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# Memory Distortion

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## INTRODUCTION

In a 1992 op-ed piece for the New York Times, Garry Trudeau recollected some of his experiences related to the draft for the Vietnam War. Trudeau remembered receiving calls of concern from friends and family on the night of the draft lottery, after they had heard about his low number. He then recalled a series of events involving his attempts to gain a draft deferment: requesting a national security deferment from the draft board for his work with a magazine; deciding not to apply for conscientious objector status because he could imagine circumstances in which he would take another's life; preparing for his interview with the draft board by receiving a "memorable haircut"; and finally, gaining a medical deferment from the board after sending them, upon his physician father's advice, X-rays revealing a past ulcer. This recollection, he reported, remained unchanged for 20 years.

However, after talking to others and examining the records of his draft correspondence, Trudeau uncovered some notable discrepancies between his recollection and what actually happened. No family member or friend remembers making a call of concern. Trudeau now believes he imagined their concerns, because the act of examining this recollection led him to remember that he was in fact out having a few beers that night. He discovered that he actually applied for an occupational deferment and, upon reflection, wonders how he could have believed that working for a "glorified travel magazine" was justification for a national security deferment. He also never received a "memorable haircut," and the actual reason he did not apply for conscientious objector status, was, in part because of the prohibitive paperwork.

Trudeau's misrecollection of his past is unsettling, but far from uncommon. As Marcia Johnson has asked: "To what extent is the life we remember, the knowledge and expectations we have, and the self we seem to ourselves to be, a product of experience and to what extent a product of our imagination?" (Johnson, 1985, p. 2). The answer to this question depends on understanding the properties of our memory systems that contribute to both distorted and veridical memories.

Cognitive psychologists have long focused on memory distortion, and have produced numerous findings and ideas that have increased our understanding of why memory is sometimes inaccurate (for reviews, see Johnson, Hashtroudi, & Lindsay, 1993; Roediger, 1996; Schacter, 1995, 1999b). Cognitive neuropsychologists, by contrast, have traditionally shown less interest in questions concerning accuracy and distortion in memory, focusing instead on such issues as multiple forms of memory (e.g., Gabrieli, 1998; Schacter & Tulving, 1994; Squire, 1992) and the nature of encoding and retrieval deficits in amnesic patients (e.g., Mayes & Downes, 1997). Although studies of such striking clinical phenomena as confabulation have long been of interest to cognitive neuropsychologists (for review and discussion, see Burgess & Shallice, 1996; Johnson, 1991; Moscovitch, 1995), there have been relatively few systematic experimental or theoretical attempts to apply a cognitive neuropsychological approach to phenomena of memory distortion.

During the past few years, however, the situation has begun to change: a new line of research concerning the cognitive neuropsychology of memory accuracy and distortion has emerged (for a collection of relevant papers, see Schacter, 1999a). These newer studies have attempted to examine memory distortion in brain-damaged patients with a view toward obtaining insights into basic mechanisms of accuracy and distortion in memory.

In this chapter we consider research that has explored various aspects of the cognitive neuropsychology of memory distortion. To provide a conceptual context for this discussion, we first outline a general framework for understanding the processes that contribute to constructive memory phenomena. We then focus on a particular type of memory distortion, referred to as *false recognition,* and consider how this phenomenon is influenced by factors operating primarily at the encoding or retrieval stages of memory. This approach allows us to integrate findings from both cognitive studies and neuropsychological investigations of patients with brain damage.

## A CONSTRUCTIVE MEMORY FRAMEWORK

Constructive memory phenomena are generally characterized by the acceptance of something occurring that did not occur, such as misrecollecting that John said something when in fact it was Tom (i.e., source confusion), or recognizing something as previously studied that is actually a new item (i.e., false recognition). Our view of constructive memory, which we refer to as the constructive memory framework (CMF; Schacter, Norman, & Koutstaal, 1998), draws on the ideas of several investigators, including Johnson et al. (1993), McClelland, McNaughton, and O'Reilly (1995), Moscovitch (1994), Norman and Schacter (1996), Reyna and Brainerd (1995), and Squire (1992), among others. This framework focuses on the important encoding and retrieval processes that contribute to both accurate and inaccurate memories.

When we encode an experience, such as talking with a friend in a café, the resulting memory representation will consist of a pattern of features constituting a record of the processes that were active during the experience. Some features, for instance, would represent the output of different sensory processes, such as the various sights, sounds, and smells in the café. Other features would reflect the output of conceptual processes, such as what we were thinking and feeling. This pattern of features is widely distributed across different parts of the brain, such that no single location contains a complete record of the trace or engram of a specific experience (Damasio, 1989; Squire, 1992). In short, the memory representation is this distributed pattern of features. Remembering this experience involves a process of reactivating the features making up the desired memory representation. Specifically, retrieval is a process of *pattern completion* (McClelland et al., 1995) in which a retrieval cue activates a subset of the features comprising a particular past experience, and activation spreads to the rest of the constituent features of that experience.

To produce largely accurate representations of past experiences, a memory system that operates in such a manner must solve several problems. At encoding, the features comprising an episode must be linked together to form a bound or "coherent" representation (i.e., *feature binding* process; see Johnson & Chalfonte, 1994; Moscovitch, 1994; Schacter, 1989). When the features of a memory are inadequately bound together because of factors like stress, distractibility, intoxication, and so forth, the individual may subsequently retrieve fragments of the memory without remembering how or when the fragments were acquired, a phenomenon known as *source memory failure* (Johnson et al, 1993; Schacter, Harbluk, & McLachlan, 1984, Squire, 1995). For instance, after inadequate feature binding a person might remember sitting in a café and not remember which friend she was talking to. Or conversely, she might remember the friend and not remember where she was talking. The binding process is the "glue" that holds the different features of the pattern or memory together. A closely related encoding process, sometimes referred to as *pattern separation* (McClelland et al., 1995), is required to keep bound episodes separate from one another. For instance, if an individual regularly meets a friend in a particular café then the memory representations for these different episodes will share many characteristics. The patterns comprising the separate memories of these episodes will overlap. If the patterns overlap extensively with one another, then the person may subsequently only recall the general similarities (Hintzman & Curran, 1994) or gist (Reyna & Brainerd, 1995) common to the many episodes. She may fail to recollect distinctive, item-specific information that distinguishes one episode from another, such as remembering what she was talking about with the friend on a particular day.

Similar kinds of problems arise when retrieving information from memory. Retrieval cues can potentially match stored representations other than the sought-after one (Nystrom & McClelland, 1992). For instance, if given the retrieval cue "having coffee with a friend" there could be countless memories that contain this characteristic and that would potentially be remembered. Thus, retrieval often involves a preliminary stage in which the rememberer forms a more refined description of the characteristics of the episode to be retrieved (Burgess & Shallice, 1996; Norman & Bobrow, 1979), referred to as a process of *focusing* (Norman & Schacter, 1996). Poor retrieval focus can lead to recollection of information that does not pertain to the target episode. It can also produce impaired recall of an episode's details when activated information from nontarget episodes interferes with recall of target information.

