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Citation for published version:

Cubelli, R, Beschin, N & Della Sala, S 2020, 'Retrograde amnesia: A selective deficit of explicit autobiographical memory', *Cortex*, vol. 133, pp. 400-405. <https://doi.org/10.1016/j.cortex.2020.10.003>

Digital Object Identifier (DOI):

[10.1016/j.cortex.2020.10.003](https://doi.org/10.1016/j.cortex.2020.10.003)

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Peer reviewed version

Published In:

Cortex

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**RETROGRADE AMNESIA:
A SELECTIVE DEFICIT OF EXPLICIT AUTOBIOGRAPHICAL MEMORY**

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“Why else should we be impressed by the fact that a response to a current stimulus can be influenced by a past event of which the subject is unaware? Isn't that how most organisms behave most of the time” Lockhart (1989, p.6).

In patients with retrograde amnesia (RA), declarative memory is severely impaired for events that occurred prior to onset of the disorder. Implicit memory might be preserved (Kopelman, 2002), but it is usually tested with priming or procedural learning tasks (Kopelman and Kapur, 2001) that reveal sparing of memory for anterograde events. That is, these tasks assess memory for episodes which happened after the onset of RA. As such, they are appropriate to investigate implicit memory in anterograde amnesia (Schacter, 2019), not in RA.

To assess implicit memory in RA all information and abilities acquired before amnesia should be considered. Implicit memory includes procedural knowledge, i.e. motor abilities like playing a musical instrument or practising a sport, and cognitive skills like calculation, syntax and scripts. It also includes “the habits and preferences that are inaccessible to conscious recollection, but they nevertheless are shaped by past events, they influence our current behavior and mental life” (Squire and Zola-Morgan, 1991, p.3). Finally, it encompasses episodic and semantic information acquired in the retrograde period and retrieved as a “tool to accomplish a present task” (Jacoby and Kelley, 1987, p. 314). All these different types of implicit memory processes dissociate from one another (Roediger, 1990; Willingham and Preuss, 1995), thus making it difficult to conceive implicit memory as a monolithic function that can be assessed by means of a single test, independently of when information is acquired. Moreover, it is imperative to distinguish between memory contents (episodes, semantics,

and procedures) and modes of retrieving such memory contents (explicit or implicit). Even if episodes are mainly retrieved explicitly and procedures are mainly retrieved implicitly, any content of memory, independently of the modality of learning, can be implicitly retrieved (Cubelli and Della Sala, 2020). This implies that, contrary to what is commonly held, procedural memory and implicit memory are not overlapping: implicit memory has a wider meaning.

This more encompassing definition of implicit memory considers RA as a deficit of explicit declarative memory, which is limited to autobiographical episodic and semantic memories (often sparing encyclopaedic and categorical knowledge) and framed within circumscribed time windows (in most cases from a few days to many years immediately preceding the onset of amnesia). We will clarify this point briefly reporting on case LZ, a patient with an isolated form of RA.

The case of LZ

LZ (fictitious initials), a right-handed man with 11 years of formal education, was 47 year old when he was found confused and agitated, lying on the floor at his working place. He had no fever and there were neither apparent signs of head trauma, nor signs of bowel or bladder lack of control. LZ was disoriented and amnesiac but with no signs of neurological abnormalities. He did not recognise his wife and children, and had no recollections of his adult life. He insisted that he was 17 and had to take his younger brother, who died 15 years earlier, to school. He remembered well his friends from school times. The neurological examination was normal. A psychiatrist's interview did not disclose overt functional symptoms, though they could be hidden and not easy to detect; secondary gains did not emerge, but they may not be promptly evident. EEG, CT were normal as were the MRI scans two days and a year later. A PET scan a year later was also normal. A sleep-deprived EEG showed slow waves on the left fronto-temporal regions, which persisted a year later. He had a history of hypertension and a stressful job. A clinical psychologist followed up the patient, initially with weekly and then monthly meetings for over four years, interviewing him, his wife (both separately and together) and other members of the family, as well as friends and colleagues. Nothing eventful emerged which would support a psychogenic cause of LZ's amnesia. However, typically such evidence is difficult to detect and accrue (Kapur, 2000; Kopelman, 2000, 2002; Harrison et al., 2017). He did not receive pharmaceutical treatments. Soon after discharged from the hospital, he had no problems driving his car, but did not seem to recognise his home, which however he did not find strange, though he could not find things around the house such as cutlery or the sugar.

