

# PURE RETROGRADE AMNESIA FOLLOWING A MILD HEAD TRAUMA: A NEUROPSYCHOLOGICAL AND METABOLIC STUDY

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## ABSTRACT

After a minor closed head injury, a 33-year-old man acquired extensive retrograde amnesia (RA) covering the previous ten years and concerning autobiographical, semantic and procedural memories. The patient's learning abilities remained excellent and he recovered considerable information from his wife, the media and personal documents. This relearned information did not, however, provide a sense of personal experience in the first weeks. CT and MRI failed to show brain damage, but EEG and SPECT examination showed a marked right temporal dysfunction. After three months the patient had almost completely recovered from RA. Interestingly, a parallel recovery was observed in the second SPECT obtained at this period. There was clearly a blockade of retrieval, while the stored engrams were probably intact. The mechanisms underlying such a functional amnesia are discussed in the light of previous reports of amnesia without brain lesions.

Key words: retrograde amnesia, recovery, SPECT, procedural memory

## INTRODUCTION

Ribot (1881) has probably to be credited for the first description of a pure retrograde amnesia. He reported the case of a young woman who, in the course of an epileptic seizure, displayed an extensive amnesia for past events only. However, it was then often assumed in neurological practice that retrograde amnesia never occurred without concomitant anterograde amnesia, (e.g., Russel and Nathan, 1946; Squire et al., 1975). In recent years, this postulate has been challenged in the light of several cases of 'focal retrograde amnesia' (FRA) or 'pure retrograde amnesia', mostly secondary to herpes encephalitis or head trauma (for review, see Kapur, 1993, 1999). We report a case of FRA, whose particularity was its occurrence after mild head trauma without brain damage but with demonstrable temporal lobe dysfunction.

## CASE REPORT

FP, a 32-year-old man, with a 9-year educational level and no history of neurological or psychiatric disorder, slipped on ice and sustained a mild posterior head trauma, on January 2, 1996. He did not lose consciousness and immediately got up without help. His

wife reported that less than a minute later FP looked strange, did not remember the trauma and no longer knew where he was. He never lost his sense of personal identity and never failed to recognize family members. On admission to a local hospital, the neurological examination and a CT scan were normal. When FP was discharged 3 days later his anterograde memory was described as normal but he had no recollection of the 24 hours following the trauma. Above all, he had an extensive retrograde amnesia for all events occurring since 1985. He did not remember that he had been married for 10 years and had a 7-year-old son, that he had built a house in 1988 and had his own business. His amnesia also concerned semantic information, i.e. political or cultural events that occurred during the same period. He had no past history of psychiatric disorders and at the time of the examination there were neither psychiatric nor psychological disorders.

FP was examined as an outpatient between January 6 and March 14, 1996. He then resumed his work as a carpenter without difficulty. On examination, FP was always fully alert and cooperative and his behaviour appropriate. He was able to explain his difficulties and progressively 'rebuilt' his past memory with the help of his wife and information gathered from television, newspapers and his photo albums. The many 14-year political retrospectives broadcast after President Mitterrand's death in January 1996, were very useful to FP for the reconstitution of his memory.

Neurological examination was otherwise normal. An EEG performed on January 6 showed slow waves distributed bilaterally in the posterior temporal areas, with a preponderance of theta and delta waves on the right side. These abnormalities disappeared progressively, but the right temporal slowing was still present in February. At that time MRI scan was normal and SPECT scans demonstrated a marked right temporal hypoperfusion in the resting condition. Perfusion indexes were calculated by producing a region of interest/cerebellum activity ratio. For the anterior temporal region this ratio was 28.8 on the right side and 32.2 on the left (Figure 1).

