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**Phantabulation:
A case of visual imagery interference on visual perception**

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Abstract

We report the case of a 52-year old man who, following rupture of an anterior communicating artery aneurysm, presented with a phenomenon not previously described, which we have labelled ‘Phantabulation’. Phantabulation is characterised by frequent and purposeful interactions with contextually appropriate imagined objects. We suggest that this phenomenon results from confusion between real and imagined objects, caused by failure to inhibit florid visual-imagery, facilitated by cortical release mechanisms.

Introduction

We report on the case of patient MT who, following the rupture of an anterior communicating artery aneurysm, presented with a phenomenon not previously reported. He mimed actions with non-existent objects, interacting with them appropriately to the context, and confabulating about them, in the absence of any signs of classic hallucinations. For example, he would appear to smoke a cigarette and extinguish it in an ashtray, though neither object was present. When asked to draw, he reached as if for the real pencil on the table, but then mimed the picking up and drawing actions, leaving no visible marks on the paper. He ignored the fact that his actions had no actual results, and could provide detailed sensory descriptions of the (phantom) objects with which he was interacting. On direct, repeated questioning, he was able to achieve insight into the imaginary nature of these objects; yet he showed remarkably little concern about this behaviour. We have termed this phenomenon “Phantabulation”, echoing a label given to the complex hallucinations of Charles Bonnet syndrome: “Phantom visual images” (Schultz, Needham, Taylor, Shindell & Melzack, 1991).

Case Report

MT (not his real initials) is a right-handed (laterality quotient = 0.79; Oldfield, 1971) man with 11 years of formal education, who at the time of testing was 52 year old. He had a history of untreated anxiety. Prior to his stroke, he had been a heavy drinker and smoked cannabis regularly. He was admitted to hospital for the rupture of an aneurysm of the anterior communicating artery. An external ventricular drain was inserted immediately and coil embolization of the right anterior communicating artery was performed on the following day. A series of neuroimaging scans (see Figure 1) performed ten days after the vascular accident showed a right ventro-medial frontal and intraventricular haemorrhage. As it is typical in haemorrhages (Catani et al., 2012a), the lesion also damaged white matter tracts, including short frontal lobe connections (Catani et al., 2012b) as well as the longer arcuate fasciculus (Catani & Thiebaut de Schotten, 2008).

On clinical examinations, the patient proved blind in the right eye, in line with pre-chiasmatic damage; he did not show motor or somatosensory deficits, his proprioception was also normal.

--- Insert Figure 1 about here ---

MT came to our attention two months later, when he was transferred to the brain injury rehabilitation ward. He appeared as an intelligent man with a good understanding of social context, able to make occasional subtle and appropriate humorous jokes. General examination was part of routine assessment but informed consent was obtained to further investigate some aspects of his cognitive deficits.

Cognitive assessment

MT's performance at formal assessment is reported in Table 1. He was disorientated to time and space: he committed gross errors in estimating the current date, including the year and the month; he frequently got lost in the ward and was unable to find his room or familiar communal rooms. There was no evidence of verbal short-term memory impairment, simultanagnosia, neglect or constructional apraxia. He performed poorly on most subtests of the VOSP, and just above cut-off on the Street Completion task, which assesses visual perception of degraded figures. He responded correctly when presented with classical illustrations to assess amodal perception (i.e. perception of a complete structure when only some of its parts are presented). He performed very well on visual imagery tests, with ceiling performance on two (object sizes and object colours) of the three sub-tests of the visual imagery test battery. MT showed persistent long-term memory impairments and deficits on executive tests. When asked about his problems, he mentioned only some vision and memory difficulties.

--- Insert Table 1 about here ---

Verbal Continuous Recognition Task

To avoid interference from visual perceptual problems, a verbal version of the classical Continuous Recognition Task by Schnider and Ptack (1999) was devised. Names of objects illustrated in the

Snodgrass and Vanderwart pictures (used in the original test) were read aloud, and MT was required to say whether each word had already been presented in that current run. There were four runs and each of them consisted of 80 words of which four targets were repeated eight times. Run 2 was given immediately after the first run, with Run 3 after a five-minute break, and Run 4 after a further 30 minutes. At the beginning of each run, MT was explicitly instructed to detect targets repeated on the current run *only*. MT showed a dramatic increase in false alarms between Run 1 and subsequent runs (i.e. when previous targets were now functioning as distracters) (see Table 1). He tended to falsely recognise previously encoded stimuli as current targets, suggesting a difficulty in suppressing previously acquired information.