We formally assessed him the first time a year after the event (see Supplementary Material). With the exception of autobiographical memory covering the last 30 years, his performance on neuropsychological tests was unremarkable, including his scores on anterograde declarative memory tests.

LZ quickly recovered knowledge of his past from different sources, never questioning whether the offered information was real or not, rather accepting them with a detached attitude. He never showed overt preoccupation about living on the consequences of a life that he could not remember and from which he could not reconstruct personal experience or relive emotions. He took his amnesia for granted, and did not appear to be excessively frustrated by it. He showed the pattern of symptoms referred to as "indifférence amnésique" (Ajuriaguerra and Roualt de la Vigne, 1946; Della Sala and Spinnler, 1986; historically referred to within the picture of 'la belle indifférence, Stone et al., 2006).

On one occasion, LZ went with his family to the same hotel where they used to spend their holidays but the place did not elicit any memory. On a different trip to a seaside place, he acknowledged some sense of familiarity for a shop he had been to regularly.

In sum, LZ showed decades-long loss of RA coupled with relatively well-preserved anterograde memory, spared semantic and procedural knowledge, within a clinical picture characterised by sudden onset, little evidence of brain damage, and some behavioural changes. Like previous reported cases, LZ showed an astonishingly serene acceptance of his amnesic condition and an unquestioned embracement of the forgotten life. The family and the work environment he could not explicitly recognize and was introduced to as his own were not grounds for alarm, doubt or fear. There were minimal concerns about memory deficits, but no depression or mood alteration.

LZ acknowledged his lack of empathy towards his wife and his lack of paternal feelings towards his children, aged 15, 13 and 9. Yet he eagerly accepted that they were his family and behaved accordingly. This is a common trait of several RA patients. Researchers and clinicians accept this as a fact. Yet, to other observers this is astounding. Would RA patients eagerly accept to go home, if shown a completely different house, and were falsely told it was their home? Would they accept affection from people to whom they were introduced as close relatives but who were played by actors? Obviously, these thought experiments would be highly unethical, but they exemplify the bewilderment that RA patients should show, but do not, and the astonishment that should be experienced by the clinician, but does not. Independently of the causal label that authors use to

define RA cases (organic vs psychogenic vs functional), as well as from the terminology used to identify cases of RA (pure vs isolated), we surmise that RA is characterised by an impairment of explicit autobiographical memory.

Like LZ, other RA patients appear to be able to access implicit autobiographical knowledge, to feel that their home and relatives are not complete strangers.

Sparing of past implicit memories in RA

We define a memory as implicit when the learned information is retrieved and used without awareness of remembering it and with no reference to the learning phase (Cubelli and Della Sala, 2020). According to this definition, hints that RA patients do have access to memories implicitly can be gleaned from the literature.

Case DV (Della Sala et al., 1996) affected by dense RA, had no explicit memories of his own house, nor explicit memories of his close relatives. Yet, soon after been discharged from hospital, he flawlessly drove his car to home. As soon as he arrived at home he immediately found the bathroom, even if the door was closed. Afterwards he reached for his pipe in the usual place. At his first dinner at home, he easily found kitchen tools, and automatically sat at his usual place at the table. Similarly, he proved able to access the required information from a computer at work. This gap between explicit amnesia and implicit knowledge was interpreted as an increased threshold of conscious accessibility of stored information. De Renzi et al. (1995) also suggested this interpretation by stating that RA patients' advantage of recognition over recall is suggestive of "an inhibitory process that prevents the surfacing of memory records, whilst leaving them accessible in situations less dependent upon conscious control" (p. 538).