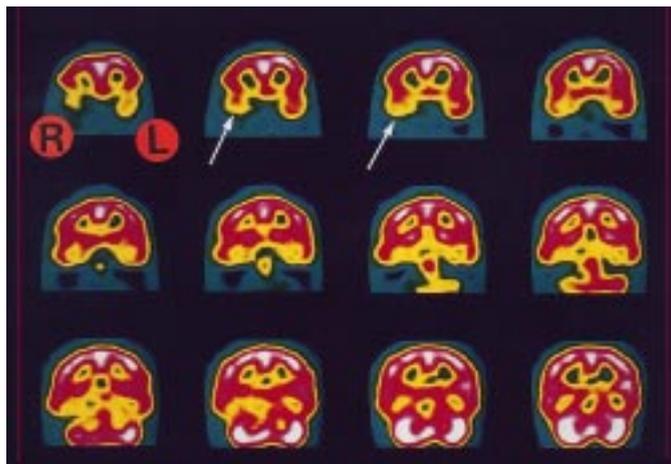


Fig. 1 – Coronal slices of FP's first SPECT scan showing well defined right temporal hypometabolism.

## NEUROPSYCHOLOGICAL FINDINGS

### *Anterograde Memory*

In everyday life, FP did not complain of difficulty in learning new information, and the relearning of much information lost in the post-traumatic period also supports the absence of significant anterograde amnesia. He was

perfectly well oriented in time and space. Performances on the Revised Wechsler Memory Scale (Wechsler, 1991), reported in Table I, were normal on all the subtests except story recall (score: 16,  $N = 28.0 \pm 6.8$ ). Although the verbal index was significantly lower than the nonverbal index, verbal learning capacities appeared to be fairly well preserved, since in Rey's 15-word learning task FP had high scores. There was no abnormal forgetfulness: 9 days later, FP was still able to recall 8 of 15 words on free recall, and 14 words on recognition (Table I).

TABLE I  
*FP's Scores on Standard Memory Tests and on Kopelman et al.'s (1989) Questionnaire of Autobiographical Memory*

	FP	Norms
Wechsler Memory Scale-Revised		
Verbal memory quotient	75*	> 85
Visual memory quotient	114	> 85
General memory quotient	86	> 85
Attention-concentration quotient	102	> 85
Delayed recall quotient	96	> 85
Rey's 15 words recall		
5 trials (respectively)	8,11,14,15,15	75th-100th percentile
Recognition	15/15	100th percentile
Delayed recall (9 days later)	8/15	
Delayed recognition (9 days later)	14/15	
Questionnaire of Autobiographic Memory		cut-off
Semantic: Childhood	18/21	14-15
Semantic: Adulthood	21/21	16
Semantic: Recent life	17/21*	18
Episodic: Childhood	7/9	5
Episodic: Adulthood	6/9	5-6
Episodic: Recent life	5/9*	6

\*Abnormal scores.

### *Retrograde Memory*

Retrograde memory was assessed in the three weeks after the trauma.

### *Autobiographical Memory*

FP's autobiographical memory for events prior to the head trauma was assessed by means of a semi-structured interview covering past personal events, using procedures similar to those of Kopelman et al. (1989). FP's responses were compared with those of his wife. The questions covered 3 broad periods: infancy, young adulthood and recent life, and concerned either 'personal semantics' (e.g. the name of the first school attended, names of teachers, etc.) or autobiographical 'incidents' from the patient's life (a broken leg, marital problems, etc.). A source of difficulty in assessing autobiographical memory stemmed from FP's rapid re-acquirement of forgotten events. However, he spontaneously distinguished between events he had never forgotten – a feeling of "actual experience" – and those he had only recently relearned. This distinction does not appear in our scoring but has its importance in a qualitative analysis. FP's autobiographical memory loss concerned recent life (since 1985),

and mostly episodic events, i.e. there was a temporal gradient (Table I). For instance, he could give details about the end of his short stay in hospital but was unable to say where he had been on holiday before his accident.

### *Public Events*

A questionnaire on major public events was used to assess semantic memory (Thomas-Antérion et al., 1994). The protocol used 28 sentences and 26 pictures related to 20th-century events. FP was required to recall each event, then to recognize it in a multiple-choice question and finally to answer two questions on details about the public event. For instance, FP was asked to say what event Chernobyl referred to; next, whether it was a Russian ballet dancer, a civil nuclear disaster, or Khrushchev's successor; lastly, in what country Chernobyl was located and how many casualties were reported officially. The chosen events were distributed throughout the century, with a larger representation of more recent years. Two sessions were necessary to present all the questions, the 'verbal battery' 9 days before the 'visual' one: this may explain FP's better results on the visual items, whereas control performances on the two batteries were fairly similar in Thomas-Antérion et al.'s study.