Source Monitoring Test

Some authors have observed that even healthy volunteers, especially older people, may have difficulties in discriminating between external and internal sources of information (e.g., Johnson, De Leonardi, Hashtroudi & Ferguson, 1995). These “reality monitoring errors” may occur if memory traces derived from imagination are mistakenly identified as referring to an actual percept. To assess whether Phantabulations may, at least in part, result from reality monitoring errors, MT and five age-matched healthy controls (average age 60.0, $sd = 3.5$) were given a modified version of Henkel, Johnson and De Leonardi’s (1998) test. They were asked to view a series of 30 large stimuli. Half of the stimuli (Perceived condition) consisted of a concrete word with the related black and white line drawing displayed underneath it (e.g. the word “APPLE” with a picture of an apple below it); the other half (Imagined condition) consisted of a concrete word only (e.g. the word “BOX” written without any picture). Stimuli for Perceived and Imagined conditions were piloted to balance them for physical and semantic similarity.

Stimuli from each condition were displayed for six seconds each, in random order, and participants were asked to estimate how many seconds it would have taken to draw the picture indicated by the word. This drawing time estimation task was used to induce a mental image of the stimulus. Participants were then engaged in a general conversation for 15 minutes, after which they were given a surprise memory test in which the 30 words were re-presented, shuffled randomly with 15 new

concrete words. For each word, participants were asked to state whether it had been presented earlier with a picture, had been imagined, or was new.

MT identified most of the perceived stimuli correctly, but erroneously classed many imagined and new stimuli as previously perceived (see Table 2). Misidentifications of imagined and new stimuli were respectively seven and 17 standard deviations higher than those of the matched controls. This strong tendency to misidentify even new stimuli as perceived suggests that MT elicited strong visual images of the object not only in memory, but even during stimulus word viewing. This is supported by a chance observation made during a practice trial: the examiner pointed out that, for a word that MT had just read, there was no image and MT had to imagine one; to which MT commented with surprise, “Oh...there isn’t one?!”.

--- Insert Table 2 about here ---

Observations of ‘Phantabulations’

Phantabulations occurred quite regularly and did not appear to be specific to any situation, time or location. They could occur spontaneously during a conversation with the examiners, relatives or friends, and sometimes during formal test sessions that were video or audio recorded, allowing later evaluation and transcription. Phantabulations were mainly linked to visual information, and MT never reported auditory hallucinations. However, some involvement of somatosensory modalities was occasionally observed. On one occasion, for instance, MT held an imaginary bottle, commenting “it’s quite light”. Phantabulations could be triggered by a variety of stimuli, which could be either endogenous (e.g. talking about or imagining an object) or exogenous (e.g. seeing a basin could trigger MT to begin brushing his teeth with an imaginary toothbrush).

Nevertheless, simply asking MT to imagine an object did not necessarily trigger a Phantabulation. On a few occasions, MT was asked to look at a white sheet and to imagine that some drawings (i.e., either a picture of a house or a clock) were illustrated on it. He was then encouraged to enrich each image by responding to some questions about colour, size, pleasantness or the position of details (e.g. “Point to the windows of the house” or “Point to the digits of the clock”). MT’s visual

imagery was very good, he provided clear plausible responses and showed a good ability to form and manipulate visual images. However, when asked whether there was a drawing on the sheet in front of him, he said "...there is nothing here... it's all my imagination". Similarly, Phantabulations were not easily induced by looking at another person's behaviour. During a testing session, the examiner pretended to grasp a box of sweets from a shelf, to pick one out and unwrap it; then MT was asked to kindly put the wrapper in the bin. MT looked puzzled, he held out his hand to get the paper and then asked "Are we pretending?"

