CORTEX XXX (2013) 1–12

Available online at www.sciencedirect.com

SciVerse ScienceDirect

Journal homepage: www.elsevier.com/locate/cortex

Special issue: Research report

Disordered recognition memory: Recollective confabulation

*Chris J.A. Moulin**

Laboratoire d'Etude de l'Apprentissage et du Développement, CNRS UMR 5022, Université de Bourgogne, Dijon, France

ARTICLE INFO

Article history:
Received 31 January 2012
Reviewed 12 April 2012
Revised 24 September 2012
Accepted 24 January 2013
Published online xxx

Keywords:
Dementia
Déjà vu
Reduplicative paramnesia
Familiarity
Metacognition

ABSTRACT

Recollective confabulation (RC) is encountered as a conviction that a present moment is a repetition of one experienced previously, combined with the retrieval of confabulated specifics to support that assertion. It is often described as persistent déjà vu by family members and caregivers. On formal testing, patients with RC tend to produce a very high level of false positive errors. In this paper, a new case series of 11 people with dementia or mild cognitive impairment (MCI) and with déjà vu-like experiences is presented. In two experiments the nature of the recognition memory deficit is explored. The results from these two experiments suggest – contrary to our hypothesis in earlier published case reports – that recollection mechanisms are relatively spared in this group, and that patients experience familiarity for non-presented items. The RC patients tended to be overconfident in their assessment of recognition memory, and produce inaccurate assessments of their performance. These findings are discussed with reference to delusions more generally, and point to a combined memory and metacognitive deficit, possibly arising from damage to temporal and right frontal regions. It is proposed that RC arises from a metacognitive error; an attempt to justify inappropriate feelings of familiarity which leads to false recognition.

1. Introduction

In this article, I report a case series of patients who experience almost constant false recognition for unfamiliar materials such as television premieres, new places, and events in the news. These patients present with striking delusion-like features, such as calling a TV repairman because the television is constantly repeating, or claiming that other people – strangers – have very regular habits, doing things at the same time in the same place every day. Carers, spouses and medical practioners refer to these experiences as like near-persistent déjà vu.[1] Two recognition memory tasks are used to explore the cognitive basis of these forms of false recognition, and the extent to which recollection and familiarity processes contribute to the breakdown of recognition memory is evaluated.

Recognition memory concerns our ability to differentiate new stimuli (which are novel or not previously experienced) from those which are old (which have been previously experienced). Several authors (e.g., Mandler, 2008; Yonelinas, 2002) suggest that endorsements of prior experience can be made on the basis of recollection (which involves retrieval of a definite prior episode and 'mental time travel') or familiarity (which is an assessment of prior experience which is devoid of contextual information and the retrieval of specifics).

* LEAD, CNRS UMR 5022, Université de Bourgogne, Pôle AAFE, Esplanade Erasme, BP 26513, 21065 Dijon Cedex, France.
E-mail address: christopher.moulin@u-bourgogne.fr.

[1] Although we used the term déjà vécu in our previous work, in order to align ourselves with the reports of carers which emphasise déjà vu, it should be noted that these experiences are very different from healthy déjà vu experiences in two key ways. First, they are not brief transitory sensations which are quickly resolved, and second, the patient is not aware of the false recognition. Here then, I avoid the use of the term 'déjà vu experience' and refer instead to RCs.

0010-9452/$ – see front matter © 2013 Published by Elsevier Ltd.
http://dx.doi.org/10.1016/j.cortex.2013.01.010

Moulin et al. (2005) reported two patients with dementia who presented with what were described as having constant déjà vu[2] and who made a very high number of false positives accompanied with the subjective report of 'remembering' on tests of recognition memory. These patients (AKP and MA) exhibited striking behaviour in everyday life, withdrawing from almost all novel activities, complaining that they had experienced them before (for descriptions of further cases see O'Connor et al., 2010). One feature of the experience was the detail and justification given, typified by the response AKP made to the question of why he thought he had been previously interviewed for a radio show, when it was actually the first time:

> "The surroundings are the same, and that – without being offensive – your sight against the filing cabinets and so on, and the heater, it looks familiar. Since then, [my] memory got slightly worse, that's all. Besides, you asked the same questions. Why I remember them, and whether they are really the same, I don't know, but it seems like it".

We termed these types of memory error and false recognition as 'recollective confabulation (RC)'. This term is used to denote the reproduction of false information from a non-existent study phase when used to justify the false recognition of a person, place or event. It is in this way different from other forms of confabulation (for reviews see Schnider, 2008; Kopelman, 1987), although it may be described as a 'momentary confabulation' or 'provoked confabulation' in response to having to justify the false recognition.

We also noted that these patients made false positives for low frequency words, such as dirge or puck, an unusual error given their distinctiveness (Gardiner and Richardson-Klavehn, 2000). False recognition was also more pronounced for more distinct events in daily life, e.g., a funeral announcement, a radio interview, a striking piece of world news, seeing a woman have a fit whilst on holiday, or finding money. These errors for such distinctive events were not consistent with the view that it was pre-existing familiarity that was driving the sensation, but the opposite – novelty. Based on these experimental findings and observations, we suggested that the deficit was not driven by a mere confusion of familiarity with a defined previous event.

Our previous work claimed that RC is a critical feature of this false recognition condition. Our argument was that since veridical recollection is associated with a subjective feeling of having experienced an event before combined with the retrieval of contextual information and experiences at study, then the false recollection of erroneous contextual details pointed to this being caused by an underlying erroneous feeling of recollection.

Another explanation of our patients' RC is that they have reduplicative paramnesia, a 'rare memory disorder characterized by the subjective conviction that a place, person or event is duplicated' (Pisani et al., 2000). Feinberg and Shapiro (1989) describe a form of reduplication where 'the patient maintains that his current experiences are a repeat of past experiences'. They suggest that reduplicative syndromes occur where an unfamiliar environment or event appears in a 'pathologically familiar form', such as when a hospital room is mistaken for a patient's home; they even specify that reduplicative paramnesias may resemble déjà vu. Delusions more generally are not uncommon in dementia, with estimates of incidence as high as 30–40% (Sultzer et al., 2003). Capgras' delusion, which is the delusion that a familiar person has been replaced by a double, is thought to occur in about 2–30% of patients with Alzheimer's disease (e.g., Lyketsos et al., 2002). More specifically, Mendez (1992) cases of dementia with delusional misidentification syndromes, one of whom '… had episodes of déjà vu, e.g., saw a person on a bicycle and claimed that "I have seen all this before"' (p. 415) and another '… had episodes of unfamiliar events appearing familiar, e.g., driving on unfamiliar streets she said "that car is always here every time we go by here"' (p. 415).

There are considerable overlaps between our concept of RC and temporal reduplication. Reduplicative paramnesias are thought to arise due to a misconnection or disruption to fronto-temporal circuits, particularly following damage to right frontal areas which overlaps with our interpretation of AKP & MA. Feinberg and Shapiro (1989) specify that a right frontal disruption leads to a disturbance of familiarity, and that this leads to an illogical attempt – a confabulation – of why the 'familiar is experienced as strange or vice versa' (p. 46). Interestingly, in confabulation more generally, a deficit in temporal memory has been cited as a causal factor (e.g., Schnider, 2008), although confabulating patients do not report that the current moment is a repetition of a previous moment: presumably because in general, confabulating patients do not have false recognition, and are not given to producing high levels of false positives on recognition memory tests.

