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Neuropsychological function and memory suppression in conversion disorder

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Conversion disorder (CD) is a condition where neurological symptoms, such as weakness or sensory disturbance, are unexplained by neurological disease and are presumed to be of psychological origin. Contemporary theories of the disorder generally propose dysfunctional frontal control of the motor or sensory systems. Classical (Freudian) psychodynamic theory holds that the memory of stressful life events is repressed. Little is known about the frontal (executive) function of these patients, or indeed their general neuropsychological profile, and psychodynamic theories have been largely untested. This study aimed to investigate neuropsychological functioning in patients with CD, focusing on executive and memory function. A directed forgetting task (DFT) using words with variable emotional valence was also used to investigate memory suppression. 21 patients and 36 healthy controls completed a battery of neuropsychological tests and patients had deficits in executive function and auditory-verbal (but not autobiographical) memory. The executive deficits were largely driven by differences in IQ, anxiety and mood between the groups. A subgroup of 11 patients and 28 controls completed the DFT and whilst patients recalled fewer words overall than controls, there were no significant effects of directed forgetting or valence. This study provides some limited support for deficits in executive, and to a lesser degree, memory function in patients with CD, but did not find evidence of altered memory suppression to support the psychodynamic theory of repression.

Conversion disorder (CD), previously known as hysteria, is the condition in which neurological symptoms (such as weakness or sensory dysfunction) occur in the absence of neurological disease and are presumed to be psychological, rather than 'physical', in origin (American Psychiatric Association, 1994; World Health Organisation, 1992).

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Little is known about the neuropsychological profile of the disorder. An early study found some evidence for deficits in episodic memory using the Guessing Technique and Paired Associates Test in 17 CD patients with mixed, but mostly motor (i.e., weakness), symptoms compared to the same number of mixed psychiatric controls (Bendefeldt, Miller, & Ludwig, 1976). Another small study of 10 patients, again with mixed symptoms, also found impairments in the Paired Associates Test, as well as impairments of delayed recall (naming images) and executive function (on the Trail Making Test) compared to 10 cases of depression (Flor-Henry, Fromm-Auch, Tapper, & Schopflocher, 1981). In the seizure variant of the disorder, now most often called (psychogenic) non-epileptic seizures, there is also evidence of executive and memory dysfunction (e.g., Fargo *et al.*, 2004; Kent *et al.*, 2006; Reuber, Fernandez, Helmstaedter, Qurishi, & Elger, 2002). These findings can be considered compatible with the theory that the disorder is one of impaired executive control of functions such as the deployment of attention and planning of goal-directed behaviour (e.g., Spence, 2006).

Traditional psychodynamic (i.e., Freudian) theories of CD posit that the memory of psychically traumatic events is repressed and 'converted' into physical symptoms (Breuer & Freud, 1895). Evidence supporting the role of psychological factors includes the identification of a precipitating emotional stressor which in one study was found to be present in up to 93% of conversion patients (Raskin, Talbott, & Meyerson, 1966) but controlled, methodologically robust studies have yet to be performed to confirm these findings. Furthermore, it is clear that clinicians do not always find precipitating stressors or evidence for a convincing psychological formulation (Nicholson, Stone, & Kanaan, 2011). Nevertheless, the World Health Organisation's ICD-10 continues to allude to the importance of psychodynamic theory, suggesting that the CD patient's disability usually serves the function of 'helping the patient to escape from an unpleasant conflict' (World Health Organisation, 1992). Psychodynamic models of repression of such conflict have long been dominant in aetiological hypotheses, but this dominance is now being challenged (Stone, LaFrance, Levenson, & Sharpe, 2010) due to a lack of supportive evidence.

Recent work in cognitive neuroscience has confirmed the phenomenon of memory suppression and has mapped out a neurophysiological substrate for this effect (e.g., Anderson *et al.*, 2004). We have recently shown that such suppression may be relevant in CD using fMRI to investigate a case of motor CD (Kanaan, Craig, Wessely, & David, 2007). In this case, the patient's symptoms started immediately after hearing from her partner of 12 years that he was intending on leaving her. This ostensibly stressful life event was not reported as stressful by the patient and was therefore thought to be an example of repression of the emotional significance of the event. When recalling this event, activation in the right inferior frontal lobe and the amygdala was higher than activation when thinking about an equally stressful life event temporally unrelated to her symptoms. It is important to note that the event per se was not forgotten and that to our knowledge no studies of CD have reported deficits in autobiographical memory implying that it is the repression of the emotional salience that occurs, rather than repression of the memory itself. However, findings from these case studies need to be empirically examined and quantified using a valid measure of autobiographical memory.

This study aimed to directly investigate neuropsychological function in motor CD patients, focusing on executive and memory function based on previous findings and the rationale that set shifting (and attention) have been identified as key in the intentional retrieval of memories via executive control (Miyake *et al.*, 2000). It was predicted that there would be deficits in executive and general memory function in CD in line with

previous studies. However, we predicted that there would be no difference in the autobiographical memory of patients compared to controls.

Additionally we set out to test whether there was evidence of abnormal memory suppression in CD patients, predicting that they would show lower rates of recall in a directed forgetting task (DFT). If confirmed, this would provide empirical evidence to support suppression as a potential psychological mechanism involved in the aetiology of the disorder. Memory research has shown that emotional content and arousal at encoding render memories resistant to forgetting (Cahill *et al.*, 1994), perhaps through consolidation processes (Kensinger, Anderson, Growdon, & Corkin, 2004). However, to our knowledge, the effect of emotion has not been examined to date in a DFT paradigm. In view of our interest in the effect of emotional content of events on memory suppression, we took the opportunity afforded by this study to explore the effect of negative words on directed forgetting in both healthy controls and CD patients. We speculated that there might be an overall effect of emotional (negatively valenced) content which might attenuate the directed forgetting effect, but more importantly we sought to test whether there would be an interaction between diagnosis and emotion such that patients with a history of CD would be more able to suppress emotional material than controls.