When we remember we complete a pattern that was initiated by the retrieval cue. What is remembered, however, is not simply an activated engram. The retrieved pattern of information is a product of the contributions of the retrieval cue and the stored memory representation. Once memorial information is successfully retrieved, a decision must be made about whether the activated information constitutes a veridical recollection of a previously experienced event, or whether it is a generic image, fantasy, or thought (Johnson & Raye, 1981). This phase of retrieval involves a *criterion setting* process: the rememberer needs to consider the diagnostic value of perceptual vividness, semantic detail, and other kinds of information for determining the origin of the retrieved pattern (Johnson et al., 1993). For instance, as Johnson and colleagues have emphasized lax criteria can contribute to source confusions, such as mistaking imagined ideas for actually perceived events. Occasionally, as in Gary Trudeau's recollection, exceptionally vivid false memories sail through this criterion phase.

Numerous brain regions are likely implicated in these and other aspects of memory. Two brain regions are especially relevant to constructive memory: the medial temporal area, including the hippocampal formation, and the prefrontal cortex. A widely shared view has begun to emerge regarding how the hippocampus implements feature binding and pattern separation (recently expressed by McClelland et al., 1995; see also Squire & Alvarez, 1995; Treves & Rolls, 1994). According to this view, distributed patterns of activity in the neocortex, constituting the memory representations for different episodes, are linked to sparse neuronal representations in region CA3 of the hippocampus, such that each episode is assigned its own hippocampal "index." To the extent that the hippocampus is able to assign nonoverlapping CA3 representations to different episodes, pattern separation is achieved and this will facilitate remembering distinctive characteristics about particular episodes. The medial temporal region also contributes to pattern completion at retrieval (cf. Moscovitch, 1994). According to McClelland et al. (1995), for instance, during retrieval of recent episodes (for which there is still a hippocampal index corresponding to the episode), cues activate the episode's index in region CA3 of the hippocampus, and activation spreads from the index to all the features comprising that episode. Once an episode has been consolidated in the neocortex, however, activation can spread directly between the episode's features, and the hippocampus no longer plays an important role in pattern completion.

Prefrontal cortex also plays a role in the retrieval of memories. Perhaps the strongest evidence comes from studies using neuroimaging techniques, which have consistently shown prefrontal activity during episodic retrieval, often in a right anterior frontal region (for reviews, see Buckner, 1996; Nyberg, Cabeza, & Tulving, 1996; Tulving, Markowitsch, Kapur, Habib, & Houle, 1994). Although the exact nature of the functions indexed by these activations remains open to debate, they appear to tap effortful aspects of retrieval (Schacter, Alpert, Savage, Rauch, & Albert, 1996a) related to focusing or entering the "retrieval mode" (Nyberg et al., 1995), postretrieval monitoring and criterion setting (Rugg, Fletcher, Frith, Frackowiak, & Dolan et al., 1996; Schacter, Buckner, Koutstaal, Dale, & Rosen, 1997), or both (Norman & Schacter, 1996).

In summary, CMF emphasizes encoding processes of feature binding and pattern separation, and retrieval processes of focusing, pattern completion, and criterion setting. Although problems with any of these processes can result in memory distortion, in this chapter we will mainly emphasize the encoding process of pattern separation and the retrieval processes of focusing and criterion setting. In addition, throughout this chapter we will refer to two broad categories of memorial information. The first is typically characterized as a *feeling of familiarity* that is based on some unidimensional variable resulting from the similarity of the familiar item to memory for other items (e.g., Gillund & Shiffrin, 1984; Hintzman, 1988; Humphreys, Bain, & Pike, 1989; Murdock, 1982), the frequency of prior exposure of the familiar item (e.g., Atkinson & Juola, 1974; Underwood, 1972), or the fluency of processing the recognized item (e.g. Jacoby & Dallas, 1981). The second, often referred to as *recollection*, is described as involving memory for more specific item information, such as multiple attributes of an event, a remembered event and the context in which it occurred, or an event and associated, elaborative information (e.g., Anderson & Bower, 1972, 1974; Gillund & Shiffrin, 1984; Humphreys, Bain & Pike, 1989; Mandler, 1980). As we will discuss, there is sometimes an opposition relationship between familiarity and memory for more specific item information (Jacoby, 1991), as when seemingly familiar items can be rejected when more specific information is remembered. However, as Trudeau's example illustrates, having a vivid recollection that is full of specific information, such as receiving a "memorable haircut," does not guarantee that the memory is accurate. Both recollection of specific information and more general familiarity can contribute to constructive memory phenomena (see Johnson et al., 1993).

## MEMORY DISTORTION AND FALSE RECOGNITION

One of the most frequently studied types of memory distortion is known as false recognition, which occurs when people claim incorrectly to have previously encountered a novel word, object, face, or event (e.g., Underwood, 1965). False recognition can occur because preexisting knowledge influences memory for new information (e.g., Alba & Hasher, 1983). For example, Arkes and Freedman (1984) examined the memory of individuals who were either experts or novices with respect to their knowledge of baseball. After reading a story about a baseball game both groups completed a recognition test about what they had read. Although the experts showed more accurate memory for neutral sentences (e.g., "Bench moved up to second base.") than did the novices, there was a cost to their knowledge. The experts were more likely than novices to falsely recognize statements that were synonymous with sentences in the story. For instance, if the story contained the sentence, "The Cubs' first and third basemen crept in close expecting a sacrifice," the expert would be more likely than the novice to falsely recognize a distractor sentence in which "sacrifice" was replaced with the synonymous word "bunt" for this situation. Apparently, in the act of comprehension (i.e., encoding) people go beyond the information that is provided and use their background knowledge to build a representation of the situation. Because this representation is not just a reflection of the external world, there is the danger of including information that was not part of the actual event. In terms of the CMF, the "bound" representation of the story includes both features that were present in the text as well as features that were imported from the person's background knowledge. As we will discuss in a later section, the features that are retrieved depend, in part, on both the cues used to query memory and the criteria used to assess the remembered information.

Extremely high levels of false recognition have been demonstrated recently in experiments using a paradigm initially developed by Deese (1959), and revived and modified by Roediger and McDermott (1995; see also Read, 1996). In the Deese/Roediger-McDermott (DRM) paradigm, people study lists of words (e.g., one list might consist of the words TIRED, BED, AWAKE, REST, DREAM, NIGHT, BLANKET, DOZE, SLUMBER, SNORE, PILLOW, PEACE, YAWN, and DROWSY) that are related to a nonpresented lure word (e.g., SLEEP). On a subsequent old–new recognition test containing studied words (e.g., TIRED, DREAM), new unrelated words (e.g., BUTTER) and new related lure words (e.g., SLEEP), participants frequently judge that they previously studied the related lure words. In fact, the false recognition rate of the related lure words is so high that it is typically equivalent to the correct recognition rate of studied words (Dodson & Schacter, in press; Mather, Henkel, & Johnson, 1997; Norman & Schacter, 1997; Payne, Elie, Backwell, & Neuschatz, 1996; Roediger & McDermott, 1995; Schacter, Verfaellie, & Pradere, 1996).