Critically, reduplicative paramnesias are usually described as deriving from inappropriate familiarity, whereby the core delusion is driven by a lack of subjective familiarity, which is then interpreted by intact long-term memory systems which apply justifications to the underlying sensation. For instance, a patient with Capgras will be able to recognize his wife, but will nonetheless find her unfamiliar. To reconcile this clash in evaluations, the patient will justify this mismatch with the belief that the wife has been replaced by a double – such that it appears like her, but is not her. In the case of reduplication the underlying sensation is familiarity rather than unfamiliarity (Pick, 1903). Critically, delusional misidentifications of people, places and time, have been hypothesized as stemming from memory-like disruptions to feelings of familiarity (Feinberg and Roane, 2005).

By this view, RC would not be caused by a deficit in recollection per sé, but the use of somewhat intact recollection processes to justify erroneous feelings of familiarity. This notion has some parallels with how recollection and familiarity are suggested to operate in concert in a healthy memory system. One prominent idea is that familiarity operates as a trace strength mechanism, by which the intensity of memory can be gauged. Items generating high levels of familiarity should normally be able to be recollectively experienced. Some researchers suggest that an initial assessment of familiarity is

[2] There have been various attempts to classify different forms of déjà vu experiences, such as separating it into déjà vu and déjà vécu (O'Connor and Moulin, 2010). Where I use 'déjà vu' here I wish to use it as a generic term which is theory-neutral, which captures the patients' sense of life repeating. This idea is developed a little in the discussion.

Please cite this article in press as: Moulin CJA, Disordered recognition memory: Recollective confabulation, Cortex (2013), http://dx.doi.org/10.1016/j.cortex.2013.01.010

used to assess recognition memory and trigger other more strategic processes (e.g., Koriat, 1993; Mandler, 2008). According to this approach, RC may not arise from a deficit in recollection itself, but from generating recollection-like justifications for intense (and erroneous) sensations of familiarity. This was an argument we overlooked in our initial report, and the recruitment of a group of patients as reported here permits a better assessment of subjective familiarity and recollection.

The difference between our previously published account and this reduplicative paramnesia account is subtle, but critical. Our previous view was that 'a hippocampal dysfunction gave rise to sensations of recollection, which due to damage to the frontal lobes … was not corrected, or correctly interpreted at a later stage' (O'Connor et al., 2010, p. 13). The alternative proposed here is that recollection may be the relatively intact process at work, acting on erroneously generated familiarity signals.

In sum, I present a series of 11 cases of older adults whose presentation was similar to AKP and MA. Patients were approached to take part in the study presented here if they, their spouse/caregiver, or referral letter spontaneously mentioned déjà vu-like experiences and had a diagnosis of dementia or mild cognitive impairment (MCI). The aim was to establish the robustness of behavioural and experimental features of RC and further examine the recollective nature of any false positives made by such patients. One critical prediction is that if false positives (FPs) are driven by feelings of familiarity, them one would expect them to be higher in materials which have pre-existing high familiarity, such as high frequency words. Specifically, it was hypothesized that we would observe high levels of FPs in these RC patients, and that they would make subjective reports of 'remembering' materials not presented to them before. In keeping with our earlier reports, it was hypothesized that RC and false positive errors should be higher for low frequency words. If our original explanation stands (of deficient recollection) it would follow that when a participant reports 'remembering' in a recognition test, then their ability to detect a target from a foil should be impaired. Thus it was hypothesized that the patients would show a particular recognition memory deficit in the proportion of their responses which were accompanied with the feeling of recollection. Finally, because the familiarity account points to a deficit in the metacognitive assessment of familiarity during a recognition memory task, I ran a second experiment which explored the relationship between metacognitive certainty and recognition memory. Here it was hypothesized that RC patients would make inaccurate assessments of their recognition memory.

2. Experiment 1

2.1. Method

2.1.1. Participants

Ten novel cases of patients whose carer or referring medical professional spontaneously mentioned déjà vu experiences as part of the presenting symptoms of memory impairment took part in this study. In addition, one further patient was tested (Patient 11) who approached the research programme directly after a national radio appearance. AKP and MA are also represented here, meaning there was a total sample of 13 patients with RC. These cases form a RC group. They were tested at different points in their routine clinical visits – sometimes before a concrete diagnosis was made, and not in all cases was neuroimaging available. Diagnosis was made by independent clinicians on the basis of information gathered from neuropsychological examination, Mini-Mental State Examination (MMSE; Folstein et al., 1975), family interview, laboratory screening (i.e., haematology; B12 and folate levels; renal, liver and thyroid function; calcium and syphilis serology), and medical examination. Where clinically indicated, the patients had brain scans.

An overview of the case series is presented in Table 1. The 11 new cases showed very similar features to AKP and MA and the presence of RC was variously referred to as delusions or hallucinations as well as with the term déjà vu. Table 1 shows most patients eventually were diagnosed with MCI or Alzheimer's disease, although fronto-temporal dementia and Lewy body dementia were often queried and investigated. Although EEG was not routinely used at this memory clinic, the presence of déjà vu-like experiences often meant that EEG was performed, to rule out epileptiform features.

There were 16 older adult control (OAC) participants. They were volunteers who had previously been screened using the MMSE (Folstein et al., 1975) achieving 26 or above, but the scores were not available for the current experiments. They reported themselves free of neurological or psychiatric complaint. Their mean age was 74.44 (standard deviation 4.13). Seven of these controls were the control group in Moulin et al. (2005), and to it were added a further nine older adults. Like all of the patients, all controls were community dwelling.

2.1.2. Neuropsychological assessment

These patients had a brief neuropsychological assessment as part of the memory clinic visit (see Table 1). Usually they had a test of face recognition with equal numbers of famous and non-famous faces and with faces either shown once or twice in a continuous fashion (see Moulin et al., 2005). Participants were shown faces, and were asked two questions about each one – firstly, was the face famous, and second, had the experimenter presented the same face before. Eighteen faces were shown once and eighteen were shown twice, nine of which were famous, and nine were non-famous.

2.1.3. Case descriptions

Patient 1 was not aware himself that he was experiencing anything like déjà vu. His wife reported that the RC was limited almost entirely to places. For instance, when visiting the dentist for the first time having moved to a new area, he was adamant that he had been there before. His wife complained that the feelings of having been to places before, and the level of certainty often lead to arguments.

Patient 2 was referred to the memory clinic as suffering from déjà vu episodes. She was living independently in her own home. On testing, she repeatedly complained 'we have done these questions before haven't we?'. Her daughter reported that the RC was mainly for the television and for people, and that she was unaware of her problem. Recall on the CERAD word list (Welsh et al., 1991) was poor: 1, 2, and 3 items (out of ten) across three trials, and delayed recall was zero. She only generated 9 animals in a minute on category fluency.

Please cite this article in press as: Moulin CJA, Disordered recognition memory: Recollective confabulation, Cortex (2013), http://dx.doi.org/10.1016/j.cortex.2013.01.010

Table 1 – Patients with RC in dementia. Participant characteristics and neuropsychological test scores.