By contrast, when MT generated a mental image either spontaneously or in response to current needs, this often induced Phantabulations, as on numerous occasions when he was asked to draw pictures or write his name. MT would usually pick up the real pencil, but mime the act of drawing in the air just above the sheet, leaving no trace on the paper. When questioned about his drawings, he would answer questions and point towards specific details of his "drawing". MT seemed convinced by his "perception" of reality and he was perplexed when contradictory evidence was presented. Indeed, MT acted in accordance with his erroneous beliefs even in more intimate situations. On one occasion, for example, a nurse guided him to the toilet door, as he had some difficulty in finding his way there. Once alone in front of the toilet door, he started to undress himself to sit on an imaginary toilet. The nurse quickly came back to guide him inside of the room, at which MT looked perplexed, as if he could not understand why he was being asked to move.

These effects were quite robust and long-lasting. On several occasions, MT failed to acknowledge explicitly that his drawing was only imagined, despite occasionally showing some insight. On one occasion, while drawing a clock face, he spontaneously put down the pencil and commented "My drawing is weird, you know?....a clock should be with numbers 1, 2,...". Another time, after a long conversation about a (phantom) drawing, the examiner asked him, "If I showed this drawing to T [another examiner observing the examination] would he be able to tell what has been drawn on this sheet?" MT replied: "It would be amazing if he could", and only after several questions about the reason for this, MT added "...because there is nothing there!" After this statement he immediately stopped smiling and he looked at the sheet in a perplexed manner.

Some further interesting aspects of MT's behaviour are illustrated by the following episode. During a testing session, MT complained of having a headache and asked permission to take a painkiller. He then pretended to pull out with his right hand from the left pocket of his jacket a pill dispenser, to take one of them and to drink some water from a glass, though none of these objects was present in the room. The following (taped) conversation ensued:

Examiner: "How do you know... that these are the correct pills?"

MT: "I recognise them"

Examiner: "You recognise them from what?"

MT: "Well paracetamol is paracetamol...once you get to know them you can spot them from anywhere...very distinctive the originals [...]"

Examiner: "Are they square...are they ...?"

MT: "Round"

Examiner: "Thick or thin?"

MT: "...pretty thin really, certainly not thick"

Examiner: "Are they red...?"

MT: "No they are white...yes, [...]"

Examiner: "Would you like to show me one of these pills?"

MT: "Yes sure" [MT pulled out from his pocket an imaginary blister of pills and squeezed one out onto the examiner's hand adding "Just one paracetamol?" For the remaining part of the conversation the examiner held her right hand open in clear view of MT.]

Examiner: "OK" [...] Looking at the content of her hand the examiner added: "...and this is the white pill that you have just taken? The same?"

MT: "Yes, exactly the same"

Examiner repeated: "Is it exactly the same?"

[MT nodded to confirm].

Examiner: "...and if I take this pill will my headache go away?"

MT: "It should do, yes"

Examiner (looking at her hand) added: “You know...I have a problem... I can’t see the pill in my hand”

MT (looked very serious and concerned): “You can’t really see it?”

Examiner: “No, I can’t”

MT: “You can’t see it...oh... this is because it is not there, is it?”

Examiner: “So it’s not there?”

MT: “No it’s not”

Examiner: “Am I holding something?”

MT: “No” [...] “But I can give you a real one if you want” (giggling)

Examiner: “Yeah, is it here the real one?”

MT: “The real one is here” (again picking up an imaginary pill dispenser from the same pocket).

MT put on the table the imaginary pill dispenser and added “Here is the real one” and pretended to put a pill on the examiner’s hand.

Examiner: “Can I have also a glass of water?”

MT nodded and put an imaginary glass of water on the table.

The examiner mimicked the action of picking up the glass with her left hand and she held it in front of MT, then the examiner added “So, I’m holding a glass of water and a pill...”

MT: “Yes, the paracetamol”

Examiner: “The real one....this time?”

MT: “Yes, yes”

The examiner looked at her hands and added: “I have again a problem.... I can’t see them”.

MT (looking very perplexed) “You can’t see?”

Examiner: “No, I can’t see the glass...”