The CMF offers some potential explanations of this false recognition effect. First, false recognition of the lure words is a product of pattern separation failure. Studying many related words may produce unacceptably high levels of overlap among the corresponding memory representations. This failure to keep representations separate will result in good memory for what the items have in common but poor memory for the unique aspects of each item. Because subjects will have difficulty recollecting the characteristics of the specific studied items they will be forced to respond on the basis of overall familiarity or similarity of the lure item to memory for the studied items. Therefore, subjects will be likely to respond that a lure item was studied before since it matches so many of the representations. Second, the high false recognition rates of the lure items may be a result of the process of "implicit associative responses" (Underwood, 1965). That is, when people study the related words (e.g., BED, TIRED, etc.) they may generate on their own the new lure word (i.e., SLEEP). On the subsequent memory test people may experience source confusion with the lure words and mistakenly believe that they saw this word when in fact it was one that they had generated (e.g., Johnson et al., 1993). Although these two accounts are difficult to distinguish with the DRM paradigm, Koutstaal and Schacter (1997) have provided data that are consistent with the pattern separation failure account. After studying large numbers of pictures from various categories (e.g., cars, shoes, and so forth), participants often falsely recognized new pictures from the same categories as studied pictures. Koutstaal and Schacter reasoned that it is highly improbable that participants had generated the new related pictures in the same way that they might generate the word "sleep" when studying associated words in the DRM procedure. Instead, falsely recognizing new pictures seems to be a result of the high similarity among target items, producing robust memory for what the related items have in common but poor memory for specific items.

## FALSE RECOGNITION AND AMNESIA

As noted earlier, neuropsychological studies have only recently begun to examine systematically false recognition and related aspects of constructive memory (for a review see Schacter et al., 1998). In this section we focus on how studies of amnesic patients have contributed to our understanding of constructive memory. Patients with damage to the inner or medial regions of the temporal lobes and related structures in the diencephalon typically have difficulty remembering recent experiences, but they have normal perceptual and linguistic abilities along with IQ scores within the normal range (e.g., Parkin & Leng, 1993; Squire, 1992). Although much is known about amnesics' poor memory for events that actually occurred, little is known about amnesics' tendencies to experience false memories of events that did not occur.

To examine false recognition in amnesic patients, Schacter et al. (1996) used the DRM paradigm. Amnesics and control subjects studied lists of semantically related words (e.g., BED, TIRED, DREAM) and then completed a recognition test containing studied words (e.g., BED), new related words (e.g., SLEEP), and new unrelated words (e.g., POINT). Schacter et al. found that, as expected, amnesics recognized fewer studied items than did the matched controls. But amnesics also exhibited a lower false recognition rate of the related lure words than did the controls (see Melo, Winocur, and Moscovitch, 1999, for replication and extension). A follow-up experiment by Schacter, Verfaellie, and Anes (1997) demonstrated that amnesics' reduced false recognition of related lure items extends to perceptual materials. After studying perceptually related words (e.g., FADE, FAME, FACE, FAKE, MATE, HATE, LATE, DATE, and RATE) amnesics were less likely than controls both to correctly recognize studied words and falsely recognize perceptually related lure words (e.g., FATE). Apparently, for amnesics the same processes that support accurate recognition of studied words also contribute to the false recognition of critical lures.

In contrast to the preceding findings of reduced false recognition by amnesics in the DRM paradigm, an earlier study by Cermak, Butters, and Gerrein (1973) showed that amnesics produced *increased* levels of false recognition as compared to control subjects. In the Cermak et al. study, Korsakoff amnesics and alcoholic controls were presented a series of words and were instructed to indicate for each word whether or not they had seen it before in the list (i.e., a continuous recognition task). The key manipulation was that some of the new words were semantically or acoustically related to earlier words, such as initially seeing BEAR and then later seeing in the list the new lure word BARE. Cermak et al. found that amnesics were more likely than controls to falsely recognize the lure words (See Kroll, Knight, Metcalfe, Wolf, & Tulving, 1996, who also found that amnesics with either left or right hippocampal damage had higher than normal false recognition rates).

Why would amnesics have higher than normal false recognition rates in the Cermak et al. (1973) paradigm, but lower than normal false recognition in the DRM paradigm? In the Cermak et al. study, the number of items separating a word from its lure (i.e., the lag) may have been sufficiently small that control subjects recollected the initial study word when seeing the lure. For instance, when confronted with the new lure word BARE the control subjects may have recollected that they had earlier seen BEAR and, thus, concluded that although BARE is familiar it does not match the initially studied word. Amnesics, by contrast, are particularly deficient in reactivating earlier studied words (e.g., Johnson & Chalfonte, 1994). This deficiency may have prevented them from using recollection to counter the familiarity of the new lure word, and consequently, contributed to their higher than normal false recognition rate in the Cermak et al. paradigm.

By contrast, the amnesics' lower than normal false recognition rate in the DRM paradigm may have had less to do with recollective deficiencies and more to do with the processes that contribute to a related lure item's feeling of familiarity. Whereas in the Cermak et al. paradigm the new word (e.g., BARE) is related to a single studied word (e.g., BEAR), in the DRM paradigm the critical new word (e.g., SLEEP) is related to many studied words (e.g., BED, TIRED, etc.). A growing number of studies have shown that individuals with intact memory are more likely to falsely recognize a new item when they have earlier studied many rather than few items related to this new item (i.e., false recognition is directly related to category size) (e.g., Arndt & Hirshman, 1998; Koutstaal & Schacter, 1997; Robinson & Roediger, 1997; Shiffrin, Huber, & Marinelli, 1995). Thus, one contributor to the likelihood of falsely recognizing related lure items is the degree to which the lure item activates memory representations similar to it.

When normal controls are presented with a new lure word they may experience a strong sense of familiarity (or even feel that they can recollect earlier studying it) because this theme word activates the representations of so many earlier studied words. Amnesic patients, by contrast, encode or retain less information about the individual items on the list. In comparison to control subjects, amnesics are less likely to falsely recognize the theme word because it activates the representations of fewer associated words and/or they are activated less strongly.

In sum, different processes may contribute to the occurrence of false recognition in the continuous recognition task of the Cermak et al. (1973) study and in the DRM paradigm. The inability to recollect previously studied items likely contributed to amnesics' increased false recognition rate (relative to the control subjects) in the Cermak et al. study. But in the DRM paradigm, the amnesics' low false recognition rate is likely attributable to the reduced amount of activation (and therefore, familiarity) that is generated by the lure item. In this paradigm, since people are instructed to remember the studied words, the amnesics' inability to associate the related studied items, and construct an organized representation of the list may have diminished the activation generated by the lure items and therefore, produced the low false recognition rate. Subsequent experiments have further examined these processes in amnesics and controls by manipulating (a) the number of study/test repetitions in the DRM paradigm and (b) the number of studied items related to the lure item in a similar paradigm.