Case	M/F	Age	Diagnosis	MMSE	National adult reading test (NART) IQ	Face recognition		Example behaviour (caregiver report)	Neuroimaging report
						FPs	False fame		
1	M	80	Alzheimer's	22	115	.50	.39	He and his wife recently moved to a new area, and when they visited the hospital for the first time, He was certain that he had been there before and had sat in the same chair.	None available.
2	F	77	Alzheimer's	25	98	.64	.11	Her daughter reports that she comments that she has seen things or has been places before when she hasn't.	None available.
3	M	79	Alzheimer's	10	118	.00	.05	Déjà vu mainly only occurs for television programmes, and is most notable for premieres.	None available.
4	M	77	Fronto-temporal dementia	27	124	–	–	Wife reports that he has a tendency to stare at people and feels he recognizes strangers, for example a man at the bus stop who he thought knew from Cambridge.	CT revealed 'no definite abnormality'. MRI shows atrophic changes. EEG abnormality in temporal and occipital regions.
5	M	82	Alzheimer's disease	23	–	.05	.00	Déjà vu occurs when visiting novel places.	None available.
6	M	79	Alzheimer's disease	28	123	.00	.28	Symptoms of déjà vu are most prevalent at night, thinks he has repeatedly got up in the night. Reports thinking that he knows and recognizes everybody. Feels as if he has already watched TV programmes and can predict what happens.	CT shows cerebral atrophy with moderate dilation of the ventricular system and sulci. EEG shows no abnormality.
7	M	81	Alzheimer's disease	23	107	.17	.67	Practically all of the time when watching television he will think he has seen the programmes before and cannot be persuaded otherwise.	MRI showed generalized atrophy, most marked over the temporal lobes. No sizeable focal infarct or lesion. CT scan shows bilateral low attenuation over fronto-temporal regions.

Please cite this article in press as: Moulin CJA, Disordered recognition memory: Recollective confabulation, Cortex (2013), http://dx.doi.org/10.1016/j.cortex.2013.01.010

8	F	75	MCI	26	110	.83	.72	She reports having been places before when she has not. Also described having already seen a plastic bag in the hedge before, and of having read a newspaper before that she had already purchased.	SPECT shows 'subtle hypoperfusion in the right frontal lobe and lateral part of the right temporal lobe'.
9	M	76	Alzheimer's disease	21	107	–	–	His wife said that often when walking down the road, he would say 'I saw that person dressed the same, at exactly the same time last week'.	MRI showed considerable evidence of white matter disease around the ventricles. No mass lesions or substantial infarction.
10	M	77	Alzheimer's disease	21	102	.67	.78	His partner commented that he had episodes of déjà vu, particularly for places. When visiting new places for the first time, or seeing a place on television to which he had never been, he would comment that he remembered going to them.	CT scan showed temporal lobe atrophy.
11	F	84	MCI	28	120	–	–	She wrote to the BBC complaining that everything on TV was a repeat. She also called a TV repairman to come to fix her TV due to it repeating everything.	None available.
AKP	M	80	MCI	25	115			Wife finds a £1 coin in the street, AKP claims he put it there for her to find; complains that he has watched or read the news before.	MRI shows little atrophy, EEG in normal limits. SPECT: reduced perfusion to medial cortex of both temporal lobes and to visual cortex.
MA	F	70	Alzheimer's disease	20	103			On a trip to an electrical store to mend the washing machine, MA reported that she'd been to the exact same office before and sat in the same chairs with the same people.	Abnormal EEG: excess of slow wave activity over left temporal region and on occasion on the right. Generalized atrophy, no infarct, haemorrhage or lesion.

Please cite this article in press as: Moulin CJA, Disordered recognition memory: Recollective confabulation, Cortex (2013), http://dx.doi.org/10.1016/j.cortex.2013.01.010

Table 2 – Group means on the recollective experience task (Experiment 1) for high and low frequency words. Controls, $n = 16$, RC patients, $n = 13$.

	Controls		RC patients	
	High frequency	Low frequency	High frequency	Low frequency
Hits	13.31 (1.49)	14.00 (.97)	11.08 (3.30)	11.23 (3.11)
False positives	1.44 (1.86)	.37 (.86)	8.46 (5.12)	4.84 (3.97)
Proportion of hits R	.81 (.16)	.81 (.22)	.54 (.32)	.49 (.29)
Proportion of hits F	.16 (.13)	.17 (.19)	.34 (.22)	.38 (.26)
Proportion of FPs R	.08 (.16)	.08 (.17)	.31 (.27)	.23 (.29)
Proportion of FPs F	.50 (.43)	.33 (.47)	.46 (.36)	.52 (.36)
Proportion of R correct	.99 (.04)	.99 (.05)	.63 (.27)	.87 (.17)
Proportion of F correct	.64 (.39)	.60 (.49)	.56 (.28)	.67 (.27)

In contrast to most other patients, Patient 3 understood the term déjà vu and commented that he 'certainly does have situations like that', but he was unable to give any examples. Also unlike the other patients, he was happy to be corrected by his wife, and she suggested that it did not occur for people or places, but mostly the television. Within the sample, Patient 3 is something of an outlier – he seemed not to hold his FPs with any great conviction, and indeed does not make many false positives on neuropsychological assessment. His MMSE score (Table 1) is notably lower than the other participants.

Patient 4 was a retired University lecturer with a complex presentation which involved hallucination (for example, seeing a gorilla in a tree) and spontaneous grandiose confabulation in conversation as well as the feeling that he recognizes strangers. His test scores on verbal fluency and trail making were abnormal. Recall on the Hopkins Verbal Learning Test (HVLT; Brandt, 1991) was 15/36, which is borderline abnormal. On an informal face recognition examination, he reported knowing (as famous) all of the non-famous faces, despite being able to name famous faces correctly.

Patient 5 was unaware of experiencing anything like déjà vu – and said that his problem was more forgetting things than remembering them. He was tested in his own home, and reported a few times during assessment he 'had done this before', for tasks which he had not completed before.

Patient 6 was a retired Hospital Chaplain, with a sudden onset of 'déjà vu symptoms' which he himself reported, and appeared aware of. Initially he was diagnosed with depression, but on follow up he was diagnosed with Alzheimer's disease. His neuropsychological profile showed deficits in delayed recall of a story, borderline normal verbal learning performance, but zero out of ten on visual recognition. His frontal test scores were in the normal range.

Patient 7 reported having met the psychologist before at the first meeting. He did not understand the term déjà vu, and after being explained the concept, said he had never experienced it. His wife felt that his RC was predominantly for places, people and the television. For instance, when on holiday in a hotel he had never been to before, he was adamant it was the fifth time they had stayed there. RC was present when arguing about his conviction that he had experienced events before – for instance when remarking that he had seen a strange woman on the bus before, he justified his belief on the basis that he had talked to her last time he was on the bus.

Patient 8 self-referred to the memory clinic, and did not mention déjà vu on initial assessment. Nearly two years later, she began reporting having been places before when she had not. When tested in her own home on the experimental tasks referred to below, like AKP and MA, she complained of having completed the tasks before. Although diagnosed with MCI at the time of the study, a diagnosis of fronto-temporal dementia was queried on the basis of her SPECT and unusual presentation.

Patient 9 was referred to the memory clinic as having 'hallucinations' alongside his memory problems – although these hallucinations appeared on further questioning to be sensations of reduplication, which his wife described as like déjà vu – and no further evidence of any hallucination or other delusion was found. He would spontaneously report reduplication such as when walking down the road (see Table 1) or claiming that the same cars or lorries as last week were turning in the side road next to his house. He also said that he had seen a lady dressed in entirely in blue outside his door on three separate occasions with the experience being exactly the same each time, although this was reported as a memory, not as a hallucination. On the HVLT, he scored 11 for recall which is in the abnormal range. His recognition memory performance was poor on this task, with 9 false positives, and a discrimination index of 3.