Method

Design

A between-subjects design was used in which two groups (patients with CD and healthy controls) each completed a short battery of neuropsychological tests, focusing on memory and tests of executive functioning, in addition to a DFT. Recall rates in the DFT were used as an index of memory suppression and compared between the two groups. Current anxiety and depression levels were also rated, using a validated brief self-report scale, in addition to estimated IQ, as they are potential confounders of memory performance.

Participants

Motor CD patients (n = 21), diagnosed according to ICD-10 criteria by a consultant psychiatrist, were recruited from both inpatient and outpatient neuropsychiatry services in the South-East of England. The patients all had motor weakness as their primary (most disabling) symptom and the mean duration of symptoms at the time of the study was just over a year (16 months) with a range of 3 months to 3 years. At the time of testing all patients were symptomatic: for four patients, symptoms were minor (little impairment of function) for eight they were moderate (significant impairment of function), and for nine they were major (major impairment of function and little or no improvement from their peak disability). The median impairment was moderate. All but two CD patients were taking psychotropic medications, ranging from a single medication such as an antidepressant up to multiple psychotropic medications.

Healthy controls (n = 9) were recruited from a primary care clinic in the same catchment area as the patients to control for socio-economic status. As recruitment via this method proved difficult, additional controls (n = 27) were recruited via opportunity sampling. Subjects were excluded if they were not fluent in English or had a neurological, somatoform or active major mental health disorder on self-report. Controls were not specifically screened for medication use or psychiatric comorbidity.

Procedure and measures

Neuropsychology battery

The following tests were performed on all subjects: National Adult Reading Test (NART; Nelson & Willison, 1991) for estimation of IQ. Logical memory (sub)test of the Wechsler memory Scale-third edition (WMS-III; Wechsler, 1997b).

Autobiographical Memory Interview (AMI; Kopelman, Wilson, & Baddeley, 1989). This is a semi-structured interview of autobiographical memory, which encompasses two components, assessing memories from three periods of the participant's lifetime: childhood, early adult life, and recent life. The first component, the 'personal semantic' schedule, assesses recall of facts (such as the participant's previous addresses), whereas the second, the 'autobiographical incidents' schedule, examines recall of specific events or incidents.

Trail Making Task (TMT; Reitan, 1958). Part A of the TMT is a simple measure of visual attention and processing speed while part B includes set shifting. Subtracting A from B is thought to provide a purer measure of set shifting ability.

Stroop colour-word test (Stroop, 1935). The Stroop task measures selective attention, cognitive flexibility and processing speed and contains three sections. In section A, participants read aloud lists of colour words. Section B requires participants to name the colour that each series of 'xxxx' are printed in. In Section C, the lists are the names of colours, printed in an incongruent colour ink (e.g., the word 'RED' printed in blue ink). Participants are required to name the colour ink. The number of items read within the given time for each subtask (45 s) is noted and the interference of the printed word on naming the colour of the ink is calculated using a formula in which a predicted score for Section C (based on the scores from the previous two sections) is subtracted from the achieved score for Section C (a lower score is indicative of greater interference).

Directed forgetting task (DFT)

This task was adapted from the paradigm used by Cottencin *et al.* (2008), which was in turn adapted from Zacks, Radvansky, and Hasher (1996). In our DFT, four lists of 24 words each are shown successively on a computer screen. Each word is shown for five-seconds, followed by the instruction, 'Remember' or 'Forget', displayed for 2 s. Each list includes 12 neutral words and 12 negative words (i.e., words of negative emotional valence). The instruction 'Remember' is randomly assigned to both sets of words and the instruction 'Forget' to the remaining half in each list. The words used were selected from those used in a study of intentional forgetting in individuals with depression (Joormann, Hertel, LeMoult, & Gotlib, 2009). These were chosen from the Affective Norms for English Words (ANEW; Bradley and Lang, 1999), which rated words on a nine-point scale according to valence. Those rated below 4 were categorised as negative, those between 4 and 6 were deemed neutral and those rated above 6 were deemed positive (see Joormann *et al.*, 2009 for details). Americanisms, and other words considered ambivalent in British usage, were removed and replaced with words taken from a study of emotional memory (Medford *et al.*, 2005), which had also been selected using ANEW.

The order of all words (along with their subsequent instruction) in each list was set at random, with the same order being kept for all participants. The instruction is given after the word has been shown so that participants do not know in advance which words are to be remembered and which are to be forgotten. After being shown each list, participants are instructed to recall as many of the words to be remembered as possible, in a maximum time of 2 min (the immediate conditional recall phase). Participants then complete

10 min of the neuropsychological battery, in order to prevent rehearsal of the words, after which they are asked to recall as many words from the four lists as possible, both those to be remembered and those to be forgotten. Participants are given a maximum of 5 min for this second phase of testing (the final unconditional recall phase). Scores for each phase consist of the number of words to be remembered that were recalled, the number of words to be forgotten that were recalled, and the number of intrusions (words not in the lists, but recalled by the participants). Spelling errors and slight variations of words (e.g., plurals) were accepted.

Anxiety and depression

Current anxiety and depression levels were assessed using the Hospital Anxiety and Depression scale (HADS; Zigmond & Snaith, 1983).