Schacter, Verfaellie, Anes, and Racine (1998) examined false recognition in the DRM paradigm by presenting amnesic patients (both Korsakoff and amnesics of mixed etiology) and matched controls with lists of associated words, testing their memory for the lists, and then repeating this study and test cycle with the same lists five times (i.e., five different trials). As seen in panels A and C of Figure 18.1, with repeated study and testing both amnesics and controls correctly recognized increasingly more studied words. False recognition rates to the related lure words are presented in panels B and D of Figure 18.1. As shown in these panels, control subjects falsely recognized fewer related lure words across the five study-test trials (see also McDermott, 1996). By contrast, the Korsakoff amnesic patients falsely recognized increasingly more related lure words with repeated study and testing (see panel B), whereas the mixed amnesic patients showed fluctuating levels of false recognition across trials (see panel D). With repeated study and testing, the controls presumably encoded more distinct features of the individual words on the lists. Put in terms of the CMF, the representations of the words overlapped less and less with repeated study and testing; there was more pattern separation. Greater pattern separation heightened the probability that the control subjects recollected the studied words, and thus increased the recognition rate for these words. In addition, with better pattern separation for the studied words these subjects were more likely to notice a difference between the studied words and the related lure word, resulting in a diminished false recognition rate across trials. For instance, after repeated study and testing control subjects may reject the related lure word SLEEP because they remember studying TIRED, DREAM, and PILLOW and so forth and they do not remember studying SLEEP. In short, with repetition of the study and test lists the healthy controls used their increasingly better memory for the studied words to reject the related lure words.

By contrast, the higher levels of false recognition across trials by the Korsakoff amnesics indicate that they were not able to use memory for the studied items to suppress false recognition responses of the lure words. Instead, repeated study and testing likely allowed the Korsakoff amnesics to form additional memory representations of the studied items (and enrich existing ones). But repetition did not increase the pattern separation amongst the memory representations; apparently, they still overlapped considerably. Consequently, the Korsakoff amnesics falsely recognized increasingly more lures with repeated study and testing because of the activation of increasingly more memory representations. And, importantly, these amnesics were not able to counteract the occurrence of false recognition by remembering specific item information since the memory representations of the studied items overlapped

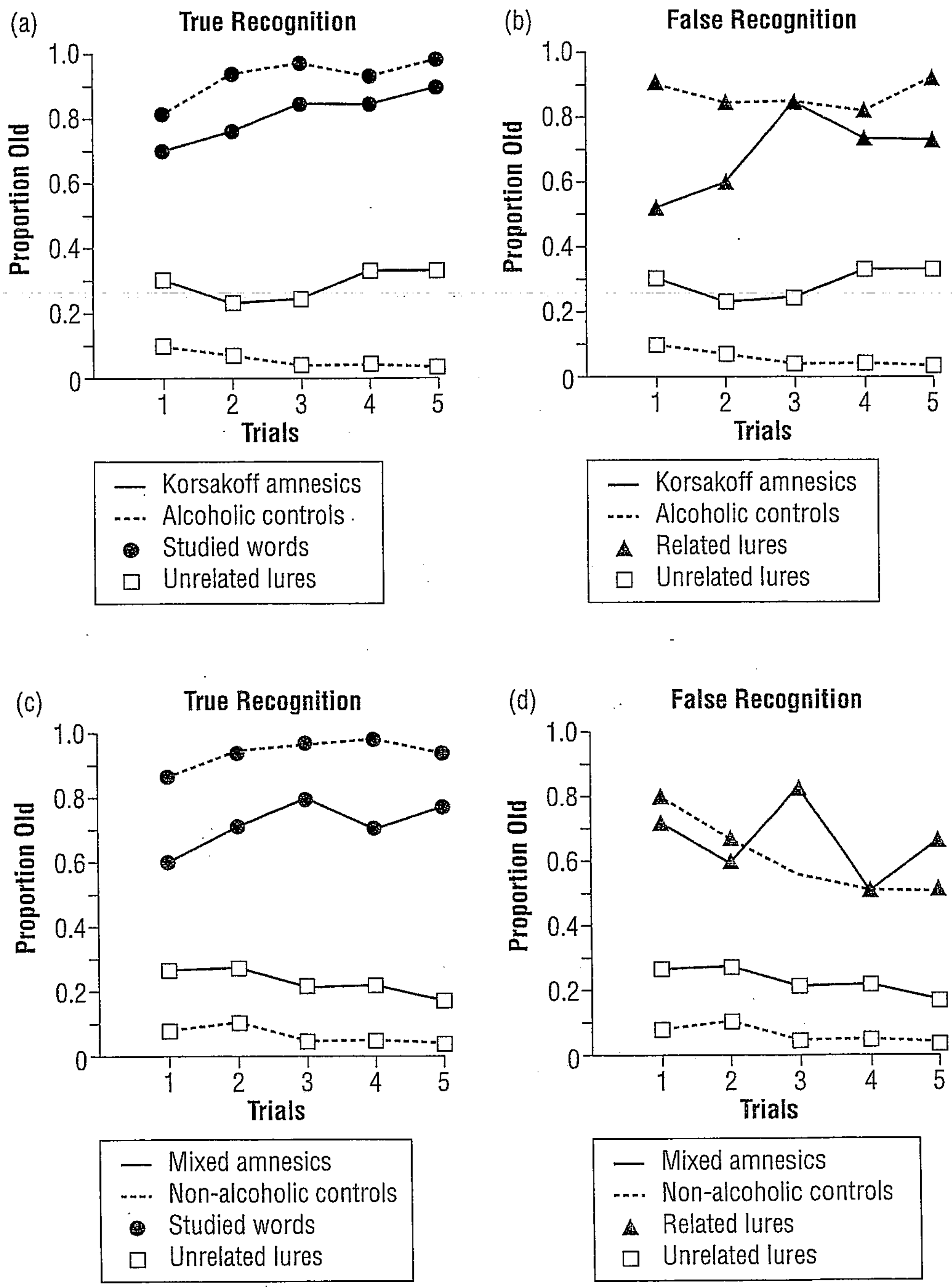



Figure 18.1: Proportions of old responses to studied words (panels A and C), related lures (panels B and D), and unrelated lures (panels A–D) in the two subgroups of amnesics (Korsakoff and mixed) and their respective control groups (alcoholic and nonalcoholic) as a function of study-test trial. Korsakoff and mixed amnesics showed similarly impaired true recognition. However, Korsakoff patients showed increasing false recognition across trials, whereas mixed amnesics showed a fluctuating pattern across trials.

too much (poor pattern separation) and they were too impoverished. In sum, these data highlight the importance in healthy individuals of recollecting detailed information for resisting the tendency to falsely recognize similar items.