Instances of implicit declarative and non-declarative memories are noted in the reports of other RA cases. All motor skills that RA patient MA acquired before his amnesia were intact (De Renzi et al., 1995). Case MM (Lucchelli et al., 1995) stated that, "although he could not come up with any contextual information regarding people from his past, he nonetheless felt an 'emotional' sense of familiarity building up after a while, in a vague but confident sort of way." (p. 172). Patient A, reported by Staniloiu et al. (2018), had a very severe RA with a rather flat emotional response; he could not overtly recognise his father though acknowledged that he had a sense of familiarity towards him. Case FF (Antérion et al., 2008) could easily count in Euros, even if this currency substituted French Francs only three months prior to his RA. Campodonico and Rediess (1996),

reporting on case LJ acknowledged that some “aspects of remote information were preserved despite her impaired explicit knowledge of such material.” (p.155), given the patient’s relatively spared performance on a test assessing the association between people famous during her amnesia and their profession. Hippocampal case VC (Cipolotti et al., 2001) had retained some implicit knowledge of public figures despite the severe loss of explicit knowledge. The same was true for case NN (Fast et al., 2008), whose memory for public figures was above average. Similarly, case MA (De Renzi et al., 1995) performed better on a series of famous name-activity congruous associations than with unknown people name-activity associations, “suggesting that he had retained some implicit knowledge of names that were not consciously recognised” (p. 534). Lucchelli et al. (1998) noted that there is anecdotal evidence suggesting that some RA cases “entail impaired explicit access to knowledge that may be accessible implicitly” (p. 109). Antérion (2017) reported the case of a young RA patient who lost access to all her autobiographical memories, yet “she did not modify her lifestyle (values, beliefs, home, friends)”. The same access to her past affective life transpires in the diary of Frances, a patient whose severe RA followed an encephalitis. Frances wrote “The first thing you truly realise is that you love the people around you even if you can’t remember their names.”¹ The above examples encompass instances of procedural, semantic and episodic implicit memory. The RA impairment in these examples is relatively pure, however the considerations on the nature of RA applies to all RA cases.

This impaired access to explicit memory has been accounted for in terms of dysexecutive suppression of autobiographical memory retrieval (Kopelman, 2000, 2002) triggered by a variety of causes including minor head injury and depression. Similarly, an ‘amnesic block’ has been adduced, triggered by stress (Markowitsch, 2002; Staniloiu et al, 2020). Whatever the triggering mechanism may be, RA patients should be assessed with instruments appropriate to elicit the presence or the absence of implicit memory relative to learning which happened before the onset of their amnesia. These should of course include detailed interviews with the patients and their relatives to thoroughly investigate all those aspects of a person’s behaviour which may reveal preserved feelings, habits and familiarity with their environment. The sparing of a variety of such implicit memories, including emotions, the effect of past frequent exposures and the feeling of effortless comfort (Kaplan and Kaplan, 1982), may explain the patient’s acceptance of their own explicitly forgotten life.

Importantly, the presence of implicit memory should be ascertained, soon in the course of the disease, also by means of tests assessing previously acquired procedures as well as formal

¹ <https://www.encephalitis.info/frances>

“indirect” tests (see Baddeley et al., 2020) like assessing knowledge of famous people names described in Cipolotti et al. (Exp. 4, 2001). If a RA patient has access to implicit knowledge of previously known people, then their recognition score would be similar to that of the age matched controls, even if, contrary to the controls, that RA patient would fail to overtly identify familiar people. Moreover, older RA patients’ performance could be compared to that achieved by younger healthy people; in the presence of implicit access to remote information, the RA patients’ scores ought to be greater than those achieved by a group of younger people, whose familiarity with and knowledge of people who had been famous in the past, but no longer are, should be minimal.

RA as explicit autobiographical deficit

In the classical taxonomy of memory accepted as accrued wisdom (Squire, 1987, 2007), implicit memory and non-declarative memory coincide, whereas declarative is equated to explicit and encompasses both episodic and semantic memory.

However, the distinction between declarative and non-declarative is based on contents, whereas the explicit/implicit dichotomy refers to retrieval modes. Declarative memory literally encompasses what we know that we can tell through words, drawings or gestures, and includes the content of semantic and episodic memory. Non-declarative memory instead includes what we know that we can show by doing (Breedlove et al., 2010), like the procedural contents of memory as well as feelings, attitudes, or inclinations manifested through non-verbal behaviour. The explicit/implicit dichotomy is characterised by overt reference to the learning phase (I know that I am remembering) opposed to the influence of previous experience on one’s behaviour without reference to such learning (I am not aware that I am remembering). Hence, non-declarative and implicit should not be conceived as synonyms (Cubelli and Della Sala, 2020). All contents of memory could be retrieved either explicitly or implicitly (Cubelli, 2010). This concept is summarised in Figure 1. Depending on the learning experience, contents of memory could be associated with emotions and feelings, which can be retrieved implicitly, even when memory contents are not explicitly accessible.