Procedure

Participants completed all tasks wherever possible and in the same order. Data on ratings were incomplete on two patients due to practical problems in testing. The DFT was only offered to a subset of the participants (11 patients and 28 controls) who were able to take part in a more extensive study involving functional imaging. Informed consent was gained for the testing, and approval for the study was given by the National Research Ethics Service (study number 07/H0805/33).

Data cleaning

Outliers were identified and as a result one patient was excluded from analysis of the DFT. This patient's score on one variable was over five standard deviations outside the mean. Also, the mean estimated IQ score for all patients was calculated and assigned to one patient for whom an estimation of IQ was not available.

Data analysis

Group differences in neuropsychological battery test results, NART and HADS scores were compared using independent samples *t* tests or Mann-Whitney *U* tests depending on their distribution. Additionally, the relationships between significant between-group differences (in IQ, depression and anxiety scores) and results of each test were examined via correlations and univariate ANOVAs. Mean values from the DFT were compared between groups using a mixed-model ANOVA. Intrusion scores in the DFT were examined using Mann-Whitney *U* tests because of their distribution. An alpha level of .05 was used for all statistical tests.

Results

Demographic and clinical variables

For all subjects there were no significant differences between groups in age or gender (see Table 1 for details). However, there was a significant difference on estimations of IQ using the NART; on average, controls had a significantly higher estimated IQ than patients (107.75 vs 101.30), although both were in the average range. Also, analyses showed that there were significant differences between groups on both the depression and anxiety

Table 1. Summary of participant characteristics for all subjects and those participating in Directed Forgetting Task

Subjects	Variable	Patients	Controls	Statistic	*p*-value (effect size *d*)
All	Number	21	36		
	Female, *n* (%)	14 (66.67)	22 (61.11)	$v^2 = 0.18$	0.68
	Age, Mean (*SD*)	38.10 (11.57)	38.94 (12.44)	$t(55) = 0.26$	0.80
	IQ estimate, mean (*SD*)	105.13 (10.19)	108.75 (8.37)	$t(54) = 2.16$	0.04* (.57)
	HADS anxiety, Mean (*SD*)	10.00 (4.06)	6.25 (3.36)	$t(54) = -3.24$	0.02* (.86)
	HADS depression, Mean (*SD*)	5.80 (3.94)	2.54 (2.33)	$t(26) = -3.26$	0.03* (.97)
DFT only	Number	10	28		
	Female, *n* (%)	6 (60.00)	16 (57.14)	FET	1.00
	Age, Mean (*SD*)	39.30 (13.48)	38.75 (13.23)	$t(36) = -0.11$	0.91
	IQ estimate, Mean (*SD*)	105.13 (10.19)	108.75 (8.37)	$t(36) = 1.11$	0.28
	HADS anxiety, Mean (*SD*)	10.00 (4.06)	6.25 (3.36)	$t(36) = -2.87$	0.007** (1.00)
	HADS depression, Mean (*SD*)	5.80 (3.94)	2.54 (2.33)	$t(11) = -2.47$	0.03* (1.00)

FET = Fisher's exact test, *t* = Student's *t* test, *U* = Mann-Whitney *U* test.
*$p < .05$; **$p < .01$.

sub-sections of the HADS; patients scored significantly higher on this measure of depression ($M = 8.05$, $SD = 5.78$) and anxiety ($M = 11.15$, $SD = 5.02$; both out of a maximum of 21) than controls ($M = 3.47$, $SD = 3.29$; $M = 7.31$, $SD = 3.79$; respectively). As noted, a subset of 11 patients and 28 controls also participated in the DFT. The sub-groups did not differ significantly with regard to gender, age or IQ. There was however a significant difference between groups on both depression and anxiety scores; patients had significantly higher depression ($M = 5.80$, $SD = 3.94$) and anxiety ($M = 10.00$, $SD = 4.06$) scores than controls ($M = 2.54$, $SD = 2.33$; $M = 6.25$, $SD = 3.36$; respectively).

Analyses

Neuropsychology battery

Logical memory subtest. Group differences between total recall of exact story units were significant in both the immediate ($t(29) = 2.10$, $p = .044$) and delayed ($t(31) = 2.93$, $p = .006$) recall stages (refer to Table 3 for group means and *SD*), with patients performing more poorly than controls. However, total recall of thematic story units did not significantly differ between groups in either the immediate ($t(55) = 1.57$, $p = .12$) or delayed ($t(29) = 1.66$, $p = .11$) recall stage. In addition, analyses did not reveal a significant difference between groups on auditory-verbal recognition scores ($t(30) = 1.94$, $p = .061$), although patients tended to show poorer recognition. However, overall percent retention scores did significantly differ between groups ($t(27) = 2.21$, $p = .036$); patients had significantly lower retention scores (11.65%).

TMT. Analyses revealed a significant difference between groups on time scores of both part A ($t(27) = -3.16$, $p = .004$) and part B ($t(21) = -2.48$, $p = .021$) of the TMT, and B-A ($t(22) = -2.13$, $p = .045$) with patients inferior to controls. There was however,

no significant difference between groups in terms of the number of errors made in either part A ($t(54) = -.86$, $p = .39$) or B ($t(54) = -.26$, $p = .79$).

Stroop test. An independent-samples t test carried out on interference scores on the Stroop test of colour naming showed a significant difference between groups ($t(53) = 2.42$, $p = .019$) with patients showing greater interference than controls ($MD = 8.01$).

AMI. Analyses revealed no significant differences between groups on personal semantic ($t(26) = 1.94$, $p = .063$) or autobiographical incidents ($t(21) = 1.95$, $p = .065$), scores of the AMI, although scores were generally lower in patients.