Patient 10's wife reported at initial assessment that he would often think he had been somewhere before when he has not. For instance, during a holiday to America, he reported it was the third time he had walked down a particular street, when in fact he had not been there before. He did not seem to be aware of these episodes, nor could he remember them when they were discussed, although he was aware of his memory problems more generally.

Patient 11 was tested in her own home. When answering the door, she claimed to have already met the psychologist. She was somewhat aware of her RC, claiming that she was sometimes confused about whether things had occurred or not. Her daughter reported that the symptoms were difficult to manage in that she had withdrawn from all enjoyable pastimes such as reading or watching television, although otherwise she was able to live independently at home. Patient 11 also greeted all strangers as if she knew them when taken out by her daughter.

Across all these cases, delusional thoughts more generally were not apparent, nor were other forms of reduplication or misidentification, such as the Capgras delusion. Critically, this group of patients did not produce spontaneous confabulation in their daily lives.[3] They did not confabulate autobiographical

[3] After about a year after initial assessment, AKP did begin to confabulate more generally, but not spontaneously, and only when given tests of autobiographical memory. He did eventually reduplicate events from his own past, also. For instance, he claimed he had married the same woman three times in three different ceremonies.

Please cite this article in press as: Moulin CJA, Disordered recognition memory: Recollective confabulation, Cortex (2013), http://dx.doi.org/10.1016/j.cortex.2013.01.010

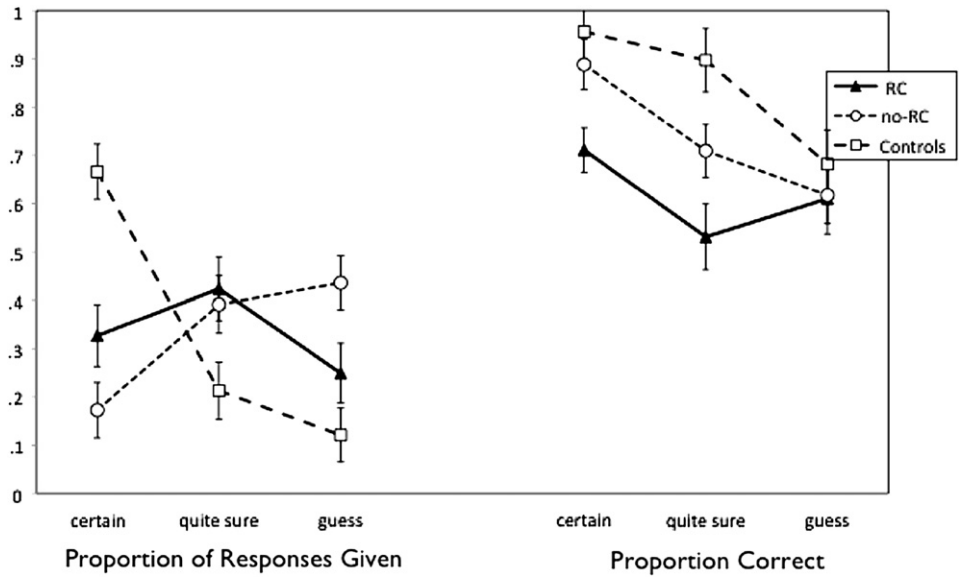

Fig. 1 – Experiment 2. Proportion of responses made for each level of confidence (left half) and proportion of correct recognition at each level of confidence (right half). No-RC = Alzheimer's disease control participants without RC. Error bars = 1 standard error of the mean.

events or episodes. Clinical notes indicate that where anti-psychotic medication or cholinesterase inhibitors (e.g., Donepezil) were prescribed they appeared to have no effect on the déjà vu-like symptoms. It is worth noting that some of our patients were followed over a longer interval, although not tested again; the RC did not reduce. AKP and Patient 11 both died whilst still regularly reporting that they had encountered events, television and people before.

2.1.4. *Design and materials*

The same task as used in Moulin et al. (2005) (Experiment 3) was given to participants. Essentially, this comprised a 30-item yes/no recognition memory test with equal numbers of high and low frequency words. Low frequency words e.g., Bayonet had a mean frequency rating of 2.7, and the high frequency words, e.g., Marriage, a mean frequency rating of 5. All stimuli (and ratings) were taken from Gilhooly and Logie (1980).

2.1.5. *Procedure*

At study, participants were visually presented 30 words intermixed in a pseudo-random order and made a pleasantness judgement for each word. This was followed immediately by a test in which the 30 previously presented targets and 30 word frequency matched 'new' words were read aloud individually in an intermixed pseudo-random order. Participants indicated whether the word was old or new. If they reported the word as old they immediately made a judgement of their subjective experience. A prompt (on a card) was available throughout the test phase:

> 'Remember: This is one of the words I saw/heard before. I can remember hearing it. It has a feeling of pastness. I can remember something about it when it was presented before. Familiar: This is one of the words I saw/heard before – it seems familiar to me. Guess: This is one of the words I heard before, but I'm guessing. New: This is a word I didn't see before'.

Following a Remember (R), Familiar (F), or Guess (G) response participants indicated their justification of the response by answering the question: how do you know that this response is a remember answer/familiar answer/guess?

2.2. *Results and discussion*

Recognition memory was first measured across all items and for all subjective states by analysing the discrimination index, where false positives are subtracted from hits (chance performance is equal to zero). The controls out-performed the patients, $t(27) = 8.08$, $p < .001$, with the controls and patients having respective mean (and standard deviation) discrimination indices of 25.5 (3.86) and 9.0 (6.97). The patient group was significantly above chance, however, $p < .001$ (one-sample t-test).

The hits given for high and low frequency words (see Table 2) were compared in a 2 × 2 (group × frequency) ANOVA. There was a main effect of group, such that the RC patients correctly recognized approximately two fewer words than controls, $F(1,27) = 10.02$, $p = .004$, $\eta^2p = .271$. There was no main effect of word frequency, $F(1,27) = 1.30$, or an interaction, $F < 1$. An identical analysis for false positives was carried out, showing a main effect of group, $F(1,27) = 26.24$, $p < .001$, $\eta^2p = .493$. There was also a main effect of frequency, such that more FPs were made for high frequency words, $F(1,27) = 26.48$, $p < .001$, $\eta^2p = .495$. There was also a significant interaction, $F(1,27) = 7.87$, $p = .009$, $\eta^2p = .245$. Post-hoc examinations with t-tests showed group differences for both high and low frequency words [high frequency, $t(27) = 5.10$, $p < .001$; low frequency, $t(27) = 4.41$, $p < .001$]. In turn, each group showed a significant difference for FPs made for high and low frequency words [Controls, $t(15) = 2.87$, $p = .012$; RC patients, $t(12) = 4.01$, $p = .002$].

Please cite this article in press as: Moulin CJA, Disordered recognition memory: Recollective confabulation, Cortex (2013), http://dx.doi.org/10.1016/j.cortex.2013.01.010

In sum, as expected the RC group made significantly more FP errors in recognition, but each group made on average more high frequency FPs than low frequency FPs. If anything, the difference between false positives in the RC patients group is higher than the control group's – they show more of a susceptibility to make FPs for high frequency words than low frequency words. Of the 13 participants, only 2 made more false positives for low frequency words than high frequency words (Cases 5 and 8). Given that the high frequency words have a higher resting level of familiarity, one might interpret this finding as suggesting that familiarity is driving the tendency to make false positives in this group, in keeping with healthy memory errors (Gardiner and Richardson-Klavehn, 2000).