In addition to recollecting item-specific information, occurrences of false recognition are affected by factors that influence the "false familiarity" of the related lure item. For instance, Koutstaal, Schacter, Verfaellie, Brenner, and Jackson (1999) examined the effect of varying the number of studied items (i.e., category size) on the false recognition rate of related lure items. In their experiment, control subjects and amnesics (both Korsakoff and mixed etiology) studied pictures of abstract objects. Each of the pictures belonged to a particular perceptual category and was similar to a prototype that defined the category. The categories varied in size and included either 1, 3, 6, or 9 pictures. All participants then completed a recognition test containing studied pictures and new pictures that were either related or unrelated to studied items. In line with previous studies using words, Koutstaal et al. found that for control subjects both true and false recognition of the abstract pictures increased with category size. In other words, healthy individuals were more likely both to correctly recognize previously studied pictures and to falsely recognize new pictures that were related to studied pictures from large categories (e.g., 6 or 9 pictures) than from small categories (e.g., 1 or 3 pictures). By contrast, the amnesics' true and false recognition rates were only slightly affected by the number of related pictures that were studied; category size had a minimal effect on true and false recognition.

One explanation of the above results involves processes that contribute to the activation of memory representations corresponding to studied items. For the control subjects, the false recognition rate of the related abstract pictures was proportional to the number of related studied pictures (as has been found for verbal materials by Arndt & Hirshman, 1998, and Shiffrin et al., 1995). This pattern indicates that when control subjects are presented with a related new item it will engender "false familiarity" to the degree that it activates the representations of earlier studied items. Amnesics, however, are likely to have formed degraded representations of the studied pictures so that a related new item will less strongly match and activate features of studied items. Thus, as Koutstaal et al. (1999) note, the differential build-up of familiarity in amnesics and controls appears to be a consequence of their differing abilities to encode or retain information about the studied items.

The foregoing studies illustrate two processes that affect the false recognition of related lure items. First, recollecting specific information about past events can counteract false recognition responses. As suggested by the Cermak et al. (1973) study, the amnesics' deficiency in remembering item-specific information contributed to their higher than normal false recognition rate. Thus, healthy individuals may become more vulnerable to distorted memories as they fail to recollect the discriminative features of past events (e.g., Riccio, Rabinowitz, & Axelrod, 1994). Second, occurrences of false recognition are influenced by variables, such as how many related items have been studied, that contribute to the "false familiarity" of related lure items. In short, memory distortion depends upon a dynamic interaction between processes contributing to familiarity and memory for item-specific information.

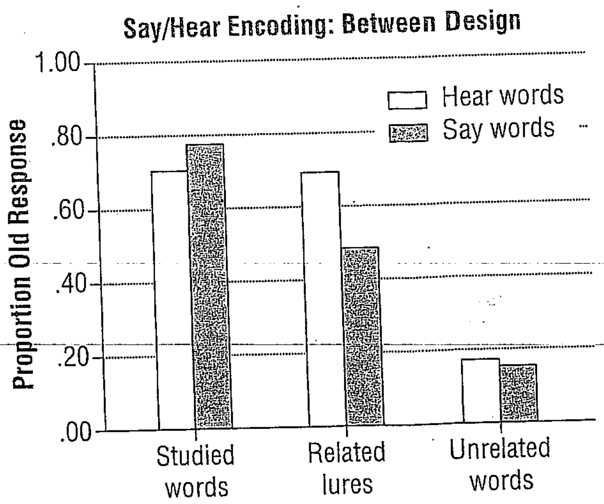
## RETRIEVAL ORIENTATION, THE DISTINCTIVENESS HEURISTIC, AND FALSE RECOGNITION

Remembering is not simply a process of passively activating stored information. Instead, people's expectations, metamemorial beliefs, even how they are instructed to examine their memory, influence the kind and amount of information that is remembered (e.g., Dodson & Johnson, 1993, 1996; Dodson & Schacter, in press; Johnson et al., 1993; Lindsay & Johnson, 1989; Marsh & Hicks, 1998; Multhaup, 1995; Schacter, Israel, & Racine, 1999; Strack & Bless, 1994). Consider, for example, the effects of misleading postevent suggestions, studied extensively by Loftus and her colleagues (for a recent review, see Loftus, Feldman, & Dashiell, 1995).

In this paradigm, subjects view a sequence of slides depicting an event and then receive an ostensibly accurate written description of the previously seen material. However, the description contains misleading information, such as inaccurately characterizing an object presented earlier (e.g., a stop sign is referred to as a yield sign). On a final recognition test, subjects often respond on the basis of the misleading information, claiming to have seen items that were only read about. In essence, subjects confuse the origin of their memories, mistakenly reporting that the misinformation was seen in the slides. However, subjects are better able to distinguish between which objects were seen in the slides and which were only suggested when they are given a memory test that requires them to identify the source of each test item (i.e., was it seen, read, both seen and read, or new; Lindsay & Johnson, 1989; Zaragoza & Lane, 1994). Apparently, people may not always recognize the need to consider the source of their memory, and instead respond on the basis of overall familiarity. This bias to rely on familiarity unless oriented otherwise may stem from the fact that familiarity information seems to be retrieved faster and more automatically than is source information (e.g., Johnson, Kounios, & Reeder, 1994). In short, false recognition is partly attributable to the retrieval strategies that people use to query their memories of past events.

Retrieval strategies can be affected not only by the type of test but also by the metamemorial beliefs that people possess about what they feel they ought to remember about past events (Johnson & Raye, 1981). That is, according to the source monitoring framework of Johnson and colleagues people can flexibly weight different characteristics of a memory depending on the conditions of the test and/or their metamemorial beliefs. Consistent with this notion, we have shown that people can use a "distinctiveness heuristic" to suppress the large false recognition rate of lure words in the DRM false memory paradigm (Dodson & Schacter, in press; Israel & Schacter, 1997; Schacter et al., 1999). Recall that in the DRM paradigm participants initially study lists of words that are related to a nonpresented lure word. On a subsequent old-new recognition test, participants frequently judge the related lure words as having been studied before. However, as seen in Figure 18.2, Dodson and Schacter showed that saying the words aloud at study, as opposed to hearing them, reduces the false recognition rate of the related lure words. Notice that the correct recognition rate of studied words and the false recognition rate of unrelated new words are comparable between the Hear Words group and the Say Words group. This suggests that the reduced false recognition rate of the related words in the Say Words group is not a byproduct of better memory (e.g., better pattern separation) for the said words.

Figure 18.2: Proportions of old responses to studied words, related lures, and unrelated lures in the two groups of participants who encoded the words by either hearing them or saying them aloud.



