8 Confabulation and the Frontal Systems: Strategic versus Associative retrieval in Neuropsychological Theories of Memory

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It would be pleasant to record that Endel Tulving's theories of memory sparked my interest in confabulation, but the truth is that I became interested in the topic because of a patient at Baycrest Hospital in Toronto. At first, I merely listened to his confabulating stories with fascination; then I tried to elicit them when they did not occur spontaneously, and finally I began to investigate the syndrome more systematically in an attempt to understand it. I learned quickly that studying single cases is much more difficult than I had anticipated. As a consequence, my study of the confabulating patient consists more of a series of observations than of controlled experiments. Nonetheless, the observations suggest some interesting hypotheses about the nature of the phenomenon and its relevance to theories of memory.

Confabulation can be defined as "honest lying." The confabulating patient provides information that is patently false and sometimes self-contradictory without intending to lie. In fact, the patient is often unaware of the falsehoods, and even when confronted with the truth, may cling to his or her own version of it, no matter how preposterously fantastic that version may be. Talland (1965) and Berlyne (1972) restrict confabulation to verbal statements, but I think this is not correct. Our own patient's attempt to leave the hospital for home every evening because he mistook his hospital room for his office suggests that his actions can convey the same type of information as his verbal denials that he is in a hospital.

Talland (1965) correctly argued against the claim that confabulations are usually "gratuitously invented, fabricated, rather they are erroneously reproduced or reconstructed from actual data" (p. 42). Similarly, he did not believe that the core of a confabulation is produced "to oblige the listener, or to fill in gaps in their knowledge of facts" (p. 42), though "secondary" confabula-

tions may arise to explain (away) the internal inconsistencies of the primary confabulations that are sometimes apparent even to the patient.

In the end, Talland (1965) proposed the following as characteristic of all confabulations:

> (a) Typically, but not exclusively, an account, more or less coherent and internally consistent, concerning the patient. (b) This account is false in the context named and often false in details within its own context. (c) Its content is drawn fully or principally from the patient's recollection of his actual experiences, including his thoughts in the past. (d) Confabulation reconstructs this context, modifies and recombines its elements, employing the mechanisms of normal remembering. (e) This method is presented without awareness of its distortions or of its inappropriateness, and (f) serves no other purpose, is motivated in no other way than factual information based on data. (pp. 49–50)

To these I add two additional points: (g) The readiness to confabulate may be determined by the patient's "personality structure, his traits evolved in dealing with the environment and in monitoring his self image" (Talland, 1965; p. 44). As Gainotti (1975) observed, patients with a premorbid pattern of denial or rationalization of illness and with a need for prestige and domination in interpersonal relations were two to three times more likely to confabulate than patients who did not have these traits; and (h) All confabulating patients seem to suffer from anasagnosia, an unawareness of their memory deficit or, at best, a profound lack of concern and lack of appreciation of its severity and extent (McGlynn & Schacter, in press).

Patient HW

HW is a 61-year-old right-handed man who underwent surgery in 1984 to have a subarachnoid hemorrhage clipped. Clipping near the anterior communicating artery (ACoA) was followed by widespread bilateral frontal ischemia and infarction. The CAT scan shows massive bilateral frontal damage extending somewhat more superiorly in the right, than in the left. Because of visual artifacts caused by the clip, it is difficult to determine exactly which structures in the basal forebrain were damaged. Significantly, there is little or no damage to the temporal lobes either mesially or laterally.

HW was 1 of 12 children born to an observant Catholic family. He received a traditional Catholic school education and continues to be a practicing Catholic. Shortly after graduating from high school, he moved to Ontario, where he held a variety of jobs including one at a lumber mill. He had been working at H., his current place of employment since 1955 and had advanced to the position of personnel manager in 1975, the job he held at the time of his operation. In 1951, he married Martha M. and had four children who were 34, 32, 31, and 27 years old when we tested their father in 1987. When the children were young, HW was

involved in organizing sport leagues and seemed to take an active interest in sports himself. He played golf regularly and was quite knowledgeable about sports in general.

On being interviewed, HW was friendly and cooperative, almost jocular. He had little insight into his condition, often attributing his stay in the hospital to a bowel operation that he had for cancer in 1961. In fact, he was disoriented in time and place but not confused. He was also not upset when confronted with the truth of his condition. Although disoriented, he got to know the hospital routine and negotiated his way easily around the ward. The only time he was agitated, and sometimes abusive, was in the evenings when he would routinely begin to pack his bags to go home after what he considered to be the end of his day at work. He became quite upset with the attending staff who prevailed on him to stay. Aside from this, the only other behavioral problem he presented to the staff was that he was incontinent of urine and slovenly in his dress. With the help of a behavior modification program, he learned to control his bladder, modify his dressing habits, and reduce the frequency of his attempts to leave the hospital. Although he also had a history of alcohol abuse, there was no evidence of it after he entered the hospital.

Interview

HM: Do you know where you are right now?
HW: This is the H. building.
HM: This is the H. building, not the hospital that you're in?
HW: No.
HM: What floor in the H. building?
HW: Fourth floor (the correct floor of the hospital).
HM: Do you usually have beds in your room in the H. building?
HW: No.
HM: So why do you have beds here?
HW: They just put them in there since we ran into this epidemic.
HM: What epidemic is that? (no answer). Let me set you straight a bit. Let me give you a hint, it's Bay . . .
HW: . . .crest.
HM: Correct. It's not the H. building, let's get that straight. Do you know how long you have been here?
HW: Just since yesterday.
HM: What date is that?
HW: The 30th of September.
HM: What year?
HW: 1987.
HM: It's now May of 1987. You jumped a little bit ahead. Can you just tell me a little bit about yourself? How old are you?

HW: I'm 40, 42, pardon me, 62.
HM: Are you married or single?
HW: Married.
HM: How long have you been married?
HW: About 4 months.
HM: What's your wife's name?
HW: Martha.
HM: How many children do you have?
HW: Four. (He laughs.) Not bad for 4 months.
HM: How old are your children?
HW: The eldest is 32, his name is Bob, and the youngest is 22, his name is Joe.
HM: (He laughs again.) How did you get these children in 4 months?
HW: They're adopted.
HM: Who adopted them?
HW: Martha and I.
HM: Immediately after you got married you wanted to adopt these older children?
HW: Before we were married we adopted one of them, two of them. The eldest girl Brenda and Bob, and Joe and Dina since we were married.
HM: Does it all sound a little strange to you, what you are saying?
HW: (He laughs.) I think it is a little strange.
HM: I think when I looked at your record it said that you've been married for over 30 years. Does that sound more reasonable to you if I told you that?
HW: No.
HM: Do you really believe that you have been married for 4 months?
HW: Yes.
HM: You have been married for a long time to the same woman, for over 30 years. Do you find that strange?
HW: Very strange.
HM: Do you remember your wedding well?
HW: No, not particularly. (In other interviews he is able to describe his wedding in some detail.)
HM: Were your parents at the wedding?
HW: Yes.
HM: How old were they?
HW: My father is 95–96. My mother is 10 years younger so she is 85–86. (In fact, they had died quite a few years ago when they were in their 70s.)
HM: So you got married for the first time when you were 61 years old? You weren't married when you were younger?
HW: This is my second marriage. The first woman was 2 years ago.
HM: That would make you how old when you got married the first time?
HW: 50.

HM: What happened to your first wife?
HW: Not a thing.
HM: Did you get divorced?
HW: Yes.
HM: Are you Protestant or Catholic?
HW: (He laughs.) I'm Catholic.
HM: That would make it pretty difficult wouldn't it?
HW: Yes, the first one was invalid.
HM: So the first marriage was annulled. Do you know what the name of your first wife was?
HW: Yes. Her name was Martha also. (He is now referring to an old girlfriend whose name was also Martha whom he dated before he married his wife.)

COMMENTS ON LITERATURE REVIEW AND PATIENT

The confabulation that Talland described is typically associated with the acute phase of Wernicke-Korsakoff syndrome. This type of confabulation usually subsides and eventually disappears as the patient settles into the chronic amnesic phase of Korsakoff's syndrome. Some patients' confabulation never clears. The occurrence of confabulations and its persistence have little to do with the severity of the memory disorder, suggesting that different mechanisms are involved in producing amnesia and confabulation.

