Psychological Medicine, 1997, **27**, 81–90.

Cognitive performance and complaints of cognitive impairment in chronic fatigue syndrome (CFS)

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SYNOPSIS Patients with chronic fatigue syndrome (CFS) complain that they have difficulties with concentration and memory but studies to date have not found consistent objective evidence of performance deficits. Two groups of CFS patients, depressed and non-depressed, and healthy controls, were asked about concentration problems in general and specifically when reading. CFS subjects were more likely than controls to report that they had concentration problems when reading, that they needed to re-read text and that they failed to take in what they were reading. Subjects then performed a task in which their reading behaviour and text recall was measured. While all CFS subjects complained of general cognitive failures and of difficulties with reading, only depressed CFS subjects