995, Experiment 2). Subjects indicated whether they remembered studying or simply "knew" they had studied each item they classified as "old."

Another technique that might be expected to reduce the false memory effect is simply to make memory for the list items very accurate by some experimental manipulation. One might imagine the effect would then decrease, because it seems reasonable to assume that more accurate recall of events would decrease errors. However, some reflection (and some theories) can also lead to the opposite prediction: If the processes involved in list recall are the same as those that cause false recall, then increasing list recall should make it more likely that the critical lure will be activated and recalled.

There is no simple answer to the question of how accurate and illusory memories are related: Both positive and negative correlations between veridical and false recall or recognition have been reported—even in the same experiment. For example, in McDermott's (1996) Experiment 2, one variable increased both veridical and false recall, whereas another variable increased veridical recall and decreased false recall. Clearly, the relations between veridical and false recall (and veridical and false recognition) are complex and represent a crucial puzzle for theories of the false memory phenomenon.

INDIVIDUAL DIFFERENCES

Another interesting arena of research concerns individual differences among people in susceptibility to the false memory effect. Balota et al. (1999) tested patients diagnosed with early stages of Alzheimer's disease, which has a pernicious effect on remembering. These subjects were compared with healthy older and younger adults in a simplified version of the paradigm. As shown in the white bars in Figure 3, older adults recalled fewer list items than did younger adults, and Alzheimer's patients recalled fewer still. Of course, this outcome is not a surprise because it is well known that free recall is worse in older adults than younger adults and that Alzheimer's disease has a profound negative effect on memory for episodes. The interesting pattern in the figure is in the probability of false recall of critical items, shown in the shaded bars. Despite the older adults' and Alzheimer's patients' sharp decrease in accurate recall relative to younger adults, false recall of critical items was approximately equivalent across subject groups. Older adults and Alzheimer's patients actually showed a slight increase in false recall, and other researchers have also reported an increased tendency to false recall for older adults relative to young adults.

Other studies reveal interesting patterns involving other individual difference variables. For example, Winograd, Peluso, and Glover (1998) showed that self-reports of high degrees of dissociative experiences, hypnotizability, and vivid mental imagery correlated with enhanced false recall and false recognition. In addition, women who believed they had recovered once-repressed memories of abuse were reported to exhibit greater false recognition than control subjects (Clancy, Schacter, McNally, & Pitman, 2000). In sum, there is growing evidence that the tendency to exhibit false memories varies as a function of individual differences.

ACTIVATION-MONITORING THEORY

Probably the most widely endorsed theory of this associative memory illusion is some version of an activation-monitoring account, which was discussed in our original report (Roediger & McDermott, 1995). While subjects listen to a list, the critical nonpresented item may

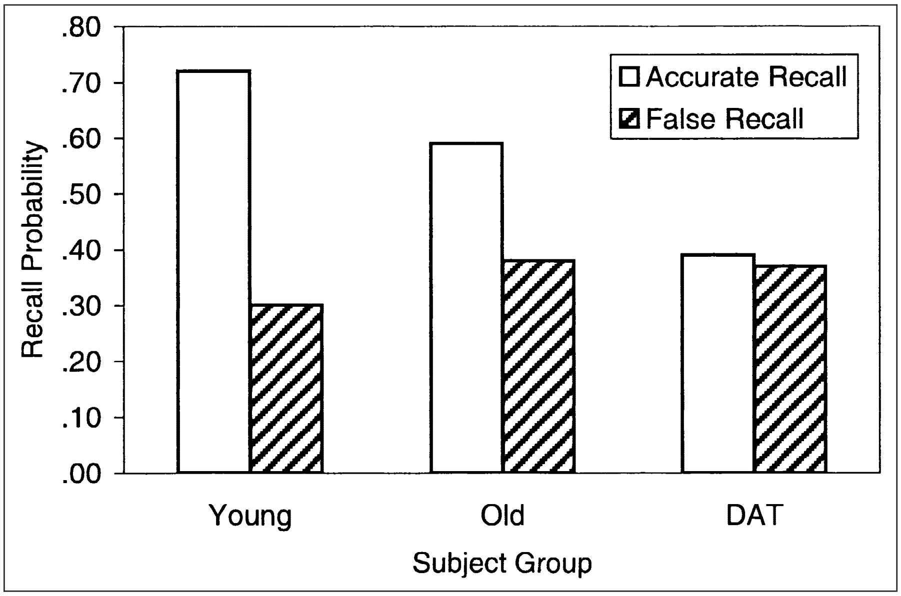

Fig. 3. Probability of veridical and false recall for young and old subjects and patients with Alzheimer's disease (Dementia of the Alzheimer Type, or DAT; from Balota et al., 1999).