Building on earlier studies by Israel and Schacter (1997) and Schacter et al. (1999; see also, Rotello, 1999; Strack & Bless, 1994), Dodson and Schacter (in press) argued that rejecting related lure words after say-aloud encoding, as opposed to hear-encoding, stems from participants' metamemorial belief that they ought to remember this distinctive "say" information. These participants used a distinctiveness heuristic whereby they demanded access to say information as a basis for judging items as previously studied. In addition, when participants failed to recall this distinctive information they inferred that the test item is new. By contrast, participants who heard words at study would not expect to have detailed recollections about studied items and, thus, would not base recognition decisions on the presence or absence of memory for distinctive information. These results are consistent with earlier studies indicating that people exhibit a bias during the memory test that appears to be based on the expectation that said information is especially memorable (e.g., Conway & Gathercole, 1987; Foley, Johnson, & Raye, 1983; Johnson, Raye, Foley, & Foley, 1981; Hashtroudi, Johnson, & Chrosniak, 1989).

Dodson and Schacter confirmed the role of a distinctiveness heuristic in a follow-up experiment by constructing a situation in which it was difficult to use it. Following the logic of Schacter et al. (1999), they used a within-groups design in which everyone heard some lists of related words and said other lists of words during the study phase, instead of the between-groups design used in the previous experiment. As seen in Figure 18.3, there was no difference in the false recognition rate of lure words that were related to words that had been earlier said or heard. In this within-groups design, the distinctiveness heuristic is rendered ineffective because there is no longer a particular kind of information that is solely diagnostic of a test item's oldness or newness. Whereas in the prior experiment the absence of information about having said an item suggested that the item was new, this is not the case in the present experiment. Because some items were said and others were heard, failing to remember "say" information does not mean a test item is new; it may only mean the item was one that was heard.

It is important to ask whether a similarity account, instead of the distinctiveness heuristic, can explain the preceding results in Figures 18.2 and 18.3. A similarity account explains recognition decisions in terms of the overall similarity between a test item and memory for studied items (e.g., Gillund & Shiffrin, 1984; Hintzman, 1988). Test items that are sufficiently similar to studied items are judged "old" and those that are not are judged "new." By this view, the typically large false recognition rates of related lures in the DRM paradigm occurs because of their high similarity to studied items (Arndt & Hirshman, 1998). To explain the suppression

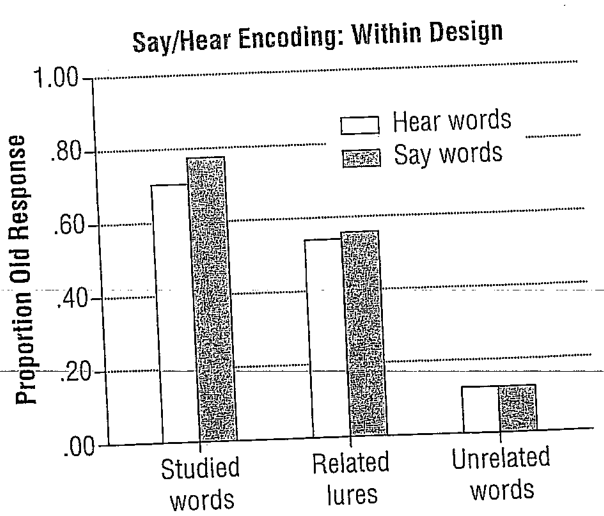



Figure 18.3: Proportions of old responses to studied words, related lures, and unrelated lures after participants heard some words and said other words during the encoding phase.

of the related lures in Figure 18.2, this similarity account would contend that say encoding is sufficiently different from hear encoding that the related lures are in some sense less similar to previously said words than to previously heard words. This dissimilarity between the related lures and memory leads to the successful rejection of the related lures after saying words aloud than after hearing words.

There are problems, however, with this explanation of our results. First, if say and hear encoding produce sufficiently different representations to account for the suppression of false memories in Figure 18.2, then this similarity explanation would predict differences in the recognition rates of spoken and heard words. This prediction was not supported by the data: in Figure 18.2, the said and heard words yielded nearly identical recognition rates for the studied words. Second, Figure 18.3 presents the data from the experiment using the within-groups design and provides further evidence against the similarity account. In this experiment, participants showed slightly higher recognition scores for spoken than for heard words. Nonetheless, there was no difference in the false recognition rate of false targets that were related to spoken and heard lists. Thus, the similarity account offers no ready explanation of these results. According to the distinctiveness heuristic account, in contrast, the absence of expected say information is diagnostic of a test item's nonoccurrence in the experiment depicted in Figure 18.2 but it is not diagnostic in the experiment depicted in Figure 18.3.

In summary, we have reviewed research that point to two different retrieval mechanisms for minimizing false memories. One mechanism involves the manner in which individuals are oriented to query their memory, with source tests generally leading to better performance than old–new recognition tests. The second mechanism involves strategies, such as the distinctiveness heuristic, for evaluating the retrieved information. The focusing mechanism of the CMF can account for the reductions in false recognition when subjects are given a source test instead of an old–new recognition test. This mechanism refers to the process by which subjects establish a description or characterization of the study episode which they then use to cue memory, such as searching memory for information that indicates that the test item was earlier seen or read. By this account, the source test is effective because it orients subjects to use retrieval cues, such as the query "is there memorial evidence that I saw this object earlier?" that are sufficiently detailed that they are likely to match some aspect of the sought-for trace, and importantly, not match aspects of competing traces. This increases the probability that the pattern completion process will retrieve the target memory. The distinctiveness heuristic, by contrast, operates on how the retrieved information is evaluated. This heuristic depends on the metamemorial knowledge about the kind of events that are likely to be remembered, such as having said something earlier. Based on this knowledge, people can make inferences that the absence of memory for this expected characteristic is diagnostic that this event did not actually occur, despite how familiar it may feel.

## THE FRONTAL LOBES AND FALSE RECOGNITION

The frontal lobes comprise roughly one-third of the cerebral cortex and are associated with a wide range of behaviors (Fuster, 1989; Goldman-Rakic, 1987). Patients with frontal lobe damage are characterized by disorders involving motor control, personality, language, problem solving, or memory (e.g., Luria, 1966; Schacter, 1987; Shimamura, 1995). Patients with frontal lobe damage have shown difficulty remembering (a) the source of previously learned facts (Janowsky, Shimamura, & Squire, 1989a), (b) reconstructing the order of a recently studied list of words (Shimamura, Janowsky, & Squire, 1990), (c) determining the relative recency of items (e.g., Milner, Corsi, & Leonard, 1991), and (d) recollecting whether a word was earlier spoken by a male or a female (Johnson, O'Connor, & Cantor, 1997). A number of recent studies have described patients with frontal lobe damage who have abnormally high false recognition rates (e.g., Curran, Schacter, Norman, & Galluccio, 1997; Delbecq-Derouesné, Beauvois, & Shallice, 1990; Rapscak, Reminger, Glisky, Kasniak, & Comer, 1999; Schacter, Curran, Galluccio, Milberg, & Bates, 1996a; Ward et al., 1999).