Table II and Figure 2 show that FP scored low in evocation and open-ended questions, particularly those covering the last decade. The better memory for public events that occurred during the patient's life than memory for events that occurred before the 60's (FP was born in 1963) is also observed in controls and is positively correlated with a low educational level (Thomas-Antérion et al., 1994). To multiple-choice questions, FP's answers were often appropriate but very slow. When FP stated that he did not know the answer, he tried to guess probable foils. Thanks to many verbalized deductions, he often chose the correct answers, but with no certainty.

### *Famous Faces*

Twenty-five photographs of prominent public figures were selected. These were persons who began to be famous in one of the three decades of FP's life: 8 well known before 1975, 8 for 1975-1984, and 9 for 1985-1994. The photos were randomly presented on 10 × 7 cm cards. FP's recognition of public figures of the most recent decade was compared to that of personalities from the two

TABLE II  
*FP's Scores on Thomas-Antérion et al.'s (1994) Public Events Test*

	Free recall	Multiple-choice questions	Open-ended questions	Total	Controls
Verbal battery	36% (10/28)	78% (22/28)	37,5% (21/56)	47% (53/112)	80,00 ± 0,02%
Visual battery	58% (15/26)	73% (19/26)	42% (22/52)	54% (56/104)	80,00 ± 0,02%
Total	46% (25/54)	76% (41/54)	40% (43/108)	50% (109/216)	80,00 ± 0,02%

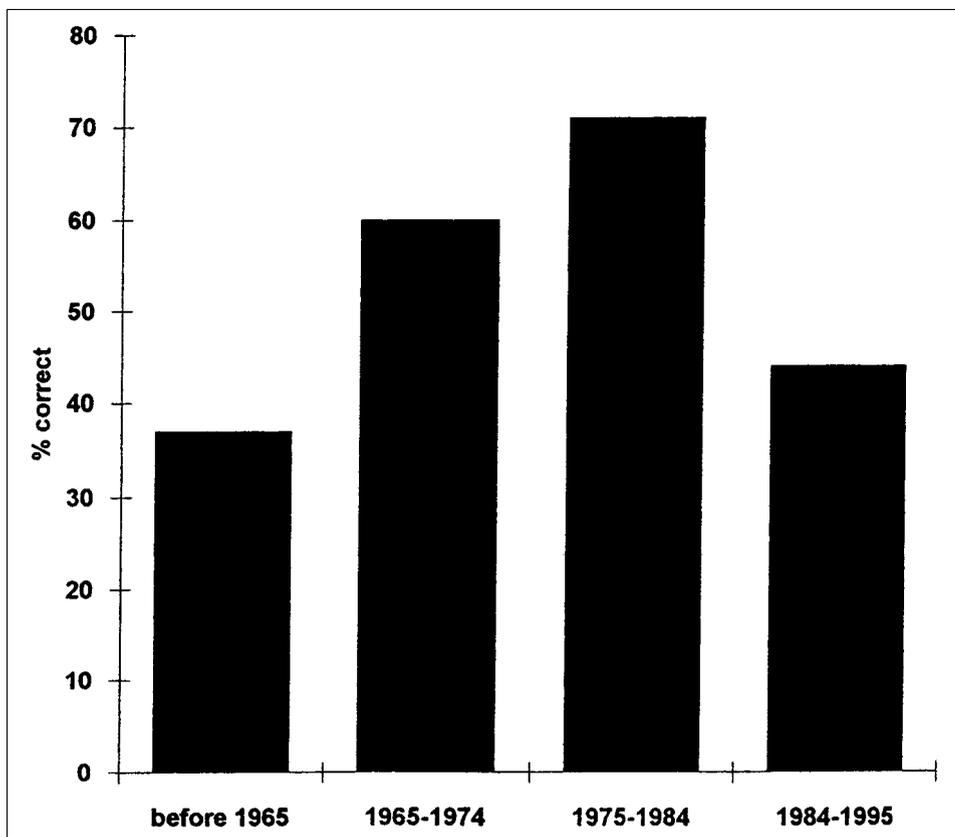


Fig. 2 – FP's scores on Thomas-Antérion et al.'s (1994) Public Events test.