Whereas amnesia is caused by bilateral damage to limbic structures, such as the hippocampus, mammillary bodies, or dorsomedial nucleus of the thalamus, confabulation is linked to lesions of the frontal lobes and related structures that include the basal forebrain, the cingulate gyrus, cingulum, septum, and anterior hypothalamus all of which are fed by the ACoA (Alexander & Freedman, 1984). Stuss, Alexander, Lieberman, and Levine (1978), Kapur and Coughlan (1980), and Baddeley and Wilson (1986) noted that confirmed or suspected frontal-lobe damage or dysfunction was a common feature of confabulation; in the case reported by Kapur and Coughlan, confabulation cleared as frontal functions returned. Lhermitte and Signoret (1976) and Luria (1976), however, believe that confabulation is associated with damage to the cingulate and to the basal forebrain and hypothalamus, respectively. Although it is probably the case that damage restricted to the frontal lobes is not sufficient to produce confabulation, it is not known whether frontal dysfunction, in combination with damage to related structures, is a necessary condition for confabulation. For convenience, therefore, I refer to the frontal lobes and the related structures served by the ACoA as *the frontal system.*

HW, like the other cases, had extensive frontal system damage. Although he

had a history of alcohol abuse, the immediate cause of his disorder was infraction of the frontal lobes and related structures that resulted from clipping the ACoA.

The implication of the frontal system in confabulation is consistent with two of the most common functional explanations of confabulation. One is that confabulation arises from "the disruption of [the patient's] temporal frame of reference" (Talland, 1965, p. 56), Van Der Holst, 1932, cited in Williams & Rupp, 1938) and the other is that it is a deliberate, but clumsy and ineffectual, attempt to cover up lapses of memory or fill in gaps of knowledge, as much to oblige a listener as to satisfy the patient's own needs. The latter, in short, is a confabulation of exigency or embarrassment (Bonhoffer, 1901; cited in Talland, 1965). Support for both explanations can be found in the interview. HW's gross underestimation of the length of his marriage can be attributed to a disordered time sense, whereas his claim that he adopted four grown children can be seen as an attempt to reconcile obviously discrepant beliefs.

These two need not be rival explanations, as they are often presented in the literature, but can be complementary instead. I would go so far as to say that they are negative and positive signs of the same underlying frontal disorder. According to the temporal explanation, the memories are intact (more or less) but their chronology is wrong. Information from events that are related but are widely separated in time and place become fused or are misattributed to another context. Confronted with the flagrantly inconsistent accounts that such a process will sometimes produce, the patient counters with an explanation that is sometimes even more preposterous (and laughable) than the inconsistencies it was meant to reconcile.

It is tempting to consider as primary those confabulations that are caused by disorders in temporal sequencing. All other forms of confabulations are secondary or reactive. Such an interpretation is consistent with evidence that temporal memory judgments are impaired after frontal lobe lesions (Milner, 1974, 1982) as, perhaps, are all attributions of temporal or spatial context to any event (Smith & Milner, 1984; Schacter, 1987). Confabulation is source amnesia (Schacter, Harbluk, & McLachlan, 1984) magnified and extended to include an entire lifetime of experience. Were the confabulations of exigency plausible, one might go along with this view of things. Yet they are often so farfetched that they demand a deeper explanation than one that merely states that confabulations of exigency are reactive, the normal response to conflicting beliefs. Moreover, a temporal disorder interpretation would fail to account for fantastic confabulations that cannot be described as true events that are merely displaced in time, but rather are honest and fabulous inventions. To identify the temporal disorder as the primary source of confabulations is to mistake a symptom of the disorder for its cause.

Before speculating about the true cause of confabulation and its relevance to theories of memory, more information is needed about the disorder itself and the

other cognitive deficits that are associated with it. From all accounts, it would seem that the memory deficit that typically accompanies confabulation is one of retrieval more than of encoding, consolidation, or storage (Lhermitte & Signoret, 1976); "of the ability to 'ekphoria' than of engram formulation" (Williams & Rupp, 1938; p. 403). Memory for the content of an event is relatively preserved, but memory for its spatial or temporal context is impaired.

Even non-Korsakoff confabulators, such as HW, suffer from severe memory disorders that make them appear to be amnesic on casual observation. Yet unlike true amnesics, confabulating patients perform unusually well on some explicit memory tests. Case 4 of Stuss et al.'s (1978) series improved his score on the Wechsler Memory Scale from 87 to 112, but his confabulation continued unabated. Kapur and Coughlan (1980) reported that their confabulating patient performed normally on tests of recognition that would stump amnesic patients, yet the same patient scored zero on the tests of recall. Is this pattern of performance on memory tests typical of confabulating patients whose memory disorder is not caused primarily by limbic system damage but rather by frontal system damage? If so, HW should perform similarly to those patients both on a standard battery of neuropsychological tests of intelligence and memory, and on a number of tests that are sensitive to frontal lobe damage. HW's results are reported in the next section.

Neuropsychological Testing

The results of standard neuropsychological tests appear in Table 8.1. His full-scale IQ is in the low average range. The verbal subtests revealed an unremarkable pattern except that his score on General Information was low. The slight drop in his full-scale IQ from his estimated premorbid level of functioning is probably the result of his impulsive, poorly organized, and idiosyncratic approach on many of the performance tests. For example, he tended to accept the presented order of cards in the Picture Arrangement subtest and provided idiosyncratic stories based on that incorrect sequence. This type of performance is consistent with radiological and behavioral evidence of frontal lobe damage. It should be noted, however, that HW did not perform poorly on all tests that are sensitive to frontal damage. Although he could not achieve more than a single correct category on the WCST, he produced the normal number of words on the FAS test of verbal fluency, suggesting that at least the left orbito-frontal region may have been spared.

His performance on tests of memory shows marked impairment in recall, scoring zero whenever a substantial delay is introduced. Significantly, however, his recognition scores were in the normal range.

No formal tests of language function were administered because his linguistic skills seemed perfectly adequate.

TABLE 8.1
Neuropsychological Test Results for Patient HW

Test	*Score*
WAIS-R Full Scale IQ	89
Verbal IQ	94
Performance IQ	83
Wechsler Memory Scale MQ	76
Logical Memory Immediate	2.5/23
delayed	0/23
Paired associate: easy: immediate	6.5/9
delayed	5/6
hard: immediate	0/12
delayed	0/4
Visual reproduction: immediate recall	2/14
delayed recall	1/14
recognition	14/14
California Verbal Learn Test	
Recall immediate (trials 1–5)	24/80
short delay	0/16
long delay	1/16
delayed recognition	12/16
Rey Osterieth Drawing	
Copy	20/36
Immediate recall	0/36
FAS Test of Verbal Fluency	37
Wisconsin Card Sorting Test	0 categories
(Test stopped after 45 cards, 39 perseverative errors)	

COMMENT ON NEUROPSYCHOLOGICAL TESTS

Dissociation Between Recognition and Recall: The role of the Frontal Lobes

There is a strong resemblance between HW and Kapur and Coughlan's patient. Although HW was not as intelligent, both patients performed similarly on tests of recall and recognition. Recognition was surprisingly well preserved, given how abysmally HW performed on tests of delayed call. The discrepancy between recall and recognition is so striking that is deserves additional comment. Although clever experimenters can contrive to make recall better than recognition (Tulving & Thomson, 1973), the reverse is typically the case. The relative superiority of recognition over recall, however, remains fairly constant both within a population and even across populations that differ in type of brain

damage that includes patients with anoxia, closed head injury, Alzheimer's Disease, and encephalitis. One can even predict the level of recognition from performance on tests of recall if the same tests are administered to all patients. The major exception to this rule are patients with ACoA aneurysms whose performance on recognition far exceeds the predicted level (Schacter, Moscovitch, & Tulving, unpublished observations).

Having been alerted to this phenomenon, I was reminded of two similar observations in the literature. Both examples concerned patients with bilateral frontal-lobe signs or with damage to structures that are intimately related to the frontal lobes. Hirst, Johnson, Kim, Phelps, Reese, and Volpe (1986) reported that patients with Korsakoff's syndrome who were matched with normal control subjects on recognition, nonetheless scored almost zero on delayed recall. Another group of patients who showed a comparable discrepancy were patients with Parkinson's Disease. In many PD patients the head of the caudate nucleus, an area sending primary projections to the frontal lobes, is dysfunctional. In a recent study, Huberman, Freedman and Moscovitch (1988) found that a subset of non-demented Parkinson's patients scored at the level of mildly demented Alzheimer's patients on immediate verbal recall, that is, they performed at the floor, getting no more than 3 out of 16 items correct. Their performance on 4-item forced choice delayed recognition, however, was 14/16 correct, a score that was at least as good as that of matched controls and much better than that of Alzheimer patients.