Next, the subjective state at the time of recognition for correct responses (hits) was analysed. The proportion of hits assigned to R and F for high and low and frequency words was calculated. These data (Table 2) were submitted to a 2 × 2 × 2 (group × word frequency × subjective state) ANOVA. There was a main effect of group, $F(1,27) = 6.10$, $p = .020$, $\eta^2p = .184$, which can be interpreted as the patient group making a significantly lower proportion of answers which were assigned R or F (i.e., they made more guesses). There was no main effect of word frequency, $F < 1$. There was a main effect of subjective state, however, with a higher proportion of answers being assigned to the R category, $F(1,27) = 27.91$, $p < .001$, $\eta^2p = .51$ (approximately 70% of hits were assigned R, and about 25% were assigned F). Given that the pleasantness judgement at encoding encourages deep processing, this is expected (Java et al., 1997). Word frequency did not interact with any other factor, $F < 1$, nor was there a significant three-way interaction, $F < 1$. However, the subjective state by group interaction was significant, $F(1,27) = 10.20$, $p = .004$, $\eta^2p = .274$, with the means showing that the patient group assigned fewer Rs and a higher proportion of Fs to their hits. This does not point to an exaggerated tendency to report subjective experience as R, at least for hits. As with other studies into memory impairment in dementia (e.g., Dalla Barba, 1997) these data show that the ability to endorse items as old on the basis of remembering is diminished.

A similar analysis could not be carried out for false positives since most control participants did not make any false positives for either low frequency words or with the R category; the sample would have been reduced to only 4 participants. Instead, a 2 × 2 (group × subjective state) ANOVA was conducted on the proportion of FPs assigned to each subjective experience category. This yielded a main effect of group, $F(1,27) = 12.52$, $p = .001$, $\eta^2p = .317$. The means in this case indicate a lower proportion of answers assigned to R and F in the control group – controls made significantly more guesses in their FPs. There was a main effect of subjective state, $F(1,28) = 9.26$, $p = .005$, $\eta^2p = .255$, such that more FPs were assigned to familiar than remember. Moreover, there was no interaction between group and state, $F < 1$. On the whole, this analysis supports RC patients making FPs on the basis of familiarity, not recollection. Of the 13 RC patients, only three produced a higher proportion of FPs assigned to R than F (Cases 8, 9 and 10), and a further patient produced false positives equally distributed across the two categories (Case 7).

An analysis left out of our original presentation was the comparison of performance given the assignment of a particular subjective category. That is, if someone assigns an R to an item at test, what is the probability that it is a correct answer? If it is dysfunctional recollection that is behind the experiences of people with RC, low levels of performance for items given an R response might be expected. To analyse this, the proportion of each subjective category that was correctly recognized was analysed. In this 2 × 2 × 2 analysis, there was a main effect of group, $F(1,27) = 4.56$ $p = .042$, $\eta^2p = .14$, such that the controls had significantly better performance than the patients, as expected (approximately 80% opposed to 67% for items assigned R or F). The main effect of word frequency did not reach significance, $F(1,27) = 2.64$, $p = .12$. There was a main effect of subjective state, however, with the proportion correctly recognized being higher for R than for F items, $F(1,27) = 18.25$, $p < .001$, $\eta^2p = .40$. The interactions with group for these two factors approached significance, frequency × group, $F(1,27) = 3.95$, $p = .06$, $\eta^2p = .13$; state × group, $F(1,27) = 3.77$, $p = .06$, $\eta^2p = .123$. The marginal means show that whereas the controls show little or no difference in performance for the high and low frequency words (with performance slightly higher on the high frequency words), the patients perform much better on the low frequency words than the high frequency words (75% *vs* 60%). This is consistent with distinctiveness being used to enhance recognition memory – again, not consistent with a deficit in recollection. Both groups show better performance for the R judgements, but this pattern is more pronounced in the control group (note that performance is around 99% correct for R judgements in the control group). The frequency × state and three-way interactions failed to reach significance, both $F < 1$.

This latter analysis permits the comparison of group performance against chance (.5) with separate one-sample *t*-tests (one tailed). For controls and for high and low frequency words respectively, R was higher than .5, $t(15) = 52.04$, $p < .001$; $t(15) = 39.00$, $p < .001$. For patients the same respective values were, $t(12) = 1.77$, $p = .051$; $t(12) = 7.35$, $p < .001$. For the items assigned to an F, the respective analyses were (controls): $t(15) = 1.44$, $p = .085$; $t(15) = .85$, $p = .20$ and (patients) $t(12) = .77$, $p = .23$; $t(12) = 1.45$, $p = .022$. Only four of the 13 patients produced performance where their proportion correct for high frequency words given R was equal to or below chance levels (Patients 4, 5, 10, and MA) and in all these cases, proportion correct for F was arithmetically equal to or better than for R. For the low frequency items given R, only one case had performance which was at chance levels (MA). Moreover, for all patients except one (Patient 10), the proportion correct for low frequency items was higher for R than F.

In summary, the patient group make fewer R responses than controls, as has been reported previously in dementia (e.g., Dalla Barba, 1997; Rauchs et al., 2007). Participants made confabulatory justifications of their false positive remember responses such as "I had to try to say it right" or "It made me have pleasant memories of foreign travel" but in other regards, justifications given by patients were appropriate, with R justifications pointing to contextual details and thoughts in general, and F justifications mentioning feelings of familiarity and uncertainty.

The analyses suggest that the RC patients represent a memory impaired group, who on the whole, whilst making a lot of false positive errors, have a pattern of subjective responses in keeping with controls. Moreover, the patients' responses are in general in line with the objective qualities of the stimuli used (word frequency). Our earlier observation

Please cite this article in press as: Moulin CJA, Disordered recognition memory: Recollective confabulation, Cortex (2013), http://dx.doi.org/10.1016/j.cortex.2013.01.010

that false positives accompanied by the feeling of recollection were higher for low frequency items, has not been supported by a larger sample of patients and a formal statistical analysis.

3. Experiment 2

Experiment 1 indicated that the feeling of recollection was somewhat appropriate in the RC patients. They did not report excess levels of remembering, and their recognition decisions were most likely to be correct (and above chance) when accompanied by 'remembering'. The RC patients then, on average, have sensations of recollection which are appropriate given their performance; except that, they are likely to justify a false positive with recollective justification. Based on the idea that like delusional misidentification, they incorrectly interpret high familiarity as evidence of a prior occurrence, it can now be hypothesized that a metacognitive deficit lies at the centre of their RC: the justifications are produced by a feeling of certainty of prior occurrence, and the failure to metacognitively oppose this evaluation. Thus, we might expect that the RC patients are overly confident in their recognition memory, being unable to counteract or moderate the feeling that they have encountered something before. This idea was tested in a second experiment.

This was a two-alternative forced choice recognition task, which has been used previously (and the data on older adults and Alzheimer's patients presented elsewhere; Moulin et al., 2004). A limitation of Experiment 1 is the use of healthy controls rather than a set of memory impaired patients who do not experience RC. An advantage of using this task was that our previous control and Alzheimer's patient data could be used, enabling the comparison of confidence in a group of controls with dementia but who do not report feelings of déjà vu or RC. Based on the idea that patients with RC endorse new items as if they are old, and then justify their reports, and are certain of their experiences, it might be expected that they will show a deficit on this kind of metacognitive task.