Schacter, Curran, and colleagues described a patient, BG, with right frontal damage who shows no signs of amnesia, does not spontaneously confabulate, and is generally alert, attentive and cooperative (Curran et al., 1997; Schacter, Curran, et al., 1996). BG, however, is prone to extremely high rates of false recognition. For example, on a memory test of earlier studied unrelated words, BG recognized studied words at a comparable rate to normal control subjects. But BG was much more likely than controls to respond that new test words had also been studied; BG falsely recognized 50% of the new words whereas the controls incorrectly claimed that 17% of the new words were studied (Schacter, Curran, et al., 1996). BG exhibits abnormal false recognition to a wide variety of stimuli, including words, sounds, and pictures, although he tends to have greater difficulty with nonverbal stimuli, such as faces, than with verbal stimuli (Schacter, Curran, et al., 1996). BG is especially likely to falsely recognize new items that are related to studied items, such as claiming to remember seeing the new word "cellar" on the study list when he had studied "basement." Building on this observation, in a follow-up experiment BG and control subjects studied pictures of inanimate objects and then completed a memory test in which the distractors were either related or unrelated to studied items. Some distractors were similar to the studied pictures in that both were from the same semantic category, such as pictures of tools or toys. Other distractors were taken from a semantic category that had not been studied, such as a picture of an animal (Schacter, Curran, 1996b). As in the prior studies, BG recognized the studied items at a comparable rate to controls and showed an abnormally high false recognition rate for related distractors. By contrast, BG almost never falsely recognized distractors that were from a different semantic category.

Schacter, Curran, et al. (1996) proposed that BG uses inappropriate decision criteria during the test. In terms of the CMF, his pathological false recognition rate stems from an excessive reliance on information about the general correspondence between a test item and earlier studied words. Responding on the basis of overall similarity led BG to exhibit very high false recognition rates to similar distractors, but not to dissimilar distractors. Alternatively, it is possible that BG fails to encode specific features of items at study so that he is forced to rely on overall similarity. That is, the memory representations of the items do not include enough item-specific information so that at test they can be identified on the basis of this specific information. Moreover, encoding items in a vague manner would result in feelings of familiarity for features that are common to many items, including both studied and new lure items that contain these features (see Curran et al., 1997).

Rapcsak et al. (1999) discussed two patients with frontal lobe damage who are also prone to falsely recognizing items. JS sustained bilateral damage to the basal forebrain/septal area and the ventromedial frontal region; BW is characterized by widespread damage to the right frontal lobe. Like BG, both patients exhibit pathologically high false recognition rates and are able to sharply attenuate their false recognition rates when presented with new items that are substantially different from studied items. For example, after studying a series of unfamiliar faces of white males both frontal patients and control subjects completed a recognition test containing the studied faces as well as similar distractor faces (i.e., other white males) and dissimilar distractor faces (i.e., white females and nonwhite males). The frontal patients showed comparable recognition rates of the studied faces as the control subjects (94% vs. 81%, respectively), and overall, the frontal patients showed much higher false recognition rates to the distractors (averaged across both kinds) than did the controls (42% vs. 11%). Both frontal patients and controls, however, made many more false alarms to the similar distractors than to the dissimilar distractors. Rapcsak et al. suggest that the frontal patients rely on the overall familiarity of the test item as a basis for judging items "old" whereas the control subjects may rely on memory for additional item-specific information.

Subsequent experiments by Rapcsak et al. (1991) further examined the retrieval processes in patients JS and BW. Healthy controls and these two patients were given a famous faces test in which a series of famous faces (e.g., politicians, entertainers, etc.) were intermingled with nonfamous faces and subjects were instructed to respond "yes" when the face was that of a famous person, and "no" when it was not. This test probes memory for information that was learned long before the patient had brain damage and, thus, specifically taps processes operating during retrieval. The frontal patients and control subjects identified comparable numbers of faces that were actually famous (94% vs. 85%, respectively). However, JS and BW showed a much greater tendency to respond that the nonfamous faces were also famous (52%) than did the controls (6%). In a follow-up experiment the same famous faces were intermixed with a new set of unfamiliar faces and all subjects were instructed to base fame judgments solely on whether or not they could remember the name and occupation of the person. With these instructions, the false recognition rates of the nonfamous faces dropped down to normal levels for the frontal patients (i.e., 6% false alarm rate for frontal patients and 1% for controls). Hit rates to the famous faces were also no different for the frontal patients and control subjects. The finding that instructions greatly improved the frontal patients' performance is in line with the results of group studies of patients with prefrontal cortex damage (Gershberg & Shimamura, 1995; Hirst & Volpe, 1988). For instance, Hirst and Volpe found that when studying categorized lists of words, frontal patients seemed unaware of the strategy of learning words by grouping them together according to category; subsequently, they recalled fewer of these words than did control subjects. However, when this mnemonic strategy was pointed out to them the frontal patients recalled just as many words as the control subjects did.

The foregoing studies indicate that frontal damage can result in a bias to rely on overall familiarity or similarity as a basis for a response unless patients are directly instructed to make judgments contingent on retrieving more specific information. In terms of the CMF, problems generating a focused description of the study episode can account for the pattern of false recognition of BG and of the frontal patients of Rapcsak et al. (1991; see Curran et al., 1997, Norman & Schacter, 1996, and Schacter, Curran, et al., 1996 for further discussion of BG's memory deficit). That is, one basis for judging an item as "old" is noting a match between the search description and the retrieved information. In the previous studies, the frontal patients may generate a search description that is extremely vague, such as whether or not the test item is a member of one of the studied categories of items. This vague description is sufficient for correctly rejecting distractors that are from nonstudied categories, but it does not exclude similar distractors from studied categories. In the Rapcsak et al. study, the instructions to base fame judgments on the retrieval of specific information about the person has the effect of focusing or refining the search description. Apparently, when they are instructed to do so these frontal patients are capable of focusing their search description and relying on more specific information since they performed as well as the control subjects in this condition.

Whereas the performance of BW and JS indicate that their faulty focusing is due to processes at retrieval, Parkin, Ward, Bindschaedler, Squires, and Powell (1999) suggest that processes at encoding can also result in an unfocused retrieval description. They present a patient, JB, who suffered a ruptured anterior communication artery (ACoA) aneurysm that damaged his left frontal cortex and left caudate. JB, like the previous case studies, has an abnormally high false-recognition rate. But, in contrast to these other patients, JB's false-recognition rate is unaffected when he is presented with new items that are either similar to or substantially different from studied items. However, JB does benefit from encoding manipulations. His false recognition rate drops dramatically after he has encoded items in a manner that focuses on the meaning of the item than after receiving no encoding orientation. Parkin et al. (1999) suggest that JB spontaneously encodes events in such a superficial and impoverished manner that during the test he does not have the appropriate specific information available that would allow for a more focused description. For instance, if JB does not register at encoding that the studied items were from particular taxonomic categories then this information will be of little help during the test. In short, whereas BW and JS fail to construct focused retrieval descriptions unless they are instructed to do so, JB is incapable of constructing a focused description because he does not spontaneously encode the necessary item-specific information.