Correlational analyses. Pearson's correlations revealed that IQ was significantly correlated with logical memory retention scores ($r = .45$, $n = 57$, $p = .001$) and with Stroop interference scores ($r = .35$, $n = 55$, $p = .008$). IQ was also significantly correlated with the time difference between TMT A and TMT B ($r = -.56$, $n = 56$, $p < .001$) and significantly correlated with personal semantic scores on the AMI ($r = .31$, $n = 57$, $p = .021$). IQ was however, not significantly correlated with autobiographical incidents scores on the AMI ($r = .21$, $n = 57$, $p = .11$). Pearson's correlations indicated that depression was significantly correlated with logical memory retention scores ($r = -.34$, $p = .011$), and highly significantly correlated with interference scores on the Stroop test ($r = -.61$, $p < .001$), the time difference between TMT A and TMT B ($r = .37$, $p = .006$), and personal semantic scores on the AMI ($r = -.65$, $p < .001$). Depression was also highly significantly correlated with autobiographical incidents scores on the AMI ($r = -.54$, $p < .001$). Regarding anxiety, correlations indicated that anxiety was not significantly associated with logical memory retention scores ($r = -.20$, $p = .14$) but was highly associated with interference scores on the Stroop test ($r = -.58$, $p < .001$), the time difference between TMT A and TMT B ($r = .45$, $p < .001$), and personal semantic scores on the AMI ($r = -.48$, $p < .001$). Anxiety was also significantly correlated with autobiographical incidents scores on the AMI ($r = -.38$, $p = .004$). In view of these results further analyses were carried out using IQ and HADS as covariates (see below).

ANOVA analyses. When adding estimated IQ as a covariate many of the above group differences were attenuated (see Table 2). In fact the only differences that remained significant at $p < .05$ were the time taken to perform both TMT A ($p = .003$) and ($p = .026$) and B and the exact unit immediate ($p = .047$) and delayed ($p = .02$) recall of the logical memory test. The difference on Stroop interference was borderline significant ($p = .068$). When IQ and anxiety (HADS-A) and depression (HADS-D) ratings were added as covariates no previously significant results remained, but one previously non-significant result, TMT B errors, became significant ($p = .031$; see Table 2).

Directed forgetting task

A 2 9 2 9 2 mixed-design ANOVA, with a between-subjects factor of group (patient or control) and within-subjects factors of instruction (remember or forget) and valence

Table 2. Summary of neuropsychological test scores in patients and controls

Test			Mean scores (*SD*) Patients (*n* = 21)	Mean scores (*SD*) Controls (*n* = 36)	Statistics	*p*-value (effect size *d*)	ANOVA *F* (*p*) for group IQ	ANOVA *F* (*p*) for group IQ, HADS-A & HADS-D
Trail Making Test	Part A: Time (s)		35.96 (14.74)	24.51 (8.98)	*t*(27) = □3.16	0.004** (.94)	9.487 (.003**)	3.035 (.088)
	Part A: Errors		0.40 (.50)	0.28 (.51)	*t*(54) = □0.86	0.39	0.311 (.058)	0.391 (.534)
	Part B: Time (s)		93.69 (66.83)	55.47 (22.34)	*t*(21) = □2.48	0.021* (.77)	5.258 (.026*)	0.933 (.339)
	Part B: Errors		0.65 (2.46)	0.53 (1.00)	*t*(54) = □0.26	0.79	0.055 (.815)	4.930 (.031)
	Time B □ Time A (s)		43.34 (34.16)	26.63 (14.82)	*t*(22) = □2.13	0.045* (.63)	3.038 (.087)	0.171 (.681)
Stroop test	Words time (s)		85.68 (20.69)	109.06 (15.75)	□	□	□	□
	Colours time (s)		64.68 (16.01)	77.31 (12.24)	□	□	□	□
	Interference time (s)		39.79 (11.81)	47.83 (11.55)	*t*(53) = 2.42	0.019* (.69)	3.471 (.068)	0.077 (.782)
Logical memory test	Immediate recall	Exact units	37.76 (12.49)	44.11 (7.81)	*t*(29) = 2.10	0.044*	4.124 (.047*)	1.113 (.297)
		Thematic units	16.14 (4.05)	17.58 (2.84)	*t*(55) = 1.57	0.152	1.676 (.201)	0.448 (.507)
	Delayed recall	Exact units	20.95 (10.35)	28.42 (7.04)	*t*(31) = 2.93	0.006**	5.792 (.020*)	2.474 (.122)
		Thematic units	10.57 (2.96)	11.75 (1.78)	*t*(29) = 1.66	0.157	1.215 (.275)	0.019 (.890)
	Auditory-verbal recognition		25.14 (3.17)	26.64 (2.03)	*t*(30) = 1.94	0.061	2.717 (.105)	0.324 (.571)
	Retention (%)		74.06 (22.34)	85.71 (11.93)	*t*(27) = 2.21	0.036*(.65)	2.446 (.124)	1.239 (.271)
AMI	Personal semantic total		59.05 (4.92)	61.28 (2.45)	*t*(26) = 1.94	0.063	2.879 (.096)	0.260 (.612)
	Autobiographical total		24.19 (5.36)	26.50 (1.13)	*t*(21) = 1.95	0.065	3.851 (.055)	0.168 (.683)

Notes. AMI = autobiographical memory interview; *t* = Student's *t* test; *U* = Mann-Whitney *U* test.
*$p < .05$; **$p < .01$; ***$p < .001$.

(negative or neutral), was carried out on data from the immediate and delayed recall conditions (see Table 3).