3.1. Method

3.1.1. Participants

There were 32 different control participants and the same RC patients as Experiment 1, with the omission of Patient 11, who did not complete this task. Sixteen controls were patients with a diagnosis of probable Alzheimer's disease (AD) (non-RC) and sixteen were OACs. The AD group had a mean MMSE score of 17.06 (5.27), diagnosis of AD and control group selection was based on the same criteria as above.

3.1.2. Materials/stimuli

There were 32 target words. Eight were common words and eight were rare words drawn from Gilhooly and Logie (1980). The other 16 were typical category exemplars taken from Battig and Montague (1969). At test these target words were presented with one distracter word, either a semantically related distracter (e.g., red–blue, doctor–lawyer) or an unrelated word, some of which were common, some of which were rare (e.g., bayonet – aunt, microbe – chair).

3.1.3. Procedure

Participants were tested individually. They were not initially instructed that this was a memory experiment, but were asked to read each target word in turn. Participants were introduced to the stimuli with an example. Targets were presented in a random order and were displayed to the participant individually on a flash card until the participant had read the word. Presentation advanced at a rate dictated by the participant, but there was no special instruction to memorise the items. Immediately after presentation of the 32 words, participants were administered the test phase; participants were visually administered test pairs in a pseudo-random order from a test booklet. Participants were instructed to select the word that they had seen before from the new word. This could be done either visually (by pointing) or verbally, and the experimenter recorded the participants' responses. They were introduced to this procedure with a previously studied example. After selecting the word they thought to be the target in each pair they were presented with a three-point scale (i.e., certain, quite sure or guessing) and instructed to rate how confident they were that they had selected the correct answer from the pair.

3.2. Results and discussion

The proportion correct was analysed first using a one-way ANOVA, $F(2,41) = 41.67$, $p < .001$. Tukey's post-hoc tests showed that whilst the OAC group differed significantly from both patient groups (both $p < .001$), there was no significant difference in performance between the RC and non-RC dementia patients. Mean proportion correct (and standard deviation (SD)) for the RC, non-RC and OAC groups respectively, were .64 (.09), .66 (.13), and .92 (.06).

The proportion of responses made in each category was submitted to a 3 × 3 (group × confidence level) ANOVA. These were proportional data, such that a between subjects effect cannot be calculated ($F = 0$). There was no main effect of confidence, $F(2,82) = 1.91$, $p = .15$, $\eta^2p = .045$, with no overall pattern in the distribution of confidence. However, there was a significant interaction, $F(4,82) = 9.80$, $p < .001$, $\eta^2p = .323$. Fig. 1 (left panel) shows that whereas the controls assign most of their responses to the certain category, the non-RC patients assign most of their responses to the guess category. The RC patients show a pattern which is somewhat between these two groups. Independent samples *t*-tests compared the RC and non-RC patients. The RC patients made significantly more certain responses than the non-RC comparison group, $t(26) = 2.05$, $p = .05$. The proportion of responses assigned to quite sure did not differ, $t(26) = .28$, whereas the non-RC group made marginally more guess responses, $t(26) = 1.78$, $p = .09$.

Thus far the RC group are a group who, objectively, perform worse than controls (as in Experiment 1) but have a level of performance which is in keeping with other patients with dementia. However, subjectively, the RC group are more confident in their recognition memory responses than the AD group. The final analysis concerns the relationship between the subjective and objective indices of memory on this task, presented in the right panel of Fig. 1. In this case, appropriate monitoring would be indicated by higher levels of performance for items for which

Please cite this article in press as: Moulin CJA, Disordered recognition memory: Recollective confabulation, Cortex (2013), http://dx.doi.org/10.1016/j.cortex.2013.01.010

the participant was more confident. A 3 × 3 (group × confidence) repeated measures ANOVA was conducted on these data. For this analysis the samples were reduced to 9 (RC), 13 (non-RC) and 9 (controls) because of participants not using all three categories in their subjective report. There was a main effect of group, in line with the group differences in the ANOVA presented at the beginning of this analysis, $F(2,28) = 7.91$, $p = .002$, $\eta^2p = .361$. There was a main effect of confidence level, $F(2, 56) = 10.96$, $p < .001$, $\eta^2p = .281$. The interaction failed to reach significance, $F(4,56) = 1.79$, $p = .11$. On the whole, the groups performed significantly better on the items which they assigned higher levels of confidence. Certainly, however, the RC group do show a somewhat different pattern: they were more likely to be correct when they guessed than when they felt quite sure.

As with Experiment 1, it was possible to compare performance with chance (.5) for each level of subjective confidence with one-sample *t*-tests. The control group had performance that was significantly above chance at all levels of confidence (all $p < .01$). The non-RC patients with dementia had performance above chance for certain and quite sure responses respectively, $t(14) = 11.219$, $p < .001$; $t(14) = 3.95$, $p < .001$. However, their guesses were only marginally above chance $t(14) = 1.52$, $p = .076$. The RC group had performance which was significantly above chance for their certain and guess responses, $t(8) = 3.35$, $p = .005$, and $t(11) = 2.47$, $p = .015$ respectively. However, their performance for quite sure responses (which should be stronger than for their guesses) was not significantly above chance, $t(11) < 1$.

The ideal test of the appropriateness of the subjective reports of confidence is to consider the confidence accuracy relation. To analyse this, a gamma correlation was calculated for each participant. This is a non-parametric measure of association between people's confidence response, and their recognition accuracy (see Nelson, 1984). A gamma correlation closer to one indicates accurate memory monitoring, where a person correctly recognizes more items of which they were more certain. A gamma correlation of zero indicates no association between confidence and recognition. The mean (and standard deviation) gamma correlations for the respective control, non-RC and RC groups were .64 (.46), .58 (.35) and .07 (.48). The sample size is reduced where there are not responses made in more than one subjective category, such that the OAC group was reduced to 12 people. A one-way ANOVA showed that these means differed, $F(2,37) = 7.06$, $p = .003$. Tukey's post-hoc tests showed that whereas the non-RC and control groups did not differ, $p = .91$, the RC group differed from both healthy controls and controls with dementia, $p = .007$ and $p = .011$ respectively. The healthy controls and those with dementia (non-RC) had gamma correlations that were significantly different from zero, $t(11) = 5.32$, $p < .001$ (controls) and $t(15) = 6.66$, $p < .001$ (non-RC dementia patients). The RC patients, however, as a group did not produce gammas that were significantly different from zero, $t(11) < 1$.

Experiment 2 shows that the RC group has a recognition memory deficit relative to healthy controls, as in Experiment 1. However, this deficit – at least on a forced choice memory task – is no different from set of data previous collected on people with dementia. However, the RC group have a metacognitive deficit: whereas the AD group are able to accurately assign subjective evaluations to their recognition performance, the RC group show a significant impairment in this regard, and actually do not make assessments of their recognition which are above chance. Moreover, they report being 'certain' significantly more often than a memory impaired comparison group.

4. General discussion

I propose that one manifestation of the temporal lobe pathology in dementia and MCI is a false recognition syndrome, which although probably relatively rare, leads to a form of reduplicative paramnesia for time, RC. Its key features are: 1) the experiment is anosognosic for the false recognition, 2) it occurs for novel and unfamiliar events and 3) it results in confabulations of a prior experience which mimic a justification of a previous study phase or previously encountered event. This type of memory error – a relatively circumscribed delusion, which is often described as like persistent déjà vu – can be shown on tests of recognition memory, where a high level of false positive errors are made, and where spontaneous reports of prior study phases for non-studied items and other forms of factual justifications are made. RC is distinct from confabulation generally, where it has been shown that false positives in recognition tasks are not associated with confabulation (Schnider, 2008).