MT: “Oh gosh!”

Examiner: “What do you think?”

MT was visibly concerned and after some thinking added “It is not a question of lack of light, is it?... The light is on, here... and it’s not dark”

Examiner: “Indeed”

MT: “We can still use the torch (picking up with his right hand an imaginary torch, then pointing it down on the top of the examiner’s hands and moving it left and right)... just to check if you can see the light bouncing...”

Examiner: “Yeah...but why do you think that I cannot see these things?” [looking at her hands]

MT: “...it’s...it’s... because there’s nothing there, is it?”

Examiner:” Is nothing there?”

MT: “Yeah”

Examiner: “This explains why I cannot see them”

MT: “Yeah... it’s just pretending”

Examiner: “Ok, so were we just pretending?”

MT (looking a bit relieved): “Well... I think it looks in that way, isn’t it? really...logically”

Examiner: “Yes, it looks so. But before, you actually saw the pill in my hand?”

MT:” Well ... it’s suggestion, isn’t it? I thought I did, I wanted to, so I didbut I don’t think I can actually see it to be honest...because it’s not there!” [...]

Examiner: “Does this happen frequently?...To think that things are there when they are actually not?”

MT: “Not often... fairly... rarely...when I’m very tired [...]”

Finally, MT also showed a few instances of a phenomenon that looked like reduplicative paramnesia for places. On one occasion, after a testing session, he welcomed the examiners into his hospital room behaving as if this was his house. “This is my room where I live...it is my mum’s house”. Once inside, he opened the door of an en-suite bathroom and added “Two beds, one here (indicating the WC) and one there (indicating the basin)”. Then, walking towards the mirror as if to avoid bumping into the two beds, he pointed to the mirror and added “This is the window”. Going back to the bedroom MT claimed that it was his bedroom in the flat that his partner had decorated.

Recovery and follow-up

About eight months after his brain lesion, MT showed a dramatic reduction in the number of episodes of Phantabulation. Three months later, these had ceased completely, and he was discharged.

The examiners visited MT one last time, at home, 15 months after his acute brain lesion. He was eager to converse with the examiners but was not much interested in completing formal tests; though, on request, he drew a clock from memory flawlessly. He appeared much better oriented to space and time, committing only one error on the date of the month (anticipated by one day). He still had a visual deficit for the right eye, and mentioned some continuing visual and memory difficulties. Some of his conversation clearly showed some degree of retrograde and anterograde amnesia. He had difficulty remembering what had happened or what he had eaten the day before; and he could remember only some of the people he had met at the hospital, and some related events, but quite vaguely. He did not recognise the two examiners, despite having seen one of them on a daily basis during his time on the ward, and the other on several occasions.

During the conversation, which lasted a couple of hours, he interacted normally with various objects, smoking several cigarettes, drinking tea, and moving objects without any sign of Phantabulation. His mother confirmed that he had never shown Phantabulations since he left the hospital. When asked if he remembered having imagined objects that were not present, he looked surprised and asked his mum if he really had done so.

Discussion

For about eight months, MT showed a highly unusual phenomenon, unique in our experience, in which he appeared to interact purposefully with objects not physically present. These episodes of 'Phantabulation' were quite frequent and vivid, could occur at any time of day, and were triggered either by MT's urge to complete a task (e.g. performing a psychometric test) or by less explicit needs, such as holding a cigarette during a conversation.

MT could describe the imagined objects very accurately, providing rich sensory details to questioning, mostly visual but sometimes also somatosensory. Phantabulations were emotionally neutral, and always referred to contextually plausible objects. When challenged with clearly contradictory information, MT tried to account for his Phantabulations with logical explanations, often confabulating. Therefore, MT seemed able to reach logical conclusions, though they were based on incorrect premises. On repeated questioning, he would usually capitulate eventually, concluding or acknowledging that the objects must have been ‘pretended’. This suggests that the phenomenon was not completely detached from monitoring of reality. Considering MT’s non-verbal communication, he was apparently unaware of the unreal nature of his perceptions while he was experiencing them. He typically looked puzzled when confronted with contradictory information, and quite relieved when he managed to provide what he considered, a plausible explanation. Such “explanations”, together with evidence of reduplicative paramnesia, are unusual in patients suffering from hallucinations and they support the hypothesis of an important delusional component of Phantabulations.