previous decades. FP was asked to say if he had ever seen the target face. If he was unable to name the person, he was asked to describe the person in detail. For example, for someone he identified as an actor, he was asked in what play, film or television series he had appeared. FP was questioned until the examiner was convinced that the patient had given sufficient identifying information, or until it was clear that his information was vague or nil. In Figure 3, showing FP's identification of famous faces, it is clear that the more recent the public fame, the poorer FP's recognition.

### *New Words*

We selected new French words that had appeared for the first time in the annual editions of the *Petit Larousse* dictionary during the most recent decade. Eighteen were selected (fax, *parapente*, Walkman, etc.). FP was asked to define the words. A score of 0 was given for no or incorrect response, 1 for a vague definition, 2 for a correct definition. His responses were compared to those of 3 controls, matched for sex, age and educational level. FP obtained a score of 20/36 (three controls: 29, 30 and 31/36, respectively). Two types of responses

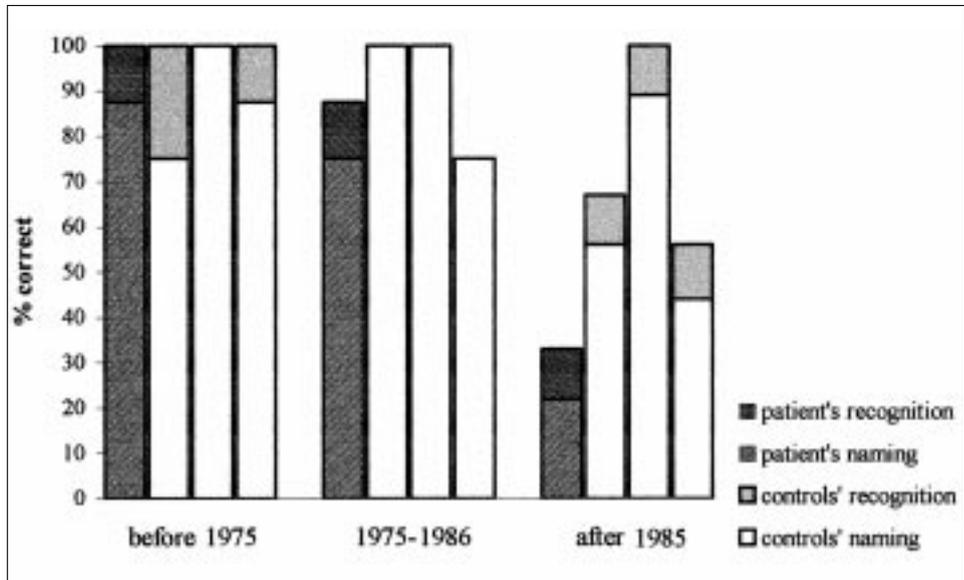


Fig. 3 – FP's scores on a Famous Faces Recognition Test. Performances are compared to those of 3 controls, matched for sex, age, profession and educational level.

suggested a loss of words: sometimes FP said he did not know words he obviously must have known before his trauma: for instance, among other words, he had forgotten *parapente*, although he had marvelled at them during his last holidays, in Savoie in 1995. For several other words, such as 'fax', he defined them correctly, but acknowledged that he had relearned them a few days before with his wife or from television. Nevertheless, they were scored 2.