The discovery of a large discrepancy between performance on implicit and explicit tests of memory in amnesic patients, a discrepancy as large as the one between recognition and recall in some confabulating patients, has been offered as evidence in support of the idea that performance on implicit and explicit tests is mediated by independent memory systems. If I were a proponent of such a position, I would be forced to consider seriously the proposition that recognition and recall are also mediated by different systems. If one adds the evidence of functional independence between recognition and recall, then only the outcomes of tests of stochastic independence stand in the way of such a conclusion. In some circumstances, however, the dependent relationship that is observed is sufficiently small that it sometimes is only a matter of faith whether one chooses to interpret the results as favoring a multiple memory system hypothesis or refuting it.

Because I do not wish to be drawn into this debate again, let me return to the interpretation advanced by Williams and Rupp (1938), which is that retrieval, rather than retention, is impaired in patients whose memory disorder is of frontal origin. I will go a bit further and specify the type of retrieval process that is impaired. Tulving has long argued that retrieval is necessary for both recognition and recall, and I do not think that the present finding need challenge his argument. Rather, it is necessary to distinguish between two types or components of

retrieval. Retrieval processes have both a *strategic or organizational* and a *associative* component (Lockhart, Craik, & Jacoby, 1975). Working from minimal cues, processes that comprise the strategic or organizational component are largely self-initiated and goal-oriented (Craik, 1983). They are concerned with reinstating the temporal and spatial context in which the target is embedded and, having reinstated it, they coordinate the various other retrieval processes that utilize general knowledge as well as episodic cues to home in on the target. The process can be likened to one that occurs when solving problems. A general problem is set up and relevant knowledge is recruited to constrain it further until local routines can be applied to arrive at a solution. Once you figure out that, say, a solution requires that you divide x by y, the operation of division, the local routine, is easily executed. The homologue in memory to the local routine is associative retrieval. It is a retrieval process that is mediated by local, or proximal, cues whose relation to the target is more direct and specific than the general, quite distal cues that initiate strategic retrieval. At the extreme, the associative component deals with that information that was encoded as a unit with the target.

One might presume from this discussion that associative retrieval always follows strategic. Although that might be typical of free recall, it need not always be that way. The two processes are interactive, but somewhat independent of each other. One can easily imagine the situation in which the target is retrieved associatively with the aid of a highly distinctive cue and then, using this knowledge, the individual retrieves strategically the context in which the target was embedded. Again, the analogy from problem solving is instructive. In those cases in which one cannot even frame the problem properly, being provided with the answer allows one to work backwards to derive the steps leading to it.

It is apparent from this discussion that I believe that the strategic component of retrieval is selectively impaired in patients who confabulate but who show relatively preserved recognition. The strategic component is mediated by frontal system structures. Before I speculate further about the role of the frontal system in this process, I wish to present some additional observations concerning HW's confabulation and memory. In particular, the way I have formulated my hypothesis of impaired strategic retrieval suggests that it would apply equally to remote as well as to recent and newly acquired memories, to semantic as much as to episodic memories, and perhaps to any problem, mnemonic or otherwise, that requires a deliberate, organized, and sequential search. Similar proposals have been advanced by a number of other investigators (Baddeley & Wilson, 1986; Goldberg & Bilder, 1986; Goldberg & Costa, 1986; Lhermitte & Signoret, 1972, 1976; Luria, 1976; Mercer, Wapner, Gardner & Benson, 1977; Rozin, 1976; Schacter, 1987; Shapiro, Alexander, Gardner, & Mercer, 1981; Stuss & Benson, 1986, among others). The following observations and experiments generally confirm these predictions.

ADDITIONAL OBSERVATIONS

Crovitz (1973) Test: Critique and Data

Beginning with Kinsbourne and Woods (1975), a number of investigators have used this test to see whether amnesic patients can retrieve episodic memories in response to a word cue, such as "flag." The object of the test is to describe in detail a specific episode that the word conjures up. Kinsbourne and Woods' patients typically gave general answers (eg., I see flags at parades) rather than specific episodes, and this was taken as evidence that episodic, but not semantic, memory was impaired in these patients (see Robinson, 1976, and Rubin, 1986, for other studies using the Crovitz technique).

The conclusion is not warranted for two reasons. First, no comparably difficult test was administered that tapped semantic memory. For example, it is conceivable, indeed highly likely, that had some patients been asked to describe a remote historical event in which a "flag" or "gun" figured prominently, they would have been as much at a loss as they were in describing a specific episode. Both episodic and semantic answers demand strategic retrieval, a process that the patients being Korsakoff amnesics with probable frontal dysfunction, would fail (see Goldberg & Bilder, 1986; Goldberg & Costa, 1986, for similar ideas concerning generic and singular memories).

Second, performance should not be uniformly poor. Sometimes, the cue word may have a strong associative link to a memory and that memory, if it is highly unitized, would emerge in rich detail.

Robin Green and I administered the Crovitz test twice to HW. The first time, he retrieved only 2 memories to 12 of the same prompts used by Baddeley and Wilson (1986); the second time, he retrieved an additional 3. Here is an example: In response to the word "game" he said, after a long silence, "I didn't start playing golf until about 5 years ago and that's a little late; you should start playing when you're younger. [He stopped and had to be prompted to produce a particular episode]. I can remember playing in a tournament. [He then described the rules of tournament play and had to be reminded again that we were after a specific episode]. I'm always reluctant to play first, but this time I got caught and went first. There were a lot of people waiting to hit and a fair group that was watching. I set my ball up. There was a bit of chatter going around. It didn't bother me but the starter told them all to quiet down. They all quieted down and they were looking at me. I'm normally a nervous person anyway. So I swung and missed the ball. What if I missed it again? Finally I hit the ball, a beautiful one, better than 200 yards."

I admit that with a confabulating patient it is difficult to know whether the story is true. He did, however, tell a very similar story the second time we tested him a few days later. The only significant detail that changed concerned his membership in the club where the tournament was held.

The story may also be part of one's "personal folklores" (Cermak, 1984; Cermak & O'Connor, 1983). These stories are so well rehearsed that they lose their episodic, personal character and assume the status of a folktale. We have no way of judging whether this is the case except to say that he was able, when questioned, to supply additional incidental details about the event he recounted such as who was in the crowd, what kind of day it was, and what time of year the tournament was held.

HW's failures on the Crovitz test are as informative as his successes. In response to the words "letter" and "find," HW just remained silent. In response to prompts, he admitted writing and receiving letters and having found something, but could get no further than that. To the word "dog," he smiled and said, "There used to be a dog," but then required prompts to supply each additional bit of information concerning the color of the dog, its home, and where he saw it. Even with these prompts, HW could not recall a single episode involving the dog, but only generic information about him. "A black dog that my brothers and I used to see in our neighborhood." In part, this was because our prompts invited that type of information. Not having access to his episodic memory, we had no idea what prompts would serve as good associative cues to an episode. Happily, when we asked whether he had ever been bitten by a dog, he was able to supply somewhat more detailed episodic information about one of his own dogs who had bitten him on the leg because he teased the dog by prodding him with a stick.

HW's performance on the Crovitz test is consistent with the hypothesis that strategic retrieval is impaired in confabulating patients. Unless the target or later prompts triggered an episodic memory, HW seemed incapable of searching his memory systematically to find an appropriate episode. Given the nature of the deficit, my guess was that HW would experience similar difficulties when his semantic memory was probed.

The reader will recall that HW's lowest score on the verbal scale of the WAIS-R was in the information subtest where he had a scaled score of 6, which is 3 points lower than his next lowest score. When questioned about recent or remote historical events, he sometimes was way off the mark; he believed, for example, that the Magna Carta was signed by the Americans and Germans in 1400. More typically, his answers are in the right ball park, but the details are vague or incorrect. Thus, he knew that the first atomic bomb was dropped by the US on Hiroshima, but was not sure exactly what effect it had on World War II. He knew that Queen Elizabeth I and Queen Victoria both ruled England in the remote past, but could not supply the dates nor any significant events that occurred during their reigns.