Immediate conditional recall phase

Analysis revealed a significant main effect of group ($F(1, 36) = 12.72$, $p = .001$), with patients recalling fewer words than controls ($M = 22.20$, $SD = 7.77$; $M = 30.39$, $SD = 5.63$; respectively), in addition to a main effect of instruction ($F(1, 36) = 355.85$, $p < .001$), with to-be-remembered words being recalled more ($M = 26.63$, $SD = 7.10$) than those to-be-forgotten ($M = 1.61$, $SD = 1.65$). In contrast, there was no significant main effect of the valence of the words recalled ($F(1, 36) = 2.30$, $p = .138$, *ns*).

A significant interaction between group and instruction was found ($F(1, 36) = 9.62$, $p = .004$). *Post-hoc* tests revealed that this was driven by the patient group recalling significantly fewer words to be remembered than the control group ($t(36) = 3.44$, $p = .001$; $M = 20.80$, $SD = 8.31$; $M = 28.71$, $SD = 5.38$; respectively); the groups did not differ in their recall of words to be forgotten ($t(36) = .45$, $p = .65$). There were no significant interaction effects of group and valence ($F(1, 36) = .01$, $p = .9$), instruction and valence ($F(1, 36) = 1.66$, $p = .20$), or between group, instruction and valence ($F(1, 36) = .24$, $p = .63$; see Figure 1).

Delayed unconditional recall phase

Analysis revealed a significant main effect of group ($F(1, 36) = 4.91$, $p = .033$), instruction ($F(1, 36) = 36.65$, $p < .001$), and valence ($F(1, 36) = 7.22$, $p = .011$). That is, patients recalled significantly fewer words overall ($M = 11$, $SD = 6.58$) than controls ($M = 18.68$, $SD = 10.25$). Also, when collapsing across group and valence, significantly more words to be remembered were recalled ($M = 13.61$, $SD = 8.94$) than words to be forgotten ($M = 3.05$, $SD = 2.43$). Additionally, significantly more negative ($M = 9.00$, $SD = 5.04$) than neutral ($M = 7.66$, $SD = 5.31$) words were recalled overall.

Table 3. Summary of the word recall data collected from the directed forgetting task in conversion patients and controls

		Mean number of words recalled (*SD*)			
Test phase	Word type	Patients	Controls	Statistics	*p*-value
Immediate conditional recall	Negative 'Remember'	10.80 (3.52)	14.96 (3.17)	□	□
	Neutral 'Remember'	10.00 (5.29)	13.75 (3.43)	□	□
	Negative 'Forget'	0.80 (0.92)	0.79 (0.96)	□	□
	Neutral 'Forget'	0.60 (.70)	0.89 (1.20)	□	□
	Intrusions	2.00 (1.83)	1.18 (1.44)	$U = 104.50$	.129
Delayed unconditional recall	Negative 'Remember'	4.30 (2.79)	7.96 (4.32)	□	□
	Neutral 'Remember'	4.10 (2.85)	7.54 (5.37)	□	□
	Negative 'Forget'	2.00 (1.05)	2.04 (1.84)	□	□
	Neutral 'Forget	0.60 (1.07)	1.18 (1.22)	□	□
	Intrusions	2.70 (3.65)	2.00 (2.07)	$U = 132.00$	.782

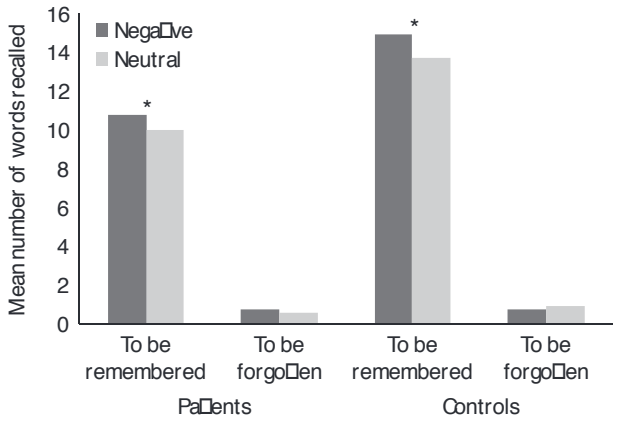

Figure 1. Mean number of items recalled by conversion disorder patients and controls in the immediate conditional recall phase. $^{*}p < .05$.

A significant interaction between group and instruction was found ($F(1, 36) = 4.71$, $p = .037$); there was no difference between groups on recall of words to be forgotten ($t(36) = .68$, $p = .50$) but patients recalled significantly fewer words to be remembered than controls ($t(36) = 2.26$, $p = .030$; $M = 8.40$, $SD = 5.36$; $M = 15.46$, $SD = 9.29$; respectively). Conversely, there were no significant interaction effects of group and valence ($F(1, 36) = .09$, $p = .77$), instruction and valence ($F(1, 36) = 1.65$, $p = .20$), or between group, instruction, and valence ($F(1, 36) = .37$, $p = .55$; see Figure 2).

Intrusion scores. There were no significant differences in intrusion scores between patients and controls in either the immediate ($U = 104.50$, $p = .219$, *ns*; patients: $Mdn = 1.00$, controls: $Mdn = 1.00$) or the delayed ($U = 132.00$, $p = .782$, *ns*; patients: $Mdn = 2.00$, controls: $Mdn = 1.00$) conditional recall phases.