It was previously hypothesized that this RC arises from an over-active or ungated recollection process triggered by novel or low frequency events and stimuli (Moulin et al., 2005). In the two recognition memory experiments presented here, these hypotheses have not been supported. The RC patients have recognition memory which is more accurate when accompanied by remembering than be a feeling of familiarity. Plus, there seems to be no particular deficit for low frequency words. In the two experiments presented here, the most compelling difference between these RC patients and a controls, is that they have significantly poorer relationship between their judgements of confidence and their objective recognition memory performance: they have a metacognition deficit. This is possibly more striking since the Alzheimer's group in this study had similarly poor recognition memory, but intact metacognition.

Thus, it would seem from this that a simple underlying deficit in recollection is not at fault as we have previously argued (Moulin et al., 2005). We previously characterised AKP and MA as having recollective experience for the present moment. The chief reason for rejecting this 'recollection of the present' hypothesis is that recollection is actually still diagnostic in these patients generally: if they report 'remembering' an item, they are likely to be correct. In addition, the second experiment is preliminary evidence that these type of patients, relative to dementia patients, have a metacognitive deficit. Further research should thus use such metacognitive paradigms to better evaluate delusional misidentification syndromes, and RC in dementia.

I posit that recollection is relatively preserved in these patients, but is wrongly applied to novel events; there is a metacognitive error combined with a feeling of familiarity. This echoes the delusion and reduplicative paramnesia literature, whereby it might be suggested that erroneous familiarity leads to false recognition, and that false recognition of objectively novel stimuli is maintained in a delusion-like fashion through the evocation of contextual details and

Please cite this article in press as: Moulin CJA, Disordered recognition memory: Recollective confabulation, Cortex (2013), http://dx.doi.org/10.1016/j.cortex.2013.01.010

specifics. Thus the RC is based on an underlying false familiarity in exactly the same way that confabulated justifications of reduplication are an attempt to reconcile the subjective unfamiliarity for familiar people in Capgras delusion.

This familiarity idea of RC fits with theories of the undamaged memory system. Koriat and Levy-Sadot (2001) for example, suggests a sequential process whereby a fast familiarity response guides retrieval processes until recollection provides a subjective feeling of remembering, and additional contextual information (see also Metcalfe et al., 1993). Unsurprisingly, the experient acts metacognitively upon these sensations of familiarity and recollection in order to regulate their mental operations. Thus, familiarity is used at a 'pre-retrieval stage' (Koriat and Levy-Sadot, 2001) to trigger a preliminary assessment of memory which helps in the selection of a retrieval strategy. At a subsequent stage, the process underlying memory predictions may become more analytic, influenced by explicit consideration of the content of the cues (or partial information, or contextual details) that came to mind during the search of the target. This two-stage process based on intuitive and quick feelings followed by the search for contextual specifics guided by strategic process has been proposed in models of how epistemic feelings guide cognitive processes (Arango-Muñoz, 2011).

This familiarity view of RC has support from other cases. Schacter et al. (1996) present a case of false recognition following right frontal lobe infarction without disturbances to daily life or spontaneous RC. Nonetheless, he was prone to making very high rates of false positives on recognition memory tests, and reported subjective remembering as the basis for his endorsement of non-studied items. Schacter et al. suggest that was due to an over-reliance on general features of the study episode, possibly based on an initial fast familiarity-like assessment, but that this was re-experienced as remembering due to a failure of strategic monitoring of memory. Hintzman and Curran (1994) have shown that initially, healthy participants assess items in a recognition memory test on familiarity, looking for a general similarity between study and test items. In this initial familiarity based assessment, false positives to similar items are particularly prevalent. Ninety milliseconds later, when recollection can bring to bear on the recognition decision, false positives are less likely, when retrieval of specifics can correct the initial feeling of familiarity based on similarity. In the patients presented here, presumably this latter stage is disrupted – confabulated specifics are retrieved in support of the sensation of familiarity.

One prominent feature of RC is that carers report that it happens only for novel events. This could merely be because this is when a mismatch between the knowledge of prior occurrence and subjective familiarity is highest, and there is therefore the greatest need to confabulate a prior experience to justify the erroneous sensation of familiarity. This phenomenon has parallels in healthy memory, neatly encapsulated in the paradox: 'Why do strangers feel familiar but friends don't?' (Whittlesea and Williams, 1998). Feelings of familiarity are more likely to be invoked in surprising contexts, as Whittlesea has demonstrated in experimental contexts on healthy participants and which is described as the discrepancy-attribution hypothesis of familiarity. When feelings of fluency, ease of processing and pastness are encountered which are in concert with expectations and prior experience, there is no striking feeling of familiarity. In support of this discrepancy-attribution account of RC, Case 11 was happy to watch DVDs of movies she knew had seen previously, but not new ones.

The data in the two experiments are consistent with the patients having a relatively intact recollection process, but metacognitive failure whereby their subjective evaluations do not reflect performance; an overconfidence. It is conceivable that this metacognitive failure captures their RC – they are unaware of their false recognition and thus they are driven to recollect specifics when it is inappropriate to do so. The nature of confidence and metacognition in delusions more generally is an issue which warrants future research. It would be of interest to see whether similar patients would be overconfident more generally on cognitive estimates, for instance, although the patients reported here did not present with any grandiose or otherwise irrational assessments in their daily lives.

Importantly, it should be noted that these findings about metacognition stem from one recognition memory task only, and it would be helpful to extend these data to different forms of recognition memory test, with different materials and different paradigms for assessing memory monitoring. The familiarity interpreted as recollection hypothesis proposed here would be better tested by objectively verifiable tasks which allow the separate estimation of familiarity and recollection, such as the process dissociation procedure (Jacoby, 1991). In cases such as these, a disproportionate deficit in familiarity, not recollection would be predicted. Previous studies using process dissociation in dementia have shown deficits in both F and R (Knight, 1998), whereas studies using subjective report seem only to detect a deficit in R (e.g., Dalla Barba, 1997). Using such process dissociation procedures, Martin et al. (2012) have shown that frequent déjà vu in temporal lobe epilepsy patients arises when familiarity is impaired but recollection is intact. The associations with such tasks, and other neuropsychological measures in patients with RC in dementia would be of interest in future studies.

Finally, it is worth noting the relationship between these patients' phenomenology and déjà vu experiences (for a review of déjà vu in healthy and pathological groups see O'Connor and Moulin, 2010). The cases reported here where participants act on their RC, and are anosognosic for it, do not per sé have a déjà vu experience. A critical feature of déjà vu experiences is that they feature a knowing clash of evaluations – in this way, déjà vu is not false recognition because one is aware of the inappropriateness of the familiarity at the core of the sensation. Where the experience is not recognized as false by the experient in the cases presented here, it is not déjà vu. Use of the term déjà vécu (a recollective form of the déjà vu experience based on the translation 'already experienced') in these cases in our previous reports has in fact proven unhelpful, insofar as it has drawn comparisons between memory experiences in the general population and something much more debilitating and so I have not used it here. It will however remain necessary to use a variety of déjà vu experience terms (déjà vu, déjà vécu) with these patients simply because they are used by carers and clinicians to convey the unusualness of the experience.