Like many Canadians, his knowledge of hockey was somewhat better than that of English history; here, too, he had the same difficulties as he had on episodic memory tasks. When asked how many Canadian teams were in the National Hockey League he answered two, Montreal and Toronto. This was the

number in the league before the late 1970s, when the league expanded and took in 5 additional Canadian teams. When I told him that there were more, he refused to believe it. When I asked him to try to figure out which cities might have teams he had no strategy for attacking the problem. I then asked him to name major Canadian cities and decide if they had teams or not. Although he could generate some appropriate cities, he still denied that they had teams. When, however, I would say, "The name of the team is the Vancouver?", he would supply the correct name to the team when I paused after saying the city's name. Nevertheless, he protested that his answers were just wild guesses.

INDUCING CONFABULATION: DATES, PLACES AND PROCEDURES

HW's performance on tests of both semantic and episodic memory is consistent with the hypothesis that strategic retrieval is impaired, whereas associative retrieval is better preserved. Confabulation seems to occur when a memory, be it episodic or semantic, can be associatively retrieved but because strategic retrieval is impaired, it cannot be placed in the proper temporal or spatial context. For example, a retrieval cue, whether self-generated or provided by an external source, can conjure up any number of memories that may be linked associatively to it. HW's answers to the question "What did you do yesterday?" are determined by those memories that were habitually linked to the query in the past. He says he went to work or, if he believes it was a holiday, he says he went to church. Having impaired strategic retrieval processes, he cannot edit or suppress the associatively retrieved memories and, consequently, accepts them as valid (Mercer et al., 1977; Shapiro et al., 1981). *Confabulation, therefore, is a function both of the accessibility of associatively retrieved memories and of the dependence of the act of remembering on strategic retrieval. This principal applies equally to semantic as to episodic memories.* Our observation of confabulation for dates, places, and procedures is consistent with this hypothesis.

Dates

Reports of confabulating patients suggest that temporal ordering and dating may be especially dependent on strategic retrieval. Many writers have commented on the temporal disorientation of the patient, which they considered to be either a sufficient or necessary condition for confabulation (for review see Berlyne, 1972; Talland, 1965). The temporal disorder prevents the patient from establishing a point of reference in time about which he or she can order the sequence of events in his or her life. Implicit in these explanations is that confabulation is restricted to the patient's personal experiences or what he or she takes to be his or her personal experiences. According to them, the material for confabulation is

episodic, not semantic, memory. I argue, however, that the temporal disorder that is characteristic of confabulation affects semantic as much as episodic memory, at least in patient HW. The evidence I present supports the claim I made earlier that temporal disorientation is a symptom, rather than the cause, of confabulation.

I asked HW to give the dates of 10 events in his own life, such as the date of his birth, wedding, high school graduation, and birth of his first child, and the date of 15 well-known historical events. Five were events that he had experienced: the beginning and end of World War II, the Korean War, the Vietnam War, and the Canada War Measures Act. The other 10 were events from the remote past, which included the date of the French Revolution, the American Declaration of Independence, and the Battle of the Plains of Abraham.

HW performed similarly regardless of whether the events were autobiographical or historical, recent or remote. Except for identifying the date of his own and Jesus' birth and the year America was discovered, HW did not get any of the answers correct. His errors were illuminating. He placed the events he experienced, whether personal or historical, in the time since his birth, whereas he assigned remote historical events to the distant past. His estimate of the dates and even order of the events were often wildly off the mark and inconsistent. For example, according to HW, World War II began sometime between 1940 and 1976 and ended as early as 1954 and as late as 1979. Sometimes he believed that it preceded the Korean War and sometimes that it followed it, and the Vietnam War, as well. After having said that America was discovered in 1492, he then claimed that the American Declaration of Independence was signed in 1400. When I called his attention to this anomoly, he gave an embarrassed giggle and changed his answer to 1500. As the initial excerpt from his interview indicates, he fared no better in dealing with personal events.

HW's performance is consistent with the hypothesis that accurate recovery of temporal information involves strategic, rather than associative, retrieval processes. The quality of the deficit was nicely captured in a temporal version of Shallice and Evans' (1978) cognitive estimation test. Shallice asked subjects to estimate the probable distance between two locations, the heights of some buildings, the weight or cost of different objects, and so on (see also Smith & Milner, 1984). HW, like other frontal patients, was obviously impaired on these tests. Not only were some of his estimates off by an order of magnitude (he thought the distance between Toronto and Vancouver was 400 miles), but the ordering was also off (he estimated the distance between Vancouver and Halifax as 250 miles). In the temporal version, I asked HW to guess the approximate date at which the following events occurred: the introduction of TV, VCRs, Xeroxing, personal computers, and satellites. I chose these events because dating them almost always induces deliberate, strategic retrieval in normal people. For each, he claimed he did not know but was willing to play along. The dates given for the above items were 1935, 1940, 1968, 1962, and 1963 respectively. When I asked

him how he arrived at this answer, he said simply that he guessed. If I tried to get him to adopt a search strategy to inform and refine his guesses, he could neither initiate the strategy that involved relating the events to known landmarks, nor benefit from it when it was initiated for him.

Places

Confabulation about place is less readily elicited than about time because associative retrieval cues are less likely to be misleading for spatial information than for temporal information. Consider the difference between these two questions that I put to HW: "How long have you been married?" and "Where were you married?" He confabulates about the first, but not about the second. The answer to the first question, however, changes with time, whereas the answer to the second is constant. Even in our own experience, we often have the sense that some events in the distant past seem to have occurred only yesterday. Our sense of the location of the events, however, is relatively fixed. To acknowledge the passage of time requires the suppression of some feelings of immediacy and the recruitment of strategic retrieval strategies. It is significant that when HW erred, he usually placed events that he experienced closer to the present. For historical dates, the ready availability of year numbers and some knowledge of the historical period in which the event occurred, was enough to elicit a confabulatory response to a recognizable event.

Although less frequent, confabulation about place, when it does occur, is probably caused by the same processes as confabulation about time. Confabulation about place, as about time, should be the same for information derived from semantic, as from episodic, memory. By and large, our observations are consistent with this prediction.

In the episodic task, HW attempted to identify a number of locations in Toronto, and for the semantic task, the capitals of 15 countries. In both conditions, some items were highly familiar and easy for HW to identify, such as the location of his house and the CN Tower or the capital of Canada or the United States; some that were less familiar, but still recognizable, such as the capital of Germany and of Switzerland or, in Toronto, the location of the YMCA and the Columbus Centre; and some that were unfamiliar and probably impossible for HW to identify, such as the capital of Borneo and Nepal or the location of the mayor's house and of an obscure church.

HW performed as predicted on the Toronto locations, getting the easy landmarks correct, admitting that he had no idea about the location of the unfamiliar landmarks, and confabulating about the less familiar, but still recognizable landmarks. On the semantic test, however, HW insisted that he did not know the capital of any country, even of Canada, although he was able to pick Ottawa from among four alternatives.

Does this mean that for places, unlike dates, confabulation occurs only for

episodically derived information? I think not. A more likely explanation is that none of the countries' names triggered a city's name as an associative response to queries about capitals. When the response items were more readily available, such as providing the continents in which each country belonged, HW behaved as predicted. He answered correctly for the European countries, but gave Asia as a response to both Brazil and Morocco. For historical dates, the ready availability of year numbers and some vague knowledge of the historical period in which an event occurred, was enough to elicit a confabulatory response to a recognizable event. The same holds true for recognizable locations where "place" responses are readily available. To queries about unfamiliar events and locations, however, HW would simply deny he had heard of either rather than confabulate or guess.

Procedures

Our hypothesis suggests that confabulation should virtually be absent for HW's knowledge about procedures or skills. In most cases, it is improbable that a strategic search is involved in figuring out whether one does or does not know how to carry out some tasks. To test this idea, we asked HW whether he could carry out some ordinary repairs that any householder might know and some specialized repairs that he conceivably might know but in fact did not. The "ordinary" repairs included changing a light bulb, installing a light socket, or changing a tire. The "specialized" repairs included fixing a typewriter, a computer, a camera, a Xerox machine. He answered "yes" to all the ordinary repair questions and was then able to give a pretty good, although not perfectly accurate, description of how to conduct the task (Tulving, Schacter, McLachlan, & Moscovitch, 1988). He answered "no" to all the specialized repair questions and would not budge from his answers even though I tried to lead him to believe that he might be able to carry them out. When he said he could not fix a typewriter, I suggested that surely he must have fixed some broken ones at work. He denied ever fixing one but was willing to say that he might see what he could do if a key got stuck.