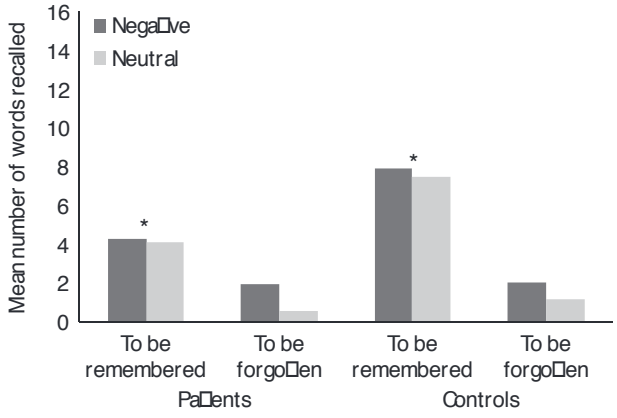

Figure 2. Mean number of items recalled by conversion disorder patients and controls in the delayed unconditional recall phase. $^{*}p < .05$.

Correlational analyses. Pearson's correlations were computed to examine the relationships between HADS scores and the total number of words recalled in each phase of the DFT. Results indicated that neither depression nor anxiety was significantly correlated with the total number of words recalled in either the immediate (depression: $r = -.21$, $n = 38$, $p = .20$; anxiety: $r = -.05$, $n = 38$, $p = .76$) or the delayed (depression: $r = -.02$, $p = .9$; anxiety: $r = .21$, $p = .2$) recall phase. The relationship between depression and valence was also examined in order to determine whether there was a mood congruent memory bias, which would result in those with higher depression scores recalling more negative words. However, depression scores were not significantly correlated with either the total number of negative words recalled, or the number of neutral words recalled, in either phase of the task (immediate recall, negative words: $r = -.27$, $p = .09$; neutral words: $r = -.12$, $p = .48$; delayed recall, negative words: $r = -.01$, $p = .9$; neutral words: $r = -.02$, $p = .8$).

Discussion

There were some significant differences across all tasks in the neuropsychological battery, suggesting that patients have deficits in auditory-verbal memory, as well as executive functioning including planning and task-switching (measured by the TMT), and cognitive flexibility and processing speed (measured by the Stroop test). Additionally, results from the AMI supported our hypothesis of patients having few or no deficits in autobiographical memory, and is in line with previous case research (Stonnington, Barry, & Fisher, 2006). However, correlations were found between IQ and all of the neuropsychological tests, except autobiographical incidents scores on the AMI. Both depression and anxiety were significantly correlated with all tests, except that anxiety was not correlated with retention scores on the logical memory test. As these variables differed between groups, it is possible that they may have confounded the results and the results of the ANOVA with covariates imply that a large proportion of the differences observed between patients and controls may be attributable to these variables.

In this study we developed and applied a version of the DFT in order to test memory suppression in patients with CD and also to explore the effect of emotional content on directed forgetting. Patients recalled significantly fewer words than controls in both the immediate and delayed recall conditions of the DFT. However, contrary to our prediction, patients did not differ significantly from controls on the number of 'forget' words recalled in either condition, suggesting that patients were not more (or less) able to suppress the words to be forgotten. Additionally, patient recall was no different for negatively versus neutrally valenced words. In fact, analysis of the delayed recall condition revealed that significantly more negative than neutral words were recalled overall but this applied to both patients and controls. Correlations revealed that neither anxiety nor depression scores were related to overall recall. Moreover, depression was correlated with neither the number of neutral nor the number of negative words recalled. Therefore, these variables are unlikely to have confounded the DFT results.

That conversion patients recalled fewer words overall than controls is in line with previous studies investigating memory retrieval in CD (e.g., Bendefeldt *et al.*, 1976). These findings are also consistent with those of the more widely studied somatoform disorders (Niemi, Portin, Aalto, Hakala, & Karlsson, 2002). Such deficits may reflect impairment of executive functioning, including set shifting and attention, as these have been implicated in the intentional retrieval of memories (Miyake *et al.*, 2000). However,

these previous studies did not control for IQ, anxiety and depression – likely confounders of neuropsychological test performance.

The lack of group differences in recall of 'forget' words suggests that conversion patients are no more likely than healthy controls to suppress memories of the presented stimuli and so does not provide support for psychodynamic theories of CD. However, caution should be exerted when extrapolating from memory for words presented under laboratory conditions to the complex self-relevant memories that Freud uncovered when studying cases of hysteria over 100 years ago. Further, the lack of difference could reflect a floor effect as the mean number of 'forget' words that controls recalled during the delayed recall phase was just 3.32; patients recalled a (non-significantly) lower mean of 2.60. A more sensitive measure might have revealed a group difference.

Our results showed that valence significantly influenced delayed recall only, suggesting that the negative valence of our stimuli exerted their effects at the retrieval or retention stage. This may be due to the salience of the words, in that they stand out as marked, relative to the unmarked neutral words or perhaps due to the consolidation process. This latter process takes time (LaBar & Cabeza, 2006) and it has been argued that emotional events are more likely than neutral ones to be consolidated (Kensinger *et al.*, 2004). This notion has been supported, with research finding that emotional memories are better remembered over delays of 1 hr to 1 day than immediately after presentation (Sharot & Phelps, 2004). The present study suggests that this effect can occur as little as 10 min after presentation. However, we were unable to demonstrate an effect of emotional valence on directed forgetting – in either direction. That is we could not show that directed forgetting could be attenuated or indeed enhanced by emotional content. It is possible that more arousing materials would have interacted significantly with the directed forgetting instruction or that to demonstrate such effects we would need many more stimuli. Given this limited statistical power we were not able to confirm or refute a subtle modulating effect of conversion on such an interaction.