### Procedural Memory

FP's handwriting changed after the trauma; he wrote again the way he had 10 years before in vocational training. Whereas the 'adult' signature he had recently adopted was rather hard to read, after the trauma he could not help signing with the nice juvenile hand he had used in his twenties (Figure 4). He then practised signing with his 'adult' signature. He was also unable to use his

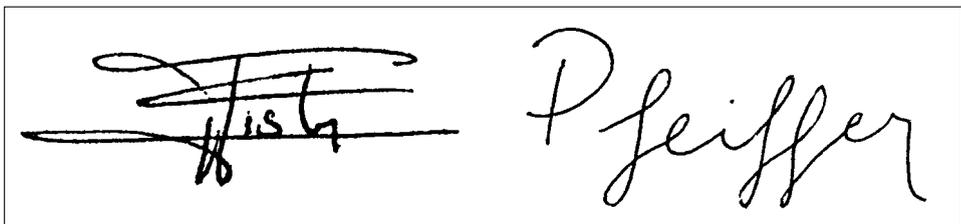


Fig. 4 – Facsimile of FP's signature before and after the trauma (the name has been slightly altered on the second signature to preserve the patient's anonymity. The patient gave his written consent).

fax before he had reread all the instructions, but he quickly relearned how to operate it.

In March 1996, the retrograde amnesia had almost completely disappeared, and the patient thought he could resume work. However, he acknowledged that he still felt unfamiliar about some relearned autobiographical events. In a control visit in October, he thought he had completely recovered. On a second SPECT, performed in October, all the metabolic ratios were symmetric and normal, likewise EEG recordings were normalised.

## DISCUSSION

We have documented the case of FP, who sustained a minor head trauma: anterograde amnesia was disproportionate to the degree of trauma but disappeared 24 hours after the accident. It corresponded to the classical picture of transient global amnesia, triggered by head trauma (Schacter and Kihlstrom, 1989). On formal testing, his anterograde memory was fairly preserved and confirmed his good learning capacity. His memory for day-to-day events showed little or no verbal memory impairment. Retrograde amnesia lasted for about 2 months and encompassed the previous 10 years. Given his recovery from retrograde amnesia, even if it occurred two months after the trauma, FP can also be thought of as a case of transient retrograde amnesia. Cases of marked retrograde amnesia and mild or absent anterograde amnesia have been reported increasingly during the last two decades. Some of the patients show evidence of brain damage or brain hypometabolism whereas others do not. In both situations, a few cases of total recovery have been documented. Thus, Lucchelli et al. (1995) reported recovery of past memories after one year of retrograde amnesia in a patient having suffered a thalamic stroke. More relevant to the present study was the case, reported by the same authors, who, following a mild head trauma showed PET scan evidence of significant hypometabolism in the posterior cingulate cortex bilaterally. The patient recovered totally from the retrograde amnesia one month post-onset (no post-recovery PET scan was taken). Two further similar cases reported in the literature were studied by Schacter et al. (1982) and De Renzi et al. (1995). Both occurred without any clear brain damage and were diagnosed as functional amnesias (see below). Though retrograde amnesia was restricted to autobiographical events, De Renzi et al. ruled out a psychogenic origin.

FP's retrograde amnesia affected both semantic information (semantic personal facts, public events, famous faces, new words) and autobiographical events. More surprising was the loss of motor skills like working with a computer, signing his name and writing which suggested a loss of procedural memory, since his post-onset handwriting was more juvenile. Though uncommon, such losses have been described after closed-head injuries: patient BG had to quickly relearn driving (Rousseaux et al., 1984) and patient MEB cooking and knitting (Mattioli et al., 1996). However, our patient's inability to perform a complex motor task could also have been part of his semantic deficit if what was forgotten were the specific actions needed to perform the activity of

producing an 'adult' signature or writing (in analogy to ideational apraxia; see De Renzi and Lucchelli, 1988).

Several lines of evidence suggested that FP did not actually lose his past memory, but that his access to it was impaired. The crucial and main evidence is his total recovery. Furthermore, during the retrograde amnesia period, the 'lost' episodes of his past life had only to be evoked once to be easily and permanently relearned. This 'saving effect', which allowed FP to relearn faster than a naive subject, indicates the preservation of covert knowledge. Moreover, though FP did not rapidly reacquire a real sense of having experienced these episodes, he acknowledged that sometimes, after a few days, their evocation elicited a strange feeling of *déjà-vu*. Secondly, he performed well above chance on multiple-choice questions about public events, even when he claimed not to remember the facts or photos presented. This finding suggests that engrams were preserved but could not be accessed consciously and responses relied upon implicit recollection. This finding provides less anecdotal evidence for the dissociation between explicit and implicit retrieval (Spinnler et al., 1996).