For procedures, the query seems associatively linked to the correct response and, if the procedure is well rehearsed or highly structured, HW's description of it will be accurate. Although he confabulated about the jobs he held, mixing up the jobs with the places in which he held them, HW was nonetheless able to give an accurate description of the duties associated with each job. About his last job he said "I administered wages and salaries by evaluating each person's job. That includes their job knowledge, the education or pertinent product background, the mental requirements to perform the job, direction of others with their supervisory positions and physical requirements. In the supervisory jobs, there is also another heading, the direction of others, which is responsibility for leading and guiding the people. In my absence or sickness it would be up to the general manager to

appoint one guy to look after it. In some cases the top foreman would take over and he knew enough people and enough about the job that he could either do it himself or assign it to someone else."

Given the appropriate conditions, it is conceivable that HW might confabulate about his knowledge of some procedures just as he would about time and place. For example, he might confabulate if the procedure is one that he once attempted but never quite succeeded in mastering, or that he always wanted to execute but never did. Here, the query might elicit a positive response that could be rejected only after a strategic search that evaluates whether he had, in fact, executed the task correctly. Little children, whose frontal lobes are not fully developed, are often caught in such "lies" when they talk about their abilities or plans.

THE FRONTAL SYSTEM AND MEMORY: A CASE FOR STRATEGIC RETRIEVAL

In his book, *Elements of Episodic Memory*, Tulving (1983) referred to a patient described by Luria (1976) who suffered from a severe amnesia following the rupture of an aneurysm of the ACoA. In many respects, that patient resembled HW. Tulving (1983) was impressed by the patient's ability to learn unrelated picture–word pairs and retain them for a few days despite not being able to describe the learning episode moments after it had occurred. He remarked, "The contents of the episode—individual pairs of associations—had become functionally separated from the episodic system" (p. 114), and referred to such decontextualized bits of information as "free radicals."

The concept of free radicals was to undergo some rapid, major modification. There is a clear line of development from Tulving's ideas about free radicals to Schacter's studies on source amnesia (e.g., Schacter et al., 1984) and to his subsequent proposal that the frontal lobes embody a mechanism necessary for ascribing spatio-temporal context to episodic memory (Schacter, 1987). Once attributed to amnesia, the existence of free radicals and source amnesia is now associated with frontal-lobe damage. Schacter favors the hypothesis, initially advanced by Pribram and Tubbs (1967), that the frontal lobes play a major role in contextual chunking, that is "the segmentation and organization of ongoing experience into distinctive units that are discriminable from one another" (Schacter, 1987, p. 32). The existence of free radicals and source amnesia is interpreted as symptomatic of an impairment in contextual chunking. Using evidence from studies on memory for frequency of occurrence, temporal order, and spatial location (e.g., Hasher & Zacks, 1979), Schacter proposed that contextual chunking is a relatively automatic process. Memory for spatial-temporal information does not depend on effortful, strategic processing.

On the face of it, this proposal seems to be at odds with my own hypothesis that front-system damage is associated with deficits in strategic retrieval. The

two hypotheses differ not only with regard to the automaticity of the processes involved but also with the stage at which they are presumed to occur. Although not stated explicitly, the contextual chunking hypothesis applies primarily to encoding, whereas mine applies primarily to retrieval (but see Schacter, this volume).

The two hypotheses need not compete with each other. Only a subset of patients with frontal-lobe lesions and amnesia confabulate. It is the behavior of this subset that the strategic retrieval deficit hypothesis was meant to explain. The contextual chunking hypothesis, on the other hand, attempts to account for the observed effects of circumscribed frontal lesions in nonconfabulating humans and in animals. Of the two hypotheses, the strategic retrieval one accounts best for HW's impairment in ascribing spatio-temporal context to remote, premorbidly acquired memories. Whether confabulating patients also have a contextual chunking deficit at encoding is not known.

At this point, I think it is important to call attention to the possibility that what is typically taken to be a deficit in encoding may, in fact, be a deficit in retrieval. Consider the finding that judgments of temporal recency (Milner 1974; 1982) and frequency of occurrence (Smith & Milner, 1988) are impaired following frontal-lobe lesions. It is as likely that the effects depend on faulty retrieval of properly encoded information as the other way around. Indeed, as a subject in a frequency estimation study, I found that the real work came at retrieval when I had to review in my mind the events that I experienced and estimate, on the basis of different kinds of information that I brought to mind, what a good answer might be. In short, the tasks required the kind of strategic retrieval process that I believe is impaired in patients who confabulate and that may also be impaired, but to a lesser extent, in many patients with circumscribed, unilateral frontal-lobe lesions.

The same argument applies to the issue of automaticity. I do not wish to dispute the evidence that spatio-temporal context is encoded with little effort. It does not follow, however, that the deficit that frontal patients have in ascribing spatio-temporal context is the result of impaired automaticity. The context may still be encoded automatically, but frontal patients may have difficulty in retrieving that information strategically.

By arguing for frontal-lobe involvement at retrieval, I do not preclude the possibility that the frontal lobes are also involved at encoding. The two hypotheses are not incompatible. I wish to emphasize, however, that the type of processing in which the frontal lobes are involved, at both encoding and retrieval, would be similar; it would be effortful and strategic, rather than automatic. At encoding, the frontal lobes may be critical for developing or acting on expectancies, organizing encoding strategies, making inferences, and even segregating the flow of events into discrete chunks, but not automatically. (For recent evidence that encoding of frequency of occurrence is not always automatic, see Fisk & Schneider, 1984; Green, 1988; Hanson & Hirst, 1988; Naveh-Benjamin & Jonides, 1986; Rowe, 1974; but see Hasher & Zacks, 1984, for a rejoinder.)

As for frontal-lobe involvement at retrieval, it is appropriate at this point to consider exactly what aspect of the retrieval process is strategic. According to Tulving (1983), if the subject is in a retrieval mode and retrieval information is available, "the obligatory elements of the retrieval process consist of ecphory, ecphoric information, recollective experience, conversion of ecphoric information, and memory performance" (p. 169). For those of you who have not committed the definition of ecphory to memory, let me remind you that "it is the process by which retrieval information is brought into interaction with stored information."[1] That interaction makes ecphoric information available, which forms the basis of the subject's recollective experience. Conversion is the process by which ecphoric information and recollective experience is translated into observable behavior.

Of all these processes, only ecphory and the availability of ecphoric information is presumed to be automatic "in the sense that once the subject is in the retrieval mode and the retrieval information and the engram are available the subject has little control over the product of the ecphoric process" (p. 190). All other aspects of retrieval are, to a greater or lesser extent, under the subject's control. This is most obvious in dealing with a post-ecphoric process, such as conversion. Poor ecphoric information may be adequate for recognition because it is based on familiarity, but it may not be adequate for recall, which requires detailed ecphoric information to support a verbal or nonverbal description of the to-be-remembered event. Even if the ecphoric information is detailed, as it sometimes is in confabulating patients, it may not be appropriate given the demands of the task, or it may be inconsistent with other knowledge, or it may be too varied, in the sense that a particular cue may give rise to ecphoric information from more than one event. In each of these cases, the subject must initiate additional processes whose outcomes will determine his or her performance on a particular task.

Let me illustrate with an example that we have all probably experienced at least once, if not often. In dating a check in the new year, there is a tendency to put the date of the previous year on the check. Our ability to correct this error, when in fact we do correct it, is based on a control process that evaluates the ecphoric information with other knowledge so that we do not immediately accept the first available answer. Or, consider your response to the query "what did you do two weekends ago?" Two different, and incompatible, events may come to mind: You were out of town at a conference, and you spent the weekend at home entertaining friends. Or the question may, for some reason, revive the memory of

[1]Many people complained that they found the meaning of "ecphory" elusive and suggested I find a substitute whose meaning is more apparent. Unfortunately, no single, common word captures the same meaning. Perhaps "contact and recovery" or simply "memory fetch" conveys the appropriate sense of an automatic memory process involving cue-engram interaction as opposed to "memory search" which is more strategic. In deference to Tulving, however, I will continue to use "ecphory" in this paper, though the troubled reader is free to substitute one of the suggested terms for it.

a particularly wonderful weekend you spent skiing with a friend in college. Your choice of the correct answer will depend on initiating a set of processes, both semantic and episodic, inferential and deductive, that will finally enable you to choose among the alternatives. When all alternatives but one are obviously wrong, the process is almost instantaneous and seemingly effortless. When the alternatives are plausible, the process is prolonged and labored. It is these strategic retrieval processes that are likely to be impaired in confabulating amnesics. Ecphoric information is offered without evaluation. When the responses are inconsistent or contradictory, the confabulating patient, although he or she may have the presence of mind to appreciate blatant errors, lacks the resources to undo them and substitutes one preposterous tale with another.