The results from the neuropsychological battery are in line with previous studies investigating motor control in motor CD with functional imaging (Browning, Fletcher, & Sharpe, 2011). Our findings implicate deficits in the retrieval of specific information from auditory-verbal memory, in addition to attention, inhibitory control, set shifting and processing speed. Poor executive functioning has been linked to enhanced reactivity to stress, in addition to prolonged activation in response to stress (Williams, 2011). Patients with CD may be more vulnerable to stress as a result of poorer executive functioning, acknowledging that the reasons for this poorer functioning include generally reduced intellectual capacity and the effects of anxiety and low mood. Regardless of the causes of poorer executive functioning, it can be considered a vulnerability factor which may, in part, explain why a subset of those who experience stressful life events go on to develop the disorder.

This study had a number of limitations, primarily the small sample size of conversion patients, particularly in relation to the DFT. Also, whilst attempts were made to recruit controls who were comparable to the patients on socio-demographic variables, this was not entirely realised. IQ significantly differed between patients and controls, and correlation analyses and ANOVAs implied this accounted for a significant proportion of the observed differences in test scores between the groups. Also, the use of psychotropic medications by CD patients may have compromised performance on these tests, although equally, it may have tended to normalise performance adversely affected by low mood and anxiety.

Future investigations should look to recruit a larger sample of conversion patients, matching them with controls on gender, age, IQ and socio-economic status, in an attempt

to minimise potential confounders. A more comprehensive measure of IQ, such as the Wechsler's Adult Intelligence scale (Wechsler, 1997a) and other cognitive functions could be employed in future investigations. The inclusion of other control groups, such as patients with a neurological or other psychiatric disorder (e.g., other somatoform or anxiety or depressive disorder), would aid in determining the specificity of the findings with respect to CD. However, it has been argued that depression and anxiety are intrinsic to CD (LaFrance & Barry, 2005), hence attempting to control for these may result in removing the effects of a fundamental part of the disorder itself.

Furthermore it is possible that results from the DFT do not support the Freudian theory of repression because the negatively valenced words are not specifically salient for each individual, or related to their proposed causal life event(s). Alternatively, it may be that partial repression occurs in CD, whereby the associated affect is repressed, rather than the memory itself (Kanaan *et al.*, 2007). Future investigations could therefore examine this, using physiological paradigms which investigate suppression of emotion, rather than memory of events, thereby enabling researchers to examine whether patients are differentially able to suppress their emotions, and whether this has longer-term implications, such as a greater ability to keep their emotions suppressed, or a reduced ability to retrieve memories of the context in which the emotions were initially suppressed. There is also recent evidence for two ways in which forgetting can occur voluntarily, via 'direct suppression' or 'thought substitution' which are thought to have different underlying mechanisms (Benoit & Anderson, 2012) that may vary according to valence (Butler & James, 2010) and would have direct relevance to future studies of memory, and or affect, repression in CD.

Conclusions

This exploratory study was the first to empirically examine memory suppression in CD and has added to the existing literature on neuropsychological function in this group. It found some evidence that CD patients performed worse, relative to controls, on tests of executive function, although this might be explained by IQ, depression and anxiety differences between the groups. Executive deficits may render patients more vulnerable to CD, in the face of significant life stress. No differences were found on autobiographical memory. However, whilst it was found that patients recalled fewer words on each phase of the DFT, they did not suppress more of the words to be forgotten than controls. Acknowledging the methodological limitations of this exploratory study, we may nevertheless conclude that the results do not support the classical psychodynamic theory of CD.

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References

Anderson, M. C., Ochsner, K. N., Kuhl, B., Cooper, J., Robertson, E., & Gabrieli, S. W. (2004). Neural systems underlying the suppression of unwanted memories. *Science*, *303*, 232–235. doi:10.1126/science1089504

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders: DSM-IV* (4th ed.). Washington, DC: Author.

Bendefeldt, F., Miller, L. L., & Ludwig, A. M. (1976). Cognitive performance in conversion hysteria. *Psychiatry, Archives General*, *33*, 1250–1254. doi:10.1001/archpsyc.1976.01770100112011

Benoit, R. G., & Anderson, M. C. (2012). Opposing mechanisms support the voluntary forgetting of unwanted memories. *Neuron*, *76*, 450–460. doi:10.1016/j.neuron.2012.07.025

Bradley, M. M., & Lang, P. J. (1999). *Affective norms for English words (ANEW): Instruction manual and affective ratings*. Technical Report C-1, Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.

Breuer, J., & Freud, S. (1895). Studies in Hysteria. In S. Freud, J. Strachey, A. Freud, C. L. Rothgeb & A. Richards (Eds.), *The standard edition of the complete psychological works of Sigmund Freud* (Vol. II). London: Hogarth Press.

Browning, M., Fletcher, P., & Sharpe, M. (2011). Can neuroimaging help us to understand and classify somatoform disorders? A systematic and critical review. *Psychosomatic Medicine*, *73*, 173–184. doi:10.1097/PSY.0b013e31820824f6

Butler, A. J., & James, K. H. (2010). The neural correlates of attempting to suppress negative versus neutral memories. *Cognitive, Affective and Behavioral Neuroscience*, *10*, 182–194. doi:10.3758/CABN.10.2.182

Cahill, L., Prins, B., Weber, M., & McGaugh, J. L. (1994). Beta-adrenergic activation and memory for emotional events. *Nature*, *371*, 702–704.

Cottencin, O., Gruat, G., Thomas, P., Devos, P., Goudemand, M., & Consoli, S. M. (2008). Directed forgetting in depression. *Journal of the International Neuropsychological Society*, *14*, 895–899. doi:10.1017/S135561770808118

Fargo, J. D., Schefft, B. K., Szaflarski, J. P., Dulay, M. F., Testa, S. M., & Privitera, M. D. (2004). Accuracy of self-reported neuropsychological functioning in individuals with epileptic or psychogenic nonepileptic seizures. *Epilepsy and Behaviour*, *5*, 143–150. doi:10.1016/j.yebeh.2003.11.023

Flor-Henry, P., Fromm-Auch, D., Tapper, M., & Schopflocher, D. (1981). A neuropsychological study of the stable syndrome of hysteria. *Biological Psychiatry*, *16*, 601–626.