The cases presented are a demonstration of how familiarity and recollection processes in the medial temporal lobe (MTL) can breakdown and yield a delusion-like symptom of RC. As Didic et al. (2011) point out, the consideration of MTL sub-regions in Alzheimer's disease has failed to keep up with

Please cite this article in press as: Moulin CJA, Disordered recognition memory: Recollective confabulation, Cortex (2013), http://dx.doi.org/10.1016/j.cortex.2013.01.010

advances in the understanding of context-free and contextual memory in dual-process theories of human memory. Relatively rare cases such as these reported here possibly offer an opportunity to better understand the interplay between familiarity and recollection systems, and functional neuroimaging of such cases remains a research priority.

Acknowledgements

I am very grateful to the following people for assistance with data collection: Elizabeth Christie, Nathan Illman, Kelly Mitchell, Louise Pryer, Amanda Salter, & Rebecca Thompson. The patients were recruited through Research Institute for the Care of the Elderly (RICE), Bath, UK and I would like to thank Professor Roy Jones for his support. I am grateful for all the volunteers and patients who took part in this study, and in particular to Patient 11 and her daughter.

REFERENCES

Arango-Muñoz S. Two levels of metacognition. *Philosophia*, 39: 71–82, 2011.

Battig WF and Montague WE. Category norms for verbal items in 56 categories: A replication and extension of the Connecticut category norms. *Journal of Experimental Psychology Monographs*, 80: 1–46, 1969.

Brandt J. The Hopkins Verbal Learning Test: Development of a new memory test with six equivalent forms. *Clinical Neuropsychologist*, 5: 125–142, 1991.

Dalla Barba G. Recognition memory and recollective experience in Alzheimer's disease. *Memory*, 5: 657–692, 1997.

Didic M, Barbeau EJ, Felician O, Tramoni E, Guedj E, Poncet M, et al. Which memory system is impaired first in Alzheimer's disease? *Journal of Alzheimer's Disease*, 27: 11–22, 2011.

Feinberg TE and Shapiro RM. Misidentification-reduplication and the right hemisphere. *Neuropsychiatry, Neuropsychology and Behavioural Neurology*, 2: 39–48, 1989.

Feinberg TE and Roane DM. Delusion misidentification. *Psychiatric Clinics of North America*, 28: 665–683, 2005.

Folstein MF, Folstein SE, and McHugh PR. Mini-mental state: A practical method for grading the cognitive state of the patient for the clinician. *Journal of Psychiatric Research*, 12: 189–198, 1975.

Gardiner JM and Richardson-Klavehn A. Remembering and knowing. In Tulving E and Craik FIM (Eds), *Handbook of Memory*. New York: Oxford University Press, 2000: 229–244.

Gilhooly KJ and Logie RH. Age-of acquisition, imagery, concreteness, familiarity, and ambiguity measures for 1,944 words. *Behaviour Research Methods and Instrumentation*, 12: 395–427, 1980.

Hintzman DL and Curran T. Retrieval dynamics of recognition and frequency judgments: Evidence of separate processes of familiarity and recall. *Journal of Memory and Language*, 33: 1–18, 1994.

Jacoby L. A process dissociation framework: Separating automatic from intentional influences of memory. *Journal of Memory and Language*, 30: 513–554, 1991.

Java RI, Gregg VH, and Gardiner JM. What do people actually remember (and know) in 'remember/know' experiments? *European Journal of Cognitive Psychology*, 9: 187–197, 1997.

Knight G. Controlled and automatical processes in Alzheimer's disease. *Cortex*, 34(3): 427–435, 1998.

Kopelman MD. Two types of confabulation. *Journal of Neurology, Neurosurgery and Psychiatry*, 50: 1482–1487, 1987.

Koriat A. How do we know that we know? The accessibility model of the feeling of knowing. *Psychological Review*, 100: 609–639, 1993.

Koriat A and Levy-Sadot R. The combined contributions of the cue-familiarity and accessibility heuristics to feelings of knowing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 27(1): 34–53, 2001.

Lyketsos CG, Lopez O, Jones B, Fitzpatrick AL, Breitner J, and DeKosky S. Prevalence of neuropsychiatric symptoms in dementia and mild cognitive impairment. *Journal of the American Medical Association*, 288: 1475–1483, 2002.

Mandler G. Familiarity breeds attempts. *Perspectives on Psychological Sciences*, 3: 390–399, 2008.

Martin CB, Mirsattari SM, Pruessner JC, Pietrantonio S, Burneo JG, Hayman-Abello B, et al. Déjà vu in unilateral temporal-lobe epilepsy is associated with selective familiarity impairments on experimental tasks of recognition memory. *Neuropsychologia*, 50(13): 2981–2991, 2012.

Mendez M. Delusion misidentification of persons in dementia. *British Journal of Psychiatry*, 160: 414–446, 1992.

Metcalfe J, Schwartz B, and Joaquim S. The cue-familiarity heuristic in metacognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 19: 851–861, 1993.

Moulin CJA, Conway MA, Thompson RG, James N, and Jones RW. Disordered memory awareness: recollective confabulation in two cases of persistent déjà vécu. *Neuropsychologia*, 43(9): 1362–1378, 2005.

Moulin CJA, James N, Perfect TJ, and Jones RW. Knowing what you cannot recognise: Further evidence for intact metacognition in Alzheimer's disease. *Aging, Neuropsychology and Cognition*, 10: 74–82, 2004.

Nelson TO. A comparison of current measures of feeling-of-knowing predictions. *Psychological Bulletin*, 95: 109–133, 1984.

O'Connor AR and Moulin CJA. Recognition without identification, erroneous familiarity, and déjà vu. *Current Psychiatry Reports*, 12: 165–173, 2010.

O'Connor AR, Lever C, and Moulin CJA. Novel insights into false recollection: A model of déjà vécu. *Cognitive Neuropsychiatry*, 15: 118–144, 2010.

Pick A. On reduplicative paramnesia. *Brain*, 26: 260–267, 1903.

Pisani A, Marra C, and Silveri MC. Anatomical and psychological mechanism of reduplicative misidentification syndromes. *Neurological Sciences*, 21: 234–328, 2000.

Rauchs G, Piolino P, Mézenge F, Landeau B, Lalevée C, Pélerin A, et al. Autonoetic consciousness in Alzheimer's disease: Neuropsychological and PET findings using an episodic learning and recognition task. *Neurobiology of Aging*, 28: 1410–1420, 2007.

Schacter DL, Curran T, Galluccio L, Milberg WP, and Bates JF. False recognition and the right frontal lobe: A case study. *Neuropsychologia*, 34: 793–808, 1996.

Schnider A. *The Confabulating Mind. How the Brain Creates Reality*. Oxford, UK: Oxford University Press, 2008.

Sultzer DL, Brown CV, Mandelkern MA, Mahler ME, Mendez MF, Chen ST, et al. Delusional thoughts and regional frontal/temporal cortex metabolism in Alzheimer's disease. *American Journal of Psychiatry*, 160: 341–349, 2003.

Welsh K, Butters N, Hughes J, Mohs R, and Heyman A. Detection of abnormal memory decline in mild cases of Alzheimer's disease using CERAD neuropsychological measures. *Archives of Neurology*, 48: 278–281, 1991.

Whittlesea BWA and Williams LD. Why do strangers feel familiar, but friends don't? A discrepancy-attribution account of feelings of familiarity. *Acta Psychologica*, 98: 141–165, 1998.

Yonelinas AP. The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language*, 46: 441–517, 2002.

Please cite this article in press as: Moulin CJA, Disordered recognition memory: Recollective confabulation, Cortex (2013), http://dx.doi.org/10.1016/j.cortex.2013.01.010