Even the adoption of a retrieval mode and the selection of retrieval information is an effortful, strategic process. In recognition, the process is not so obvious because a copy cue is given; but in free and cued recall, the information supplied by the tester is minimal. The subject must use this information to initiate an ecphoric process whose products become the retrieval information for the next ecphoric process, and so on, until the subject is satisfied that the ecphoric information and the recollective experience is suitable for the task at hand. This description of the recall process indicates that both pre- and post-ecphoric retrieval processes may be impaired in confabulating patients.

A NEUROPSYCHOLOGICAL MODEL OF MEMORY BASED ON EVIDENCE FROM AMNESIA AND CONFABULATION

The model I propose borrows heavily from Endel Tulving's ideas of encoding-specificity, ecphory, and retrieval. Amnesia, I still believe, is characterized by the following four dissociations, in which the first function is relatively well preserved and the second is impaired: (a) dissociation of intelligence from memory, (b) of primary from secondary memory, (c) of pre-morbid from post-morbid memory, and (d) of memory without awareness from conscious recollection (Moscovitch, 1982b). In the years since I proposed these dissociations, it has become clear that there are patients with severe memory disorders for whom some of these dissociations do not apply. In particular, patients have been reported whose memory loss extends as far back as childhood (e.g., Butters & Cermak, 1986; Squire & Cohen, 1982; Tulving et al., 1988), and patients whose performance on some tests of memory without awareness is as severely compromised, if not more so, as their performance on tests of conscious recollection (Martone, Butters, Payne, Becker, & Sax, 1984; Shimamura, Salmon, Squire, & Butters, 1987). Nonetheless, I propose a model that accounts for the four dissociations and then indicate what other types of memory disorders can occur if structures designated by the model to mediate different processes are damaged.

Amnesia is defined as loss of conscious recollection of post-morbid events. Since Milner and Scoville's (1957) description of amnesia caused by surgical resection of the mesial temporal lobes and hippocampus in HM, it has been assumed that these structures are critical for conscious recollection of post-morbid memories. The precise function of these structures has been debated ever since. Milner (1966) and others have proposed that they are critical for consolidation; Butters and Cermak and their colleagues (1980) have championed the role of these structures at encoding; Warrington and Weiskrantz (1973) have been the principal proponents of the view that the structures are critical for retrieval.

Although I favored a modified version of the consolidation hypothesis (Moscovitch, 1982b), there were elements of it that made me uneasy. In particular, the hypothesis has always remained primarily a physiological or biochemical hypothesis for me rather than a psychological one, despite Squire, Cohen, and Nadel's (1984) efforts to translate it into psychological terms. Here are some further thoughts on the matter.

The hippocampus is necessary for making memories of recently experienced events available to consciousness, be they episodic or semantic (Moscovitch, Winocur, & McLachlan, 1986). If we consider this statement in terms of Tulving's theories, it implies that the hippocampus is the mechanism that mediates the ecphoric process whose product forms the basis of conscious recollective experience. If the encoding specificity principle is correct, namely that a necessary condition for effective retrieval is that the retrieval cue–target relation be established at the time of storage, then it strongly suggests that the hippocampus is also involved in encoding of information in long-term or secondary memory (see Cermak, Uhly, & Reale, 1980, Schacter, 1985, L. Tulving, 1981,[2] for evidence that the encoding specificity principle is not consistently upheld in amnesia). It is this process that underlies consolidation of an event and the subsequent reinstatement of the event at retrieval. The process is depicted in Fig. 8.1.

According to the model, an event occurs that is picked up by perceptual modules whose output, but not operation, is available to conscious awareness (see Moscovitch & Umilta, in preparation; Chapter 18 of this volume; and Schacter, McAndrews, & Moscovitch, 1988, for a discussion of the dissociation of the output of specific modules from conscious awareness). The information is then organized, and what is available to conscious experience is then collated by the hippocampus with the activity (or information) in the modules that gave rise to that experience. At retrieval, the cue information made available to the hippocampus interacts with the stored engram in the modules to produce the ecphoric information that is available to consciousness. With time, or recollective experi-

[2]Linda Tulving is Endel's daughter. It seems appropriate to provide this information in a Festschrift for Professor Tulving.

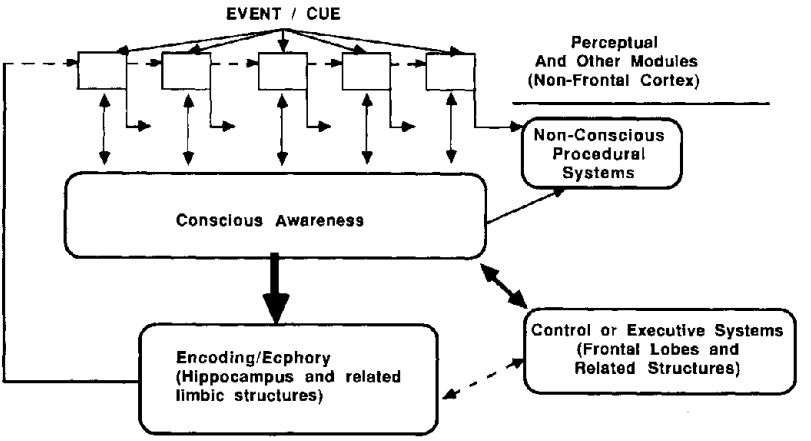

FIG. 8.1. A neuropsychological model of memory. The dashed lines indicate that the interaction is optional. The cortical modules that interact with the hippocampal system will vary depending on the information about the event that is available to consciousness when the event is initially experienced and when it is being remembered (see text for details).

ence, the ecphoric process for a particular event ceases to be mediated by the hippocampus. Instead, alternate access routes to the engram become established (see Squire et al., 1984; and Teyler & Di Scenna, 1986, for a similar proposal). What those alternate routes are is unknown, but presumably the ecphoric process must be similar to the one mediated by the hippocampus to give rise to a true consciously recollected experience, an experience of having lived an event rather than merely knowing about it.

I should point out that this model of memory is neutral with regard to the hippocampus' role in storing information. Some theorists believe that without hippocampal involvement, the engram decays rapidly, whereas others believe that engram storage is dependent only on intramodular interactions, the hippocampus being involved only in providing access to them.

If the ecphoric process is automatic, as Tulving has suggested, it implies that the process is modular in much the same way that some perceptual processes are modular (Fodor, 1983). The hippocampus can be considered a module whose input is the encoding and retrieval of information available to conscious awareness and whose output is ecphoric information (see Moscovitch & Umilta, in preparation, for an extended discussion). It is this modular aspect of hippocampal function that forms the basis for the gross errors committed by confabulators. Like all other modules, the hippocampus "lacks intelligence". Its operation is triggered by retrieval information and its output is automatic and shallow. The "intelligent" memory work is done by the system involved in conscious awareness in conjunc-

tion with a control system. For the system to operate efficiently, a control process is needed that can make appropriate encoding and retrieval information available to the hippocampus and that can organize and evaluate the ecphoric information that is its output. These control processes are mediated by the frontal lobes and its related structures.

Judging from the performance of memory-disordered people, or even normal people, memory is often fragmented. One aspect of an event may be remembered separately from another. The subject may remember the semantic attributes of an item, but not its sensory properties; the content of an event, but not its setting; the elements but not their order; and for all these examples, the reverse may also occur. Different retrieval information may be necessary to retrieve one aspect of the trace rather than another, suggesting that the information may also have been encoded differently. The foregoing indicates that the ecphoric information delivered to conscious awareness is piecemeal and not necessarily well organized or even delivered in a sequence that reproduces the initial experience. The ecphoric information is only as good as that specified by the retrieval cue. That memories often appear to be organized may be as much a function of pre- and post-ecphoric processes mediated by the frontal lobes as of ecphoric ones that are mediated by the hippocampus. Sometimes the environmental cue is sufficient to elicit the correct content and setting; sometimes only one of the two will be elicited, the other requiring additional queries that are self-generated.