Joormann, J., Hertel, P. T., LeMoult, J., & Gotlib, I. H. (2009). Training forgetting of negative material in depression. *Journal of Abnormal Psychology*, *118*, 34–43. doi:2009-01738-017

Kanaan, R. A., Craig, T. K., Wessely, S. C., & David, A. S. (2007). Imaging repressed memories in motor conversion disorder. *Psychosomatic Medicine*, *69*, 202–205. doi:10.1097/PSY.0b013e31802e4297

Kensinger, E. A., Anderson, A., Growdon, J. H., & Corkin, S. (2004). Effects of Alzheimer disease on memory for verbal emotional information. *Neuropsychologia*, *42*, 791–800. doi:10.1016/j.neuropsychologia.2003.11.011

Kent, G. P., Schefft, B. K., Howe, S. R., Szaflarski, J. P., Yeh, H. S., & Privitera, M. D. (2006). The effects of duration of intractable epilepsy on memory function. *Epilepsy and Behaviour*, *9*, 469–477. doi:10.1016/j.yebeh.2006.07.005

Kopelman, M. D., Wilson, B. A., & Baddeley, A. D. (1989). The autobiographical memory interview: A new assessment of autobiographical and personal semantic memory in amnesic patients. *Journal of Clinical and Experimental Neuropsychology*, *11*, 724–744. doi:10.1080/01688638908400928

LaBar, K. S., & Cabeza, R. (2006). Cognitive neuroscience of emotional memory. *Nature Reviews Neuroscience*, *7*, 54–64. doi:10.1038/nrn1825

LaFrance, W. C., Jr., & Barry, J. J. (2005). Update on treatments of psychological nonepileptic seizures. *Epilepsy and Behaviour*, *7*, 364–374. doi:10.1016/j.yebeh.2005.07.010

Medford, N., Phillips, M. L., Brierley, B., Brammer, M., Bullmore, E. T., & David, A. S. (2005). Emotional memory: Separating content and context. *Psychiatry Research*, *138*, 247–258. doi:10.1016/j.pscychresns.2004.10.004

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "Frontal Lobe"

tasks: A latent variable analysis. *Cognitive Psychology*, *41*, 49–100. doi:10.1006/cogp. 1999. 0734

Nelson, H. E., & Willison, J. (1991). *National Adult Reading Test manual* (2nd edn.). NFER-Nelson: Windsor.

Nicholson, T. R., Stone, J., & Kanaan, R. A. (2011). Conversion disorder: A problematic diagnosis. *Journal of Neurology Neurosurgery and Psychiatry*, *82*, 1267–1273. doi:10.1136/jnnp. 2008. 171306

Niemi, P. M., Portin, R., Aalto, S., Hakala, M., & Karlsson, H. (2002). Cognitive functioning in severe somatization – a pilot study. *Acta Psychiatrica Scandinavica*, *106*, 461–463. doi:10.1034/j. 1600-0447.2002.01445.x

Raskin, M., Talbott, J. A., & Meyerson, A. T. (1966). Diagnosis of conversion reactions. Predictive value of psychiatric criteria. *Journal of the American Medical Association*, *197*, 530–534. doi:10.1001/jama.1966.03110070054015

Reitan, R. M. (1958). Validity of the trail making test as an indicator of organic brain damage. *Perceptual and Motor Skills*, *8*, 271–276.

Reuber, M., Fernandez, G., Helmstaedter, C., Qurishi, A., & Elger, C. E. (2002). Evidence of brain abnormality in patients with psychogenic nonepileptic seizures. *Epilepsy and Behaviour 3*, 249–254. doi:10.1016/S1525-5050(02)00004-5

Sharot, T., & Phelps, E. A. (2004). How arousal modulates memory: Disentangling the effects of attention and retention. *Cognitive, Affective and Behavioral Neuroscience*, *4*, 294–306. doi:10.3758/CABN.4.3.294

Spence, S. A. (2006). Hysteria: A new look. *Psychiatry*, *5*, 56–60. doi:10.1383/psyt.2006.5.2.56

Stone, J., LaFrance, W. C., Jr., Levenson, J. L., & Sharpe, M. (2010). Issues for DSM-5: Conversion disorder. *American Journal of Psychiatry*, *167*, 626–627. doi:10.1176/appi.ajp. 2010. 09101440

Stonnington, C. M., Barry, J. J., & Fisher, R. S. (2006). Conversion disorder. *American Journal of Psychiatry*, *163*, 1510–1517.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*, 643–662.

Wechsler, D. (1997a). *Wechsler Adult Intelligence Scale – Third Edition*. San Antonio, TX: Psychology Corporation.

Wechsler, D. (1997b). *Wechsler Memory Scale – Third edition (WMS-III). Administration and scoring manual*. San Antonio, TX: Psychological Corporation.

World Health Organisation (1992). *The ICD-10 Classification of Mental and Behavioural Disorders*. Geneva: Author.

Williams, P. G. (2011). Stress regulation, executive functioning and physical and mental health. In Y. Suchy (Ed.), *Clinical neuropsychology of emotion* (pp. 235–246). New York: Guilford Press.

Zacks, R. T., Radvansky, G., & Hasher, L. (1996). Studies of directed forgetting in older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*, 143–156. doi:10.1037/0278-7393.22.1.143

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica*, *67*, 361–370. doi:10.1111/j.1600-0447.1983.tb09716.x

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