*Prima facie*, FP's focal retrograde amnesia fulfilled criteria for functional amnesia, that is, a "memory loss that is attributable to an instigating event or process that does not result in damage or injury to the brain, and produces more forgetting than would normally occur in the absence of the instigating event or process" (Schacter and Kihlstrom, 1989). Even if CT and MRI did not show macroscopic brain damage in FP, functional investigations with EEG and SPECT did suggest a temporally limited dysfunction, suggesting a different definition of functional amnesia. De Renzi et al. (1997) proposed the term 'functional amnesia' to account for cases that cannot be classified either as psychogenic or as organic amnesia: "Although the term functional is often used as tantamount to psychogenic, in its proper sense it means that the lesion affects the function and not the substrate" (p. 788). Kapur (2000) and Kopelman (2000) state that even in cases of sound brain damage, there is room for psychogenic memory problems. This suggestion could be applied *a priori* to any case of retrograde amnesia, even if there is no psychiatric signs, as in the present case. In the same vein, Markowitsch (1996) indicates that it would be too simple and artificial to separate totally organic from psychogenic mechanisms of amnesia.

Deliberate feigning on the part of FP seems unlikely since the precipitant was a head trauma, which occurred in an unremarkable psychological context and did not entail secondary gains. There was no past history of psychiatric disorders, and psychiatric examination did not disclose any psychiatric disturbances, nor an emotionally loaded event whose consequences the patient would forget. There was no notion of fugue. The duration of his amnesia was far superior to that observed in the classical psychogenic amnesia (De Renzi et al., 1997). Moreover, the selective amnesia for events of the past decade did not correspond to a particular event or situation of emotional significance: FP's failure to remember events from the last decade was consistent whatever the form of memory assessed, i.e., semantic, episodic or procedural. His memory loss respected Ribot's law, which has only been described for organic amnesias, such as Korsakoff syndrome (Seltzer and Benson, 1974), amnesia following electroconvulsive therapy (Squire et al., 1975, 1981) or transient global amnesia

(Hodges and Ward, 1989; Kritchevsky and Squire, 1989). He displayed a pattern of amnesia closely resembling that described after damage to the anterior temporal lobe both after head trauma (e.g., Rousseaux et al., 1984; Kapur et al., 1992; De Renzi and Lucchelli, 1993) and herpes simplex encephalitis (Stuss and Guzman, 1988).

FP's EEG recordings indicated a bilateral temporal dysfunction, which is in line with the observation of focal retrograde amnesias after bitemporal injuries (e.g., Rousseaux et al., 1984; Kapur et al., 1992; De Renzi and Lucchelli, 1993; De Renzi et al., 1995). SPECT scan showed a clear right temporal hypometabolism at a time when memory for major public events of the past decade had recovered, but memory for autobiographical events was still patchy. From a PET study carried out in normals Finck et al. (1996) inferred that a right hemispheric network involving temporal, posterior cingulate and prefrontal areas was engaged in affect-laden autobiographical memory. Therefore, it is possible to speculate that at the time of our first SPECT study, the progressive recovery of FP's left hemisphere allowed for a correct recall of non affect-laden public events, while autobiographical forgetfulness resulted from the persistent dysfunction of the right hemisphere. When 11 months post-onset brain metabolism became again normal, FP acknowledged that he had recovered emotional feelings for most of his relearned personal history. Thus, we could speculate that the retrieval path via right hemispheric structures, which had been blocked at the time the first SPECT was performed, was again open.