The essentially irrational, shallow, and fragmented output of the hippocampally mediated system is most obvious in the confabulating patient, HW. Having severely damaged the frontal system, HW haphazardly combines information from disparate events, jumbles their sequence, and essentially accepts as veridical whatever the ecphoric process delivers to consciousness. The minimal organization that his memories show is dependent on loose rules of plausibility and association rather than on systematic strategies aimed at recovering additional ecphoric information. In cases of fantastic confabulation (e.g., Berlyne, 1972; Stuss et al., 1978), retrieval information interacts with whatever information is currently active in the perceptual and semantic modules to deliver ecphoric information that reflects recent thoughts, perceptions, or fantasies rather than relevant past experiences. Prior to concluding my interview with HW, I had a conversation about his golfing buddy and office mate, MG. Before saying goodbye, I asked HW whether he remembered who I was. Without hesitation he replied "Sure, you're MG". More dramatic examples are recounted by Stuss et al. (1978).

IMPLICIT VERSUS EXPLICIT TESTS OF MEMORY

My remarks throughout have been addressed to issues regarding conscious recollection as reflected in explicit tests of memory. Memory may also be tested implicitly. According to my model, performance on implicit tests is dependent

on non-ecphoric activation of the engram whose output may enter consciousness or may inform and control non-conscious procedural systems. Thus, in tests of speeded reading, perceptual identification, or word completion, prior exposure allows the subsequent test stimulus to reactivate the engram directly and to deliver its output more quickly, efficiently, or with a higher probability, to consciousness or to the relevant non-conscious system. Depending on the demands of the task and the nature of the retrieval information, performance on two implicit tests of memory may be dependent or independent of each other (Witherspoon & Moscovitch, 1989). It follows that performance on one type of implicit tests of memory should be dissociable from that on another in patients whose damage affects the output of perceptual modules to non-conscious operating systems. Recent evidence supports this prediction (Heindel, Salmon, Butters, & Shutts, 1987; Martone et al., 1984). In addition, whether the frontal systems are engaged in such implicit tests depends on the level of organization that the test requires. On tests such as learning the Tower of London or Toronto (Shallice, 1982; Saint Cyr, Tylor & Lang, 1988), where planning and sequencing is critical, patients with frontal-lobe dysfunction have great difficulty acquiring the skill, although their memory for the learning episode is intact. Where the task and cue are highly structured, performance on implicit tests may be normal even in patients with frontal dysfunction (Heindel et al, 1987; Huberman et al., 1988).

PROVISO AND CONCLUSION

Although single-case studies are in vogue, I am somewhat suspicious of them. I agree with the arguments that Weiskrantz presents in this volume (chapter 6) that we learn most about the functional organization of the brain from studies of dissociation. My interpretation of HW's disorder is based as much on symptoms that were associated one with another as those that were dissociated from each other. I do not know to what extent these associated symptoms such as temporal disorders for semantic and episodic information, or retrieval of detailed semantic and episodic information on the Crovitz test, are obligatory in patients who confabulate or, for that matter, in any amnesic patient. Nor is it certain that damage to regions within the frontal lobe is responsible for confabulation and its related memory disorder. If it were, the ventromedial frontal cortex would be a likely candidate (Mishkin & Appenzeller, 1987). The critical lesion, however, may involve related, but nonfrontal, structures that comprise the territory of the ACoA.

Finally, I do not wish to leave the reader with the impression that the frontal lobes are a single, uniform structure. There is ample evidence from both animal and human research for dissociation of function between regions of the frontal lobes. The confabulating patient may show the cluster of symptoms because so much of the frontal system is dysfunctional. Nonetheless, there is something

romantic in trying to find unity or at least a family resemblance (Teuber, 1972) among the variety of memory deficits observed after frontal system damage. I end, then, by restating my belief that pre- and post-ecphoric strategic retrieval functions are mediated by the frontal lobes and related structures. Receiving as it does input from all major association cortices, the hippocampal system, and subcortical motivational systems, as well as being closely allied to motor output structures, the frontal lobes are ideally situated to guide, organize, and evaluate the essentially modular, ecphoric processes mediated by the hippocampus and its related limbic structures.

ACKNOWLEDGMENTS

I thank Morris Freedman for referring the patient to me, Lee C. Smith for administering the neuropsychological test battery and for helping me interpret the nature of HW's confabulations, Robin Green for assisting me in collecting my data, Gus Craik for commenting on a previous draft of this paper, and Maureen Patchett for preparing the manuscript. The research was supported by an MRC of Canada grant.

REFERENCES

Alexander, M. P. & Freedman, M. (1984). Amnesia after anterior communicating artery aneurysm rupture. *Neurology, 34,* 752–757.

Baddeley, A., & Wilson, B. (1986). Amnesia, autobiographical memory, and confabulation. In D. C. Rubin (ed.), *Autobiographical memory* (pp. 225–252). Cambridge: Cambridge University Press.

Berlyne, N. (1972). Confabulation. *British Journal of Psychiatry, 120,* 31–39.

Butters, N., & Cermak, L. S. (1980). *Alcoholic Korsakoff's syndrome: An information processing approach to amnesia.* New York: Academic Press.

Butters, N., & Cermak, L. S. (1986). A case study of the forgetting of autobiographical knowledge: Implications for the study of retrograde amnesia. In D. C. Rubin (Ed.), *Autobiographical memory* (pp. 254–272). Cambridge: Cambridge University Press.

Cermak, L. S. (1984). The episodic–semantic distinction in amnesia. In L. R. Squire & N. Butters (Eds.), *Neuropsychology of memory* (pp. 55–62). New York: Guilford Press.

Cermak, L. S., & O'Connor, M. (1983). The retrieval capacity of a patient with amnesia due to encephalitis. *Neuropsychologia, 21,* 213–234.

Cermak, L. S., Uhly, B., & Reale, L. (1980). Encoding specificity in the alcoholic Korsakoff patient. *Brain & Language, 11,* 119–127.

Craik, F. I. M. (1983). On the transfer of information from temporary to permanent memory. *Philosophical Transactions of the Royal Society of London. B302,* 341–359.

Crovitz, H. (1973, November). *Unconstrained search in long-term memory.* Paper presented at the meeting of the Psychonomic Society, St. Louis, MO.

Fisk, A. D., & Schneider, W. (1984). Memory as a function of attention, level of processing, and automatization. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 10,* 181–197.

Fodor, J. (1983). *The modularity of mind.* Cambridge, MA: The MIT Press.

Gainotti, G. (1975). Confabulation of denial in senile dementia. *Psychiatria Clinica, 8,* 99–108.

Goldberg, E., & Bilder, R. M. (1986). Neuropsychological perspectives: Retrograde amnesia and executive deficits. In L. W. Poon (Ed.), *Clinical memory assessment of older adults* (pp. 55–68). Washington, DC: APA Press.

Goldberg, E., & Costa, L. D. (1986). Quantitative indices in neursychological assessment: an extension of Luria's approach to executive deficit following prefrontal lesions. In I. G. Grant & K. A. Adams (Eds.). *Neuropsychological Assessment of Neuropsychiatric Disorders* (pp. 48–64). New York: Oxford University Press.

Green, R. L. (1988). Generation effects in frequency judgment.*Journal of Experimental Psychology: Learning, Memory, and Cognition, 14,* 298–304.

Hanson, C., & Hirst, W. (1988). Frequency encoding of token and type information. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14,* 289–297.

Hasher, L., & Zacks, R. T. (1979). Automatic and effortful processes in memory. *Journal of Experimental Psychology: General, 108,* 356–388.

Hasher, L., & Zacks, R. T. (1984). Automatic processing of fundamental information: the case of frequency of occurrence. *American Psychologist, 39,* 1372–1388.

Heindel, W., Salmon, D., Butters, N., & Shults, L. (1988). Implicit memory in patients with Parkinson's disease (abstract). *Journal of Clinical and Experimental Neuropsychology, 10,* 54.

Hirst, W., Johnson, M. K., Kim, J. K., Phelps, E. A., Risse, G., & Volpe, B. T. (1986). Recognition and recall in amnesics. *Journal of Experimental Psychology: Learning, Memory & Cognition, 12,* 445–451.

Huberman, M., Freedman, M., & Moscovitch, M. (1988, June). *Performance on implicit and explicit tests of memory in patients with Parkinson's and Alzheimer's Disease.* Paper presented at the meeting of the International Society for the Study of Parkinson's Disease, Jerusalem, Israel.

Kapur, N., & Coughlan, A. K. (1980). Confabulation and frontal lobe dysfunction. *Journal of Neurology, Neurosurgery, and Psychiatry, 43,* 461–463.