be mentally activated, coming to mind either consciously (with the person thinking *sleep*) or unconsciously (a representation of *sleep* may be activated without coming consciously to mind). In some sense, the 15 list items prime the concept of sleep (Roediger, Balota, & Watson, in press). If the critical item is repeatedly aroused during study, then at retrieval subjects are faced with a classic reality-monitoring problem (Johnson & Raye, 1981): "Did I hear *sleep*, or does it seem familiar for some other reason?" According to this activation-monitoring framework, processes for both encoding and monitoring retrieval must be specified to explain the illusion.

There is considerable evidence for the applicability of activation theories in understanding this associative illusion, although other perspectives are also quite promising (e.g., Reyna & Brainerd, 1995). For example, McDermott (1997) showed that presentation of the associative lists used in our previous work creates priming on perceptual implicit memory tests. That is, when asked to complete word stems (e.g., "sle-") or word fragments (e.g., "s l _ _ p") with the first word that came to mind, subjects responded with "sleep" more often if they had seen the list related to this word (i.e., *bed*, *rest*, *awake*, etc., but not the word *sleep* itself) than if this list had not been presented. Because verbal perceptual implicit memory tests show priming only following lexical activation of words, these results suggest that the false memory phenomenon is partly due to conscious activation of the critical words during list presentation. Such conscious activation would also explain the very high levels of *remember* responses to the critical lures on recognition tests: Subjects remember the experience of hearing a critical word because the concept consciously came to mind during list presentation.

The importance of retrieval factors has been highlighted by other reports. For example, Israel and Schacter (1997) showed that if studied items are made distinctive, then retrieved words that bear no specific marks of distinction may be rejected as lures. They presented some lists of words auditorily, as in the standard paradigm, but in other lists they showed a picture when each word was heard (e.g., a picture of a bed as people heard the word "bed'). They found that false recall was reduced in the latter condition, presumably because during recall subjects could reject items such as *sleep* as having occurred on the list if they could not remember a picture having been presented at the same time. In short, a growing body of evidence is consistent with an account drawing upon both activation and monitoring processes.

IMPLICATIONS

Our paradigm for studying false memories has been faulted by some researchers as being artificial and unlike conditions in which false memories are likely to arise in the outside world. However, in our opinion, this paradigm captures one prevalent source of false memories that arise routinely. Whenever people engage in conversation, listen to a talk, read a newspaper article, or watch a television program, they recode events from the outside world as they try to understand them. By "recode," we mean that people interpret events and make inferences about them on the basis of their past experience. Part and parcel of the recoding process is activation of a person's own knowledge structures, or schemata (Bartlett, 1932). The information may spark related thoughts, and these thoughts may later be remembered as having been made as explicit statements. Our paradigm provides a tractable laboratory situation for studying the cognitive processes creating these sorts of false memories. Memories are not recordings but rather recodings; that is, they are not audio or video recordings but a recoded blend of events from the external world, as interpreted by each person's unique schemata.

CONCLUSION

Does the fact that false memories can be easily created mean that humans are irrational, or have disturbingly poor memories? We think not. Although memories are prone to errors in predictable ways, these can be viewed as intelligent errors, or errors made by an intelligent cognitive system. Part of what makes humans clever is the ability to make inferences. People make inferences routinely in comprehending their surroundings, and these inferences are a critically important feature of human cognition. The fact that such inferences can lead one astray, and that people can recollect vividly events that they only inferred, is a small price to pay for the inventiveness and adaptiveness of the human mind.

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Note

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