MT had memory deficits and presented with confabulatory tendencies. However, his confabulations were unusual as, contrary to classic confabulations (e.g., Kopelman, 2010), they never concerned autobiographical or future thinking events, rather they involved solely current events, and seemed to provide him with a means to rationalise his interactions with imagined objects.

Phantabulation may appear to share some similarities with utilization behaviour (Lhermitte, 1983). However, contrary to utilization behaviours (see e.g., Boccardi, Della Sala, Motto & Spinnler, 2002), Phantabulations were not triggered by environmental cues but rather by endogenous drives. Moreover, unlike utilization behaviour (e.g., Besnard et al., 2010) the actions characterising Phantabulation episodes were never socially inappropriate.

Despite some points of resemblance, MT’s behaviour also cannot be classed within any of the various types of hallucinations described in the literature. Before brain damage, MT was a heavy drinker and cannabis user. Withdrawal from these substances may cause brief pareidolic hallucinations whose content often consists of perceiving distorted animals or persons (Lilliputian

hallucinations; Sims, 2003) and which are usually associated with tremor, occasional loss of consciousness and altered arousal with sleep disorders, such as insomnia and nightmares (Manford & Andermann, 1998). Phantabulations showed none of these features, and MT never reported sleep problems. They also appeared quite distinct from hallucinations associated with psychiatric syndromes, which are predominantly auditory, with recurrent themes of high emotional valence, often delusional and triggered by anxiety (e.g., Sims, 2003; David, 2004; Pierre, 2010). Interaction with the “object” of the psychiatric hallucinations is highly unusual and very limited (Manford & Andermann, 1998; Sims, 2003), where such interaction was a defining characteristic of Phantabulation. Moreover, Phantabulations were always contextually appropriate, such as holding a pen to perform a drawing, which is not typical of psychiatric hallucinations.

Visual hallucinations following brain damage are a central feature of the Charles Bonnet syndrome. These hallucinations appear within the blind visual field (e.g., Vaphiades, Celesia & Brigell, 1996) especially under conditions of dim light or when the patients are somnolent (e.g., Kazui et al., 2009; Schulz et al., 1996). In common with sufferers of Charles Bonnet syndrome, MT showed a visual impairment, due to damage to the visual pathway coupled with intact visual primary cortex (ffytche, Howard, Brammer, Woodruff & Williams, 1998). Moreover, Phantabulations occurred more frequently, though not solely, in MT’s blind visual field. However, the content of hallucinations in Charles Bonnet syndrome tends to be recurrent (e.g., Manford & Andermann, 1998), occasionally bizarre and amusing (ffytche et al., 1998) but not purposeful. Such patients are well aware of the unreal nature of their hallucinations while they are experiencing them (ffytche et al., 1998; Lalla & Primeau, 1993; Schultz et al., 1996; Teunisse, 1996; Kazui et al., 2009) and show very limited interaction, if any, with them. For example, Kazui et al.’s (2009) patient, claimed not to be able to touch the cats “despite her efforts to do so” (p. 79). The purposeful, contextually appropriate interaction with the imagined objects therefore distinguishes Phantabulations clearly from the hallucinations observed in Charles Bonnet syndrome.

Some authors have suggested that a cortical release phenomenon may be responsible for hallucinations. Indeed, while perception of visual stimuli normally inhibits endogenous activation of the visual cortex, in the absence of exogenous information, the spare visual areas would suffer from