Kinsbourne, M., & Wood, F. (1975). Short-term memory processes and the amnesic syndrome. In J. A. Deutsch & D. Deutsch (Eds.), *Short-term memory.* New York: Academic Press.

Lhermitte, F., & Signoret, J. L. (1972). Analyse neuropsychologique et differenciation des syndromes amnesiques. *Revue Neurologique, 126,* 161–178.

Lhermitte, F., & Signoret, J.-L. (1976). The amnesic syndromes and the hippocampalmammillary system. In M. R. Rosenzweig & E. L. Bennett (Eds.), *Neural mechanisms of learning and memory* (pp. 44–56). Cambridge, MA:MIT Press.

Lockhart, R. S., Craik, F. I. M. & Jacoby, L. L. (1975). Depth of processing in recognition and recall: Some aspects of a general memory system. In J. Brown (Ed.), *Recognition and recall* (pp. 75–102). London: Wiley.

Luria, A. (1976). *The neuropsychology of memory.* New York: Wiley.

Martone, M., Butters, N., Payne, M. Becker, J. T., & Sax, D. S. (1984). Dissociation between skill learning and verbal recognition in amnesia and dementia. *Archives of Neurology, 41,* 965–970.

McGlynn, S. M., & Schacter, D. L. (in press). Unawareness of deficit in neuropsychological syndromes. *Journal of Clinical and Experimental Neuropsychology.*

Mercer, B., Wapner, W., Gardner, H., & Benson, D. F. (1977). A study of confabulation. *Archives of Neurology, 34,* 429–433.

Milner, B. (1966). Amnesia following operation on the temporal lobe. In C. W. M. Whitty & O. L. Zangwill (Eds.), *Amnesia* (pp. 109–133). London: Butterworth & Co.

Milner, B. (1974). Hemispheric specialization: Scope and limits. In F. O. Schmitt & F. G. Worden (Eds.), *The neurosciences: Third research program* (pp. 75–89). Cambridge, MA: MIT Press.

Milner, B., (1982). Some cognitive effects of frontal lobe lesions in man. *Philosophical Transactions of the Royal Society of London, 298,* 211–226.

Milner, B., & Scoville, W. B. (1957). Loss of recent memory after bilateral hippocampal lesions. *Journal of Neurology, Neurosurgery, and Psychiatry, 20,* 11–21.

Mishkin, M., & Appenzeller, T. (1987). The anatomy of memory. *Scientific American, 256,* 80–89.

Moscovitch, M. (1982a). A neuropsychological approach to perception and memory in normal and pathological aging. In F. I. M. Craik & S. Trehub (Eds.), *Aging and cognitive processes* (pp. 55–78). New York: Plenum.

Moscovitch, M. (1982b). Multiple dissociations of function in amnesia. In L. S. Cermak (Ed.), *Human memory and amnesia* (pp. 337–370). Hillsdale, NJ: Lawrence Erlbaum Associates.

Moscovitch, M., & Umilta, C. (in preparation). *Modularity and neuropsychology.*

Moscovitch, M., Winocur, G., & McLachlan, D. (1986). Memory as assessed by recognition and reading time in normal and memory impaired people with Alzheimer's disease and other neurological disorders. *Journal of Experimental Psychology: General 115,* 331–347.

Naveh-Benjamin, M., & Jonides, J. (1986). On the automaticity of frequency encoding: Effects of competing task loads, encoding strategy, and intention. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12,* 378–386.

Pribram, K. H., & Tubbs, W. E. (1967). Short term memory, parsing, and the primate frontal cortex. *Science, 156,* 1765–1767.

Robinson, J. A. (1976). Sampling autobiographical memory. *Cognitive Psychology, 8,* 578–595.

Rowe, E. J. (1974). Depth of processing in a frequency judgment task. *Journal of Verbal Learning and Verbal Behavior, 13,* 638–643.

Rozin, P. (1976). The psychobiological approach to human memory. In R. M. Rosenzweig & E. L. Bennett (Eds.), *Neural mechanisms of learning and memory* (pp. 3–48). Cambridge, MA: MIT Press.

Rubin, D. C. (Ed.) (1986). *Autobiographical memory.* Cambridge, Eng.: Cambridge University Press.

Saint-Cyr, J. A., Taylor, A. E., & Lang, A. E. (1988). Procedural learning and neostriatal dysfunction in man. *Brain, 111,* 941–959.

Schacter, D. L. (1985). Priming of old and new knowledge in amnesic patients and normal subjects. *Annals of the New York Academy of Sciences, 444,* 41–53.

Schacter, D. L. (1987). Memory, amnesia, and frontal lobe dysfunction. *Psychobiology, 15,* 21–36.

Schacter, D. L., Harbluk, J. L., & McLachlan, D. R. (1984). Retrieval without recollection: An experimental analysis of source amnesia. *Journal of Verbal Learning and Verbal Behavior, 23,* 593–611.

Schacter, D. L., McAndrews, M. P., & Moscovitch, M. (1988). Access to consciousness: Dissociations between implicit and explicit knowledge in neuropsychological syndromes. In L. Weiskrantz (Ed.), *Thought without language* (pp. 242–278). Oxford: Oxford University Press.

Shallice T. (1982). Specific impairments of planning. *Philosophical Transactions of the Royal Society of London.* B298, 199–209.

Shallice, T., & Evans, B. (1978). The involvement of the frontal lobes in cognitive estimation. *Cortex, 14,* 294–303.

Shapiro, B. E., Alexander, M. P., Gardner, H., & Mercer, B. (1981). Mechanisms of confabulation. *Neurology, 31,* 1070–1076.

Shimamura, A. P., Salmon, D. P., Squire, L. R., & Butters, N. (1987). Memory dysfunction and word priming in dementia and amnesia. *Behavioral Neuroscience, 101,* 347–351.

Smith, M. L., & Milner, B., (1984). Differential effects of frontal lobe lesions on cognitive estimation and spatial memory. *Neuropsychologia, 22,* 697–705.

Smith, M. L., & Milner, B. (1988). Estimation of frequency of occurrence of abstract designs after frontal or temporal lobectomy. *Neuropsychologia, 26,* 297–306.

Squire, L. R., & Cohen, N. (1982). Remote memory, retrograde amnesia, and the neuropsychology

of memory. In L. S. Cermak (Ed.), *Human memory and amnesia* (pp. 275–303. Hillsdale, NJ: Lawrence Erlbaum Associates.

Squire, L. R., Cohen, N. J., & Nadel, L. (1984). The medial temporal region and memory consolidation: A new hypothesis. In H. Weingartner & E. Parker (Eds.), *Memory consolidation: Towards a psychobiology of cognition* (pp. 185–210). Hillsdale, NJ: Lawrence Erlbaum Associates.

Stuss, D. T., & Benson, D. F. (1986). The frontal lobes and control of cognition and memory. In E. Perecman (Ed.), *The frontal lobes revisited* (pp. 141–158). New York: The IRBN Press.

Stuss, D. T., Alexander, M. D., Lieberman, A., & Levine, H. (1978). An extraordinary form of confabulation. *Neurology, 28,* 1166–1172.

Talland, G. A. (1965). *Deranged memory.* New York: Academic Press.

Teuber, H.-L. (1972). Unity and diversity of frontal lobe functions. *Acta Neurologica Experimentalis, 32,* 615–656.

Teyler, T. J., & Di Scenna, P. (1986). The hippocampal memory indexing theory. *Behavioral Neuroscience, 100,* 147–154.

Tulving, E. (1983). *Elements of episodic memory.* Oxford: Clarendon Press.

Tulving, E., Schacter, D. L., McLachlan, D., & Moscovitch, M. (1988). Priming of semantic autobiographical knowledge: A case study of retrograde amnesia. *Brain & Cognition, 8,* 3–20.

Tulving, E., & Thomson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review, 80,* 352–373.

Tulving, L. (1981). *Interaction of encoding and retrieval factors in amnesia.* Unpublished master's thesis, University of Toronto.

Warrington, E. K., & Weiskrantz, L. (1973). Analysis of short-term and long-term memory defects in man. In J. A. Deutsch (Ed.), *The physiological basis of memory* (pp. 365–396). New York: Academic Press.

Williams, H. W., & Rupp, C. (1938). Observation on confabulation. *American Journal of Psychiatry, 95,* 395–405.

Witherspoon, D., & Moscovitch, M. (1989). Stochastic independence between two implicit memory tasks. *Journal of Experimental Psychology: Learning Memory & Cognition, 15,* 22–30.