Finally, an additional characteristic of patients with high false recognition rates is that their problems are sometimes specific to particular materials. For instance, Rapcsak et al. (1999) discovered that BW's pathological false recognition rate does not occur with verbal materials but rather appears to be specific to visual information. BW, JS, and normal controls were given various kinds of verbal materials to study, such as animal names, unrelated nouns, and pronounceable nonwords (e.g., FRONGE). On a later recognition test, everyone correctly recognized studied items at nearly identical rates. False recognition rates, however, were dramatically different among these individuals: JS incorrectly claimed that 50% of the new words had been studied, whereas BW and the control subjects falsely recognized only 2% and 9% of the new words, respectively.

Although material-specific deficits tend to involve differences between memory for verbal and visual information (e.g., Hanley, Davies, Downes, & Mayes, 1994; Milner et al., 1991), Ward et al. (1999) described a patient, MR, with left frontal lobe damage (related to multiple sclerosis) who exhibits an unusual kind of material-specific memory deficit. Like the previous case studies, he is prone to high rates of false recognition, but his false recognitions are restricted to faces and people's names. For example, on a famous faces test MR recognized 98% of the famous faces and incorrectly judged 77% of the nonfamous faces as famous. By comparison, the control subjects attained true and false recognition rates of 85% and 14%, respectively. MR's pathological false recognition is not limited to visual materials. When presented with names of historical figures (e.g., Duke of Wellington) intermixed with distractor names that could pass as historical figures (e.g., Horatio Felles) MR correctly recognized all of the historical figures and falsely recognized 70% of the distractors (as compared to 88% correct recognition and 6.5% false recognition for the control subjects).

There are some interesting constraints on MR's excessive false recognition rate. When either the famous and nonfamous faces or names are presented together and he is instructed to choose the famous face (or name) in the pair (i.e., a forced-choice recognition task), MR's performance was similar to controls (77% recognition of the faces for MR and 86% for the controls). In addition, MR has no problem distinguishing between real and fictional place names and does not have abnormally high false recognition rates of low frequency words or nonwords. Lastly, MR's high false recognition rate of personal names is dramatically decreased to normal levels when he receives search instructions that emphasize a nonpersonal name characteristic. For example, MR was given a list consisting of four different kinds of names: 1) books with names as titles (e.g., Oliver Twist); 2) fictitious names (e.g., Agnes Blythe); 3) books without a personal name as a title (e.g., Little Women), and 4) fictitious nonpersonal titles (e.g., Love and Hope). MR was much less likely to falsely recognize the fictitious names when given instructions to circle names of book titles than to circle literary characters' names.

The pattern of relatively normal performance on forced-choice recognition tests and impaired performance on single-probe tests supports Ward et al.'s (1999) hypothesis that MR has a problem using the appropriate criteria to make a response. On single-probe recognition tests it is necessary to set a criterion above which one judges items as "old" or "famous" and below which one judges items as "new" or "nonfamous." MR may use a pathologically liberal criterion for judging whether a name is famous or deciding that he has studied something before. This liberal criterion would inflate his false recognition rate in single probe tests. But the forced choice recognition test attenuates the effects of criteria on recognition because subjects must compare the relative familiarity of the two items in the pair and choose the more familiar one. Moreover, the fact that MR's performance improves when he is instructed to search for book titles as compared to characters' names suggests that the criteria MR use to identify items depends on how he is oriented to assess them. His pathologically liberal criteria emerge when he is attempting to identify faces and names but not when he is identifying book titles. In terms of the CMF, identifying book titles may orient MR to establish a more focused description of the information that is necessary to make a response, such as only choosing book titles for which he can remember associated information, such as the plot or the author's name. For an unknown reason, MR appears to use especially lax criteria for searching and assessing memory for faces and personal names.

In sum, the foregoing studies indicate that frontal lobe damage is associated with abnormally high false recognition rates. We have suggested that this pattern reflects a malfunctioning focusing mechanism. That is, the patients in the previous case studies tend to base recognition decisions on the presence of memorial information that is inappropriately vague or underspecified. Melo, Winocur, and Moscovitch (1999) have proposed a similar account to explain the performance of a group of patients with frontal lobe damage in the DRM paradigm. After studying lists of related words their frontal patients were more likely (but not significantly) to falsely recognize the related lure words than were the control subjects. Melo et al. argued that the frontal patients' defective monitoring mechanism led them to accept as "old" test items, such as the critical lure words, that matched the gist or general features of the studied words.

One clue as to why patients with frontal lobe damage assess memory in a nonoptimal manner comes from a study by Janowsky, Shimamura, and Squire (1989b). Janowsky et al. observed that frontal patients were less able than healthy controls to predict that they could recognize information that they were not able to recall. After learning a series of sentences, such as "Mary's garden was full of marigolds," frontal patients and healthy control subjects were given a cued recall test for a target word in the sentence (e.g., "Mary's garden was full of _______"). When subjects could not recall the target word they indicated their "feeling of knowing" for this target word by rating the likelihood of correctly recognizing this word on a subsequent multiple choice test. While recall and recognition performance was comparable between the two groups, the frontal lobe patients were at chance levels in their feeling of knowing judgments and the control subjects had high scores. Interestingly, the frontal patients had poor feeling of knowing scores because they tended to overestimate their knowledge. The frontal patients only recognized 27% of the items that they had judged as being moderately or highly confident of subsequently recognizing, whereas the control subjects recognized 42% of these items. This tendency on the part of frontal patients to overestimate their knowledge would contribute to abnormally high false recognition rates in the following way. Their apparent overconfidence that an item's familiarity means that it must have been studied earlier may have lead them to *not* use a more focused search description (e.g., search memory for more specific item information) and rely on a test item's familiarity.

## CONCLUSION

An important strategy in cognitive neuroscience research is examining how processes malfunction in order to understand how they work. We have examined memory distortion in patients with brain damage from the perspective of the CMF. The reviewed studies indicate that healthy individuals are susceptible to falsely recognizing items when they fail to recollect detailed item information. This may occur when there is a pattern separation failure and the representations of similar studied items overlap, such as in the DRM paradigm. The medial temporal lobes and related structures appear important for storing and/or retaining both familiarity information and more specific information about an item. False recognition also can be a byproduct of the retrieval process when, for instance, people use lax criteria to search memory, such as accepting memories as true that are vaguely familiar. The frontal lobes are implicated in the criteria people use to search and evaluate their memories. In short, a variety of brain mechanisms underlie the occurrence of true and false memories.

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