sensory deprivation, releasing these areas from the normal regulation system (Cogan, 1973) and leading to the formation of hallucinations as in Charles Bonnet syndrome (Kazui et al., 2009; Manford & Andeermann, 1998; ffytche et al., 1998). However the cortical release explanation predicts a relatively “casual”, simple, and probably recurrent content of hallucinations, which are unlikely to change while occurring. On the contrary, MT’s phenomenological perceptions were apparently complex and tightly linked to current context and his actual needs, more in line with a top-down process. That is, he “perceived” a toothbrush when he needed to brush his teeth, and he “perceived” a painkiller pill when he had headache. He never reported contextually incongruous hallucinations. Unlike patients showing hallucinations, MT seemed to “reinterpret” reality according to specific needs. For example, as in reduplicative paramnesia, he seemed to “reduplicate” objects. However, vividness of Phantabulations is crucial as MT actually interacted with the imaginary objects to a much greater extent than what is observed in classical reduplicative paramnesia. It is therefore important to explain why MT “saw” in first place non-existent objects and why he perceived exactly the objects that were functional to his goal. A possible explanation may be found in a combination of factors also involving visual-imagery.

The role of visual-imagery in false perception is not new and other authors have suggested that “complex visual hallucinations [...] could be initiated by visual imagery” (Wunderlich et al., 2000; p. 561; see also Goldenberg, Müllbacher & Nowak, 1995). MT’s performance on the source monitoring tests confirms his tendency to confuse imagined with real information, and his performance on the verbal continuous recognition task suggests a difficulty in suppressing previous information.

MT’s visual imagery was well preserved in formal tests and he was clearly imagining in fine detail some of the phantom objects he interacted with, and the phantom drawings he produced. Interestingly, ffytche et al. (1998) observed that the releasing mechanism could also involve ventral extrastriate activity and other authors observed additional activation of frontal and parietal cortex, suggesting that extrastriate activity may be modulated by frontal and parietal top-down mechanisms that mediate “retrieval of object representations from long-term memory and their maintenance through visual imagery” (Ishai, Ungerleider & Haxby, 2000; p. 979). MT’s executive processes are compromised, as

confirmed by his poor performance on some relevant tests (e.g., Brixton test). Therefore, visual imagery may account for the highly purposeful content of Phantabulations, which may have been enhanced by the cortical release mechanism and lack of inhibition due to the frontal damage.

Phantabulations are characterised by the purposeful interaction with contextually appropriate imagined objects. We suggest that these episodes, in patient MT, may depend on a combination of phenomena, whereby the effects of a top-down mechanism involving florid visual-imagery is facilitated by cortical release due to frontal damage, resulting in a confusion between real and imagined objects. These abnormal percepts are probably enhanced by an associated malfunction of the fronto-parietal pathway, which fails to inhibit the imaginary processes and the evocation of their related actions.

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Table 1. MT's performance on a battery of cognitive tests.

TEST ¹	MT scores #	Cut-off Test interpretation
Repeatable Battery for the Assessment of Neuropsychological Status		Cut-off
Immediate memory - index score (0-130)	57	80
Visual/constructional - index score (0-130)	50	80
Language - index score (0-130)	75	80
Attention - index score (0-130)	85	80
Delayed memory - index score (0-130)	40	80
TOTAL SCORE - index score (0-130)	52	80
Addenbrooke's Cognitive Examination		Cut-off
Attention and orientation (0-18)	15	17
Memory (0-26)	12	18
Fluency (0-14)	9	9
Language (0-26)	26	24
Visuo-spatial (0-26)	12	15
TOTAL SCORE (0-100)	74	86
Verbal short-term memory		
Span Forward (0-16)	7	4
Span Backward - (0-14)	6	4
Street Completion Test		
Corrected score (0-14)	3.25	2.25
Constructional Apraxia Test		
Corrected score (0-14)	11.75	8
Visual-imagery Test		
Colour (0-25)	25	22.7 ***
Animal's Tails (0-20)	15	14.8 ***
Size comparison (0-16)	16	16 ***
Visual Object and Space Perception Battery		Test interpretation
Screening test (0-20)	18	Pass
Incomplete Letters (0-20)	9	Fail
Silhouettes (0-30)	8	Fail
Object Decision (0-20)	2	Fail
Progressive Silhouettes (0-20)	16	Fail
Dot counting (0-10)	1	Fail
Position Discrimination (0-20)	17	Fail
Number Location (0-10)	6	Fail
Cube Analysis (0-10)	3	Fail