There are several theoretical models that try to account for access impairment (Damasio, 1989; Kapur, 1997; Gloor, 1990, among others) and several isolated retrograde amnesia case studies that have concluded along the lines of these models (e.g., Hunkin et al., 1995; Lucchelli et al., 1995; Evans et al., 1996; Fujii et al., 1999). The models have in common a conceptual framework concerning the flexibility of widely distributed neural networks, whose activation renders possible the reproduction of memories. Thus, Gloor (1990) proposed that the information is carried by "the specific pattern of connectivity woven between the neurons which creates a distributed matrix of excitation and inhibition and is specific for the experience it represents" (p. 1681). This implies that the defective patterned matrices that were temporarily unable to be activated despite intact engrams, either restore the previous distributed connectivity or are eventually activated under the new pattern of connectivity. In the latter case, the quality of recovered memories, probably due to re-learning, would be different from that obtained by restoration of previous weights of connections, particularly concerning the emotional coloration of recollections. FP stated that he recovered all his memories but that emotional warmth was present for most but not all recovered memories.

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#### REFERENCES

- DAMASIO A. Time-locked multiregional retroactivation: A systems-level proposal for the neural substrates of recall and recognition. *Cognition*, 33: 25-62, 1989.

- DE RENZI E and LUCCHELLI F. Dense retrograde amnesia, intact learning capability and abnormal forgetting rate: a consolidation deficit? *Cortex*, 29: 449-466, 1993.
- DE RENZI E, LUCCHELLI F, MUGGIA S and SPINNLER H. Persistent retrograde amnesia following a minor trauma. *Cortex*, 31: 531-542, 1995.
- DE RENZI E, LUCCHELLI F, MUGGIA S and SPINNLER H. Is memory loss without anatomical damage tantamount to a psychogenic deficit? The case of pure retrograde amnesia. *Neuropsychologia*, 34: 781-794, 1997.
- EVANS J, BREEN K, ANTOUN N and HODGES J. Focal retrograde amnesia for autobiographical events following cerebral vasculitis: A connectionist account. *Neurocase*, 2: 1-11, 1996.
- FINCK G, MARKOWITSCH H, REINKEMEIER M, BRUCKBAUER T, KESSLER J and HEISS W. Cerebral representation of one's own past: Neural networks involved in autobiographical memory. *Journal of Neuroscience*, 16: 4275-4282, 1996.
- FUJII T, YAMADORI A, ENDO K, SUZUKI K and FUKATSU R. Disproportionate retrograde amnesia in a patient with herpes simplex encephalitis. *Cortex*, 35: 599-614, 1999.
- GLOOR P. Experiential phenomena of temporal lobe epilepsy. Facts and hypothesis. *Brain*, 113: 1673-1694, 1990.
- GOLDBERG E, ANTIN S, BILDER R, GERSTMAN L, HUGUES J and MATTIS S. Retrograde amnesia: Possible role of mesencephalic reticular activation in long-term memory. *Science*, 213: 1392-1394, 1981.
- HAAS D and ROSS G. Transient global amnesia triggered by mild head trauma: A form of traumatic migraine. In H. Markowitsch (Ed.), *Transient Global Amnesia and Related Disorders*. Toronto: Hogrefe & Huber, 1990, pp. 79-88.
- HODGES J and WARD C. Observations during transient global amnesia. *Brain*, 112: 595-620, 1989.
- HUNKIN N, PARKIN A, BRADLEY V, BURROWS E, ALDRICH F, JANSARY A and BURDON-COOPER C. Focal retrograde amnesia following closed head injury: A case study and theoretical account. *Neuropsychologia*, 33: 509-523, 1995.
- KAPUR N. Focal retrograde amnesia in neurological disease: A critical review. *Cortex*, 29: 217-234, 1993.
- KAPUR N. How can we best explain retrograde amnesia in human memory disorders? *Memory*, 5: 115-129, 1997.