The difference between explicit and implicit memory resonates that proposed by Polanyi (1958) and revamped by Jacoby and Kelley (1987) about memory as tool versus memory as an object: A person’s name can be retrieved either as an object of memory, for instance when asked directly, or as a tool in a casual encounter. In the former instance, the aim of remembering is to share knowledge, in the latter the aim it is to use memory to perform an action by means of remembering, that is to greet the person. When memory is used as a tool, the focus is not on the past, but on the present” (Jacoby and Kelley,

p. 316). Similarly, Schacter et al. (1989) mapped the distinction of explicit and implicit memory onto the intentional and unintentional retrieval processes dichotomy: “When performing an implicit task such as word completion, subjects who complete test stems with study list items are engaging in ‘unintentional retrieval’ only in the specific sense that they are not deliberately trying to remember study items; in the more general sense, they are engaging in intentional retrieval of appropriate completions from semantic memory” (p. 49).

This framing of the implicit/explicit distinction could also be invoked to account for automatic/voluntary dissociations in unrelated domains, like apraxia (Cubelli and Della Sala, 1996). Apraxic errors are observed when gestures are performed in an artificial context, that is, when they are the object of a request to demonstrate an action, not so much within the typically eliciting situations, whereby gestures are performed as a means to interact with the real world (De Renzi, 1964).

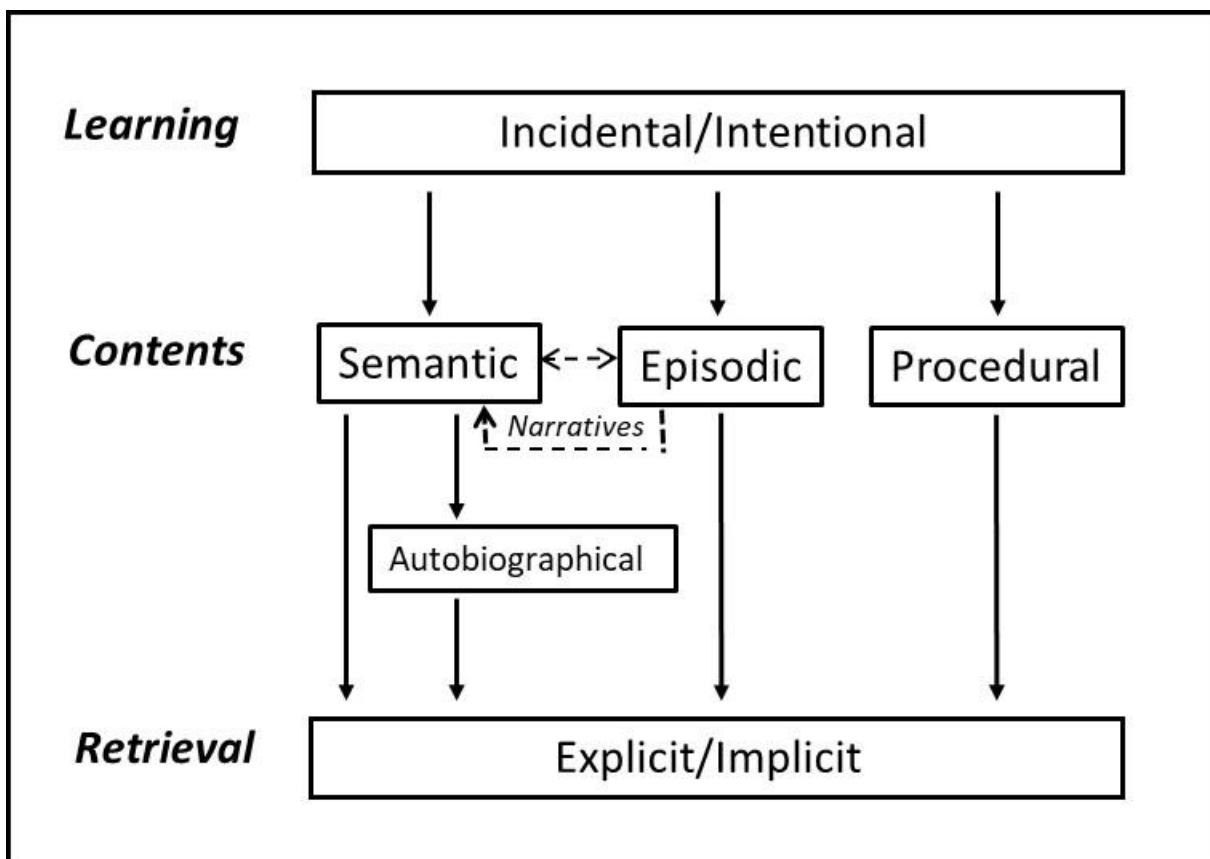


Figure 1. Three-phase model of memory including the types of learning, the different memory contents and the retrieval modes. Anterograde amnesia would be due to a lesion to the Episodic box, whereas Retrograde amnesia would identify with a damage to the Autobiographical box.

The learning phase can be intentional, studying something wanting to remember it, knowing that a test will follow, or incidental, learning something without aiming at remembering it (Baddeley et al., 2020). Although the efficiency of these two learning processes is not necessarily equipose in different contexts, all material can be learned intentionally or incidentally. Eyewitness testimony exemplifies incidental learning of an episode, on the contrary a spy may intentionally learn the details of an episode to later report it. Semantic information could be learned incidentally during a conversation or intentionally by enrolling in a formal course. The same is true for procedures: one can attend grammar classes or absorb the grammar of a language incidentally within a family setting.

The different contents interact. Semantic and episodic information converge in constructing autobiographical memory. Autobiographical memory is thus not a collection of episodes; it includes semantic information, like the name of our grandparents or our childhood home address. Autobiographical memory encompasses schemata and abstract representations of events and people; akin to episodic memory, it is organised hierarchically from general categories (life periods and themes) to specific episodes (e.g., see Conway, 1996; Conway and Pleydell-Pearce, 2000). The repeated narrative of specific episodes translates them into story telling (accurate or inaccurate), embedded into personal semantics. Such information is unavailable in RA, making it a deficit of explicit autobiographical memory sparing its implicit access. This pattern of spared and impaired abilities charactering RA differentiates it from anterograde amnesia (AA), which is usually defined as the impairment of episodic memory explicitly retrieved. Not only AA and RA differ on the temporal dimension of memory loss, before or after the triggering episode or the onset of the underlying disease. They also differ in the loci of impairment. It is relevant to stress that implicit retrieval is spared both in RA and AA relative to the content explicitly unavailable. Therefore, implicit retrieval should be assessed differently in the two conditions. This applies independently of the underlining etiology of the amnesia (Kopelman, 2000).

RA does not entail loss of previously acquired skills, including syntax, and semantic knowledge, including lexicons, nor it is characterized by overt change in habits or emotions. True RA cases should present not only with preserved procedural memory but also with spared access to the entire gamut of implicit memories, quite independently of their verbal reporting. RA patients should not face overt feelings of estrangement when returning home or when mingling with relatives and friends. Therefore, the lack of access to the vast array of implicit memories, procedural, semantic or behavioural, would suggest malingering (e.g., Kurth, 1983; Zago et al. 2004).

In non-scientific parlance, RA is often depicted as sparing procedural memories (Della Sala and Brazzelli, 1998; Baxendale S. *BMJ*. 2004 Dec 18; 329(7480): 1480–1483). Rarely though other aspects of implicit memory, as above defined, are contemplated. A telling exception is portrayed in Figure 2 taken from a comic crime story of a RA patient who does not recognize his fiancée, yet feels for her and finds solace in her company (see Fig.2).

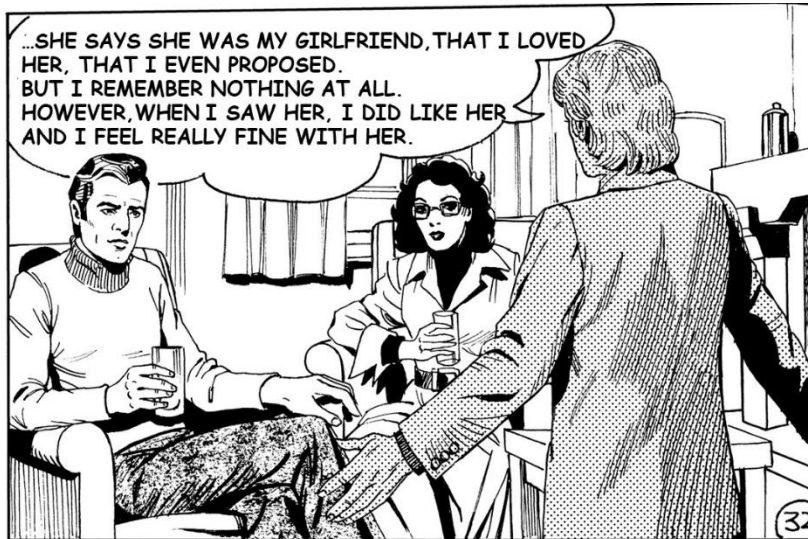


Figure 2. A vignette from the story “Nella spirale del delitto” (In the spiral of crime), of the series “Diabolik”, n. 305, XV: 1, 1976, text by Angela & Luciana Giussani, drawings by Franco Paludetti & Brenno Fiumali. Copyright Diabolik©Astorina Srl.

In conclusion, most RA patients, including LZ, seem to accept meekly to live a life that they explicitly disown. This apparent contradiction could be reconciled by considering RA, independently of aetiology, as a deficit to explicitly accessing pre-onset autobiographical memories coupled with preserved implicit knowledge, wherein “implicit” refers to the retrieval mode of any content of memory.

Acknowledgements. We are grateful to M. Kopelman and R. Logie for commenting on previous versions of this manuscript, and to A. Baddeley for fruitful discussions on this issue. We are grateful to the publisher Astorina, Milan, Italy, for their permission to reproduce the vignette in Fig. 2, and the cover illustration, which accompanies this paper.

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Supplementary Material

The Retrograde amnesia of case LZ

LZ presented with no sensory deficits, he was well oriented, during interviews and assessments his demeanour invariably appeared appropriate to his actual age, and his general cognition was compatible with his age and level of education (see Table). LZ showed a severe retrograde amnesia (RA), the remainder of the neuropsychological exam was normal, including tests of anterograde memory, though his scores on some subtests of the Rivermead (prose, remembering names) were borderline. LZ's recall of his autobiography as well as remote events was poor, showing a clear temporal gradient; however, he was able to recognize several famous people and to identify their faces; some of the people he recognised became famous within the 30 years of his amnesic blackout. His scores on language and naming tests were normal. He performed poorly on the go-no go subcomponent of the screening Frontal Assessment Battery (Apollonio et al., 2005), but this inhibition problem was not confirmed by formal go-no go testing (De Tanti et al., 2000). His scores on functional scales assessing mood and everyday activities were all normal (Beck, 1961; Lawton and Brody, 1969).

His RA was coupled with some behavioural modifications. His wife reported that LZ's overall behaviour was at time childish. For instance, she claimed that he was meeting with people much younger than him. He drove his car faster than he used to. He did not help with family chores, and when invited by his wife to do so, he complied mumbling boyishly. He played with his children as if they were playmates; likewise his attitude to sex was more akin that of a teenager than that of an adult. He admitted some impulsivity, like the urge to buy unnecessary items he saw in display windows. LZ was surprised by the age of his wife, whom looked like an old lady to him. Similarly, he thought that his father looked more like his grandfather. On the other hand, he never doubted his adult work and he adhered to adult dressing code and formal behaviour, as if a dissociation was at play between his explicit recollection and the implicit procedures embedded in everyday formal behaviour. His relatives were concerned about his autobiographical memory gap of 30 years. Sometimes he appeared stuck in the past; for instance, he cracked jokes with his cousin's current fiancée in the belief that he was talking to her previous partner, embarrassing everybody present. His procedural memories were spared: he drove with no problems recognising the road signs; he quickly relearned how to use technologies, including phone and computer as well as work related machineries.

LZ was satisfied about his work, the procedures of which were intact, except that he reckoned that sometimes he had lapses of attention, for instance he had to read twice instructions or graphs. He did not recognise his colleagues, though he has relearned well their names and functions.

LZ - Neuropsychological assessment

LZ’s performance on a formal neuropsychological assessment is detailed in the table. The Prospective and Retrospective Memory Questionnaire (PRMQ; Smith et al., 2000) did not uncover anterograde memory deficits (patient’s own evaluation: prospective 8/80 retrospective 12/80; evaluation by proxy: 6/80 e 12/80). His performance on a formal autobiographical questionnaire (Borrini et al., 1989) showed a temporal gradient: it was 100% for age 6-10 and 11-14, decreased slightly to 80% for age 15-19, whereas his scores dropped to 13% from age 20 to one year before the incident to reach zero for the last year just before the event. On a formal questionnaire on remote events (Budriesi et al., 2002), LZ scored normally for the 4-year period around his age 12-15, and pathologically on each of the 4-year period up his age 35 (7/8, 5/8, 3/8, 3/8, 3/8, 3/8, respectively). Presented with photographs of people famous in Italy before his amnesia but whose fame persists to current days, he correctly named 14 out of 50: Einstein, Mussolini, Tomba, Totò, Hitler, Kennedy, Zoff, Aldo Moro, Maradona, Schumacher, Irene Pivetti (just seen on TV), Lauda, Queen Elizabeth and Emma Bonino.

Table. LZ’s performance on a series of cognitive tests assessing various neuropsychological domains.

TEST	LZ’s Score	Cut-off
MMSE - Mini Mental State Examination <i>(Measso et al., 1993)</i>	29/30	23.80
MODA - Milan Overall Dementia Assessment <i>(Brazzelli et al. 1996)</i>	93.6/100	85.0
ATTENTIONAL MATRICES <i>(Della Sala et al, 1992)</i>	59/60	31
TMT - Trail making test B-A <i>(Giovagnoli et al., 1996)</i>	140	>188
STROOP TEST (short version) <i>(Valgimigli, 2010)</i>	14.75	>42.1
DUAL TASK <i>(Della Sala et al.,2010)</i>	96.14	82.29
FAB – Frontal Assessment Battery <i>(Appollonio et al., 2005)</i>	13/18*	13.4
FRONTAL BEHAVIOURAL INVENTORY (FBI) <i>(Alberici et al., 2007)</i>	10/72	>16.14
COGNITIVE ESTIMATES <i>(Della Sala et al, 2002)</i>	13/40	>18

WISCONSIN CARD SORTING TEST (total score) (Laiacona et al., 2000)	78/128	90.6
MIDA RTs (De Tanti et al., 2000)		
- Simple Reaction times	0.215	0.287
- Go no-go Reaction times	0.379	0.46
NAMING Test (Catricalá et al., 2013)	44/48	41.98
TOKEN TEST (Spinnler & Tognoni 1987)	34/36	26.50
VERBAL FLUENCY (letters) (Novelli et al., 1986)	16/36	8.4
VERBAL FLUENCY (categories) (Novelli et al., 1986)	73	70
IDEOMOTOR APRAXIA TEST (De Renzi et al., 1980)		
- Right hand	70/72	52
- Left hand	70/72	52
TAYLOR FIGURE (delayed recall, memory) (Casarotti et al., 2013)		
- Copy	34/36	28.88
- Recall	16/36	8.4
DIGIT SPAN (Monaco et al., 2013)		
- Forward	5	4.26
- Backward	4	2.65
CORSI SPAN (Monaco et al., 2013)		
- Forward	4	3.46
- Backward	5	3.08
RIVERMEAD 3 (weighted score) (Beschlin et al., 2013)	73	70
REY 15 WORDS (Carlesimo et al., 1996)		
- Immediate Recall	43/75	8.53
- Delayed Recall	7/15	4.69
PROSE MEMORY (Carlesimo et al., 2002)		
- Immediate Recall	5.6/8	3.10
- Delayed Recall	6.9/8	2.39
FAMOUS FACES TEST (Rizzo et al., 2002)		
- Naming from photos	14/50*	14.5
- Semantic Knowledge (from photos)	23.5/50	22.17
- Familiarity Judgements (from names)	46/50	NA
- Semantic Knowledge (from names)	31/50	20.68

*Pathological score; NA: not available.

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