Visual Illusions		
Amodal completion		
- 3D cube behind bars	"a cube with bars on it"	Expected response
- Four black circles partially covered by rectangles	"4 circles and 4 rectangles"	Expected response
Neglect Tests		
Line cancellation (0 -40)	**	No evidence of neglect
Drawings from memory (house, person, flower) (0-3)	3	No evidence of neglect
Simultanagnosia Test		
Colour test (random, single and mixed conditions) (0-6)	6	No evidence of simultanagnosia
Line length test (complete and separate shapes) (0-6)	16	No evidence of simultanagnosia
Stroop Test##		
Coloured letters (0-6)	6	
Neutral (0-9)	9	
Congruent (0-6)	6	Ceiling performance
Incongruent (0-6)	6	Ceiling performance
Hayling and Brixton Test		
Hayling - Overall scaled score (1-10)	4	Low average
Brixton - Overall scaled score (1-10)	2	Abnormal
Continuous Recognition Task - verbal version		
	Hits %	FAs %
Run 1	89	6
Run 2 (immediately after)	75	78
Run 3 (5 minute delay)	93	60
Run 4 (30 minute delay)	86	67
Increment on FAs compared to Run 1: deficit in suppressing previously encoded information		

Abnormal test performance is indicated in bold.

** MT cancelled the lines without touching the sheet so no mark was left. From direct observation, MT clearly attended to all stimuli.

*** Cut-off scores represent the value at 2 SDs from age-matched controls' average performance. Data taken from Hanley et al., 1991.

Patients' responses were very quick. At the end of the test MT added: "I concentrated on the task and ignored the different colour".

¹ Repeatable Battery for the Assessment of Neuropsychological Status (Randolph, 1998); Addenbrooke's Cognitive Examination - revised (Mioshi et al., 2006); Verbal short-term memory (Wechsler, 1997); Street Completion Test (Spinnler & Tognoni, 1987); Contrustional apraxia test (Spinnler & Tognoni, 1987); Visual-imagery test (Hanley et al., 1991); Visual Object and Space Perception Battery (Warrington & James, 1991); Visual illusions (taken from Kanizsa, 1980- figures 2.4 and 2.6); Neglect tests (from BIT; Wilson, et al., 1987); Simultanagnosia test (Humphreys & Riddoch, 1993); Stroop test (Ridley, 1935); Hayling and Brixton test (Burgess & Shallice, 1997); Continuous recognition task (Schnider & Ptack, 1999).

Table 2. MT's and matched controls' performance on the Source Monitoring Test.

		Perceived stimuli recognised as			Imagined stimuli recognised as			New stimuli recognised as		
		perceived	imagined	new	perceived	imagined	new	perceived	imagined	new
MT		<u>86.7</u> *	6.5	6.5	46.7**	<u>26.7</u>	26.7	53.3***	13.3	<u>33.3</u>
Healthy controls	<i>mean</i>	<u>72.0</u>	12.0	16.0	5.3	<u>90.7</u>	4.0	1.3	2.7	<u>96.0</u>
	<i>sd</i>	19.1	11.9	10.1	5.6	3.7	3.7	3.0	3.7	6.0

Correct responses are underlined

* within 1 standard deviation from norms

** 7.4 standard deviations higher than norms

*** 17.4 standard deviations higher than norms

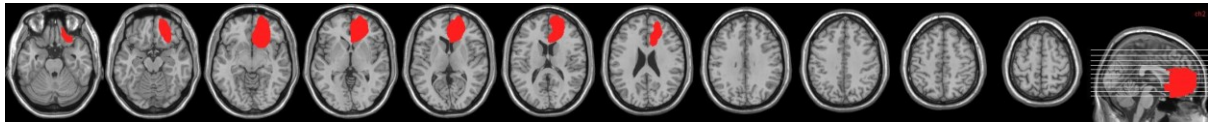


Figure 1. Reconstruction of MT's area of lesion (MRICro, www.micro.com, Rorden and Brett, 2000) at 10 days post-stroke. The patient's lesion was superimposed onto a 2D axial rendering on the Montreal Neurological Institute (MNI) representative brain in stereotactic space. Note that the right side of the reproduction corresponds to the right side of the brain.