- KAPUR N. Syndromes of retrograde amnesia: A conceptual and empirical synthesis. *Psychological Bulletin*, 125: 800-825, 1999.
- KAPUR N. Focal retrograde amnesia and the attribution of causality – An exceptionally benign commentary. *Cognitive Neuropsychology*, 17: 623-637, 2000.
- KAPUR N, ELLISON D, SMITH M, MCLELLAN D and BURROWS E. Focal retrograde amnesia following bilateral temporal lobe pathology. *Brain*, 115: 73-85, 1992.
- KOPELMAN M. Focal retrograde amnesia and the attribution of causality – An exceptionally critic review. *Cognitive Neuropsychology*, 17: 585-621, 2000.
- KOPELMAN M, WILSON B and BADDELEY A. The autobiographical memory interview: A new assessment of autobiographical and personal semantic memory in amnesic patients. *Journal of Clinical and Experimental Neuropsychology*, 11: 724-744, 1989.
- KRITCHEVSKY M and SQUIRE L. Transient global amnesia: Evidence for extensive, temporally graded retrograde amnesia. *Neurology*, 39: 213-218, 1989.
- LUCCHELLI F, MUGGIA S and SPINNLER H. The 'Petites Madeleines' phenomenon in two amnesic patients. Sudden recovery of forgotten memories. *Brain*, 118: 167-183, 1995.
- MARKOWITSCH H. Organic and psychogenic retrograde amnesia: Two sides of the same coin? *Neurocase*, 2: 357-371, 1996.
- MARKOWITSCH H, CALABRESE P, FINK G, DURWEN H, KESSLER J, HÄRTING C, KÖNIG M, MIRZAIAN E, HEISS W, HEUSER L and GEHLEN W. Impaired episodic memory retrieval in a case of probable psychogenic amnesia. *Psychiatric Research: Neuroimaging Section*, 74: 119-126, 1997.
- MATTIOLI F, GRASSI F, PERANI D, CAPPÀ S, MIOZZO A and FAZIO F. Persistent post-traumatic retrograde amnesia: A neuropsychological and (18F)FDG PET study. *Cortex*, 32: 121-129, 1996.
- RIBOT T. *Les Maladies de la Mémoire*. Paris: Librairie Germer Baillière, 1881.
- ROUSSEAU M, DELAFOSSE A, CABARET M, LESOIN F and JOMIN M. Amnésie rétrograde post traumatique. *Cortex*, 20: 575-283, 1984.
- RUMELHART D and MCCLELLAND J. *Parallel Distributed Processing: Explorations in the Microstructure of Cognition*. Vol. 1. Cambridge, MA: MIT Press, 1986.
- RUSSEL W and NATHAN P. Traumatic amnesia. *Brain*, 69: 280-300, 1946.
- SCHACTER D and KIHLMSTROM J. Functional amnesia. In F. Boller and J. Grafman (Eds), *Handbook of Neuropsychology*. Amsterdam: Elsevier, 1989, pp. 209-231.
- SCHACTER DL, WANG PL, TULVING E and FREEDMAN M. Functional retrograde amnesia: A quantitative case study. *Neuropsychologia*, 20: 523-532, 1982.
- SELTZER B and BENSON D. The temporal pattern of retrograde amnesia in Korsakoff's disease. *Neurology*, 24: 527-530, 1974.
- SPINNLER H, LUCCHELLI F and MUGGIA S. The 'Petites Madeleines' phenomenon in two amnesic

- patients: Sudden recovery of forgotten memories. *Brain*, 119: 1403-1404, 1996.
- SQUIRE L, SLATER P and CHACE P. Retrograde amnesia: Temporal gradient in very long-term memory following electroconvulsive therapy. *Science*, 187: 77-79, 1975.
- SQUIRE L, SLATER P and MILLER P. Retrograde amnesia and bilateral electroconvulsive therapy. Long-term follow-up. *Archives of General Psychiatry*, 38: 89-95, 1981.
- STUSS D and GUZMAN D. Severe remote memory loss with minimal anterograde amnesia: A clinical note. *Brain and Cognition*, 7: 21-30, 1988.
- THOMAS-ANTÉRION C, LAURENT B, LEMESLE B, LAPORTE S and MICHEL D. Etude de la mémoire rétrograde événementielle chez les traumatisés crâniens (à partir de 36 cas). *Annales de Réadaptation et Médecine Physique*, 37: 381-388, 1994.
- WECHSLER D. *Echelle Clinique de Mémoire de Wechsler-Révisée* (French version). Condé-sur-Noireau (France): Les Editions de Psychologie Appliquée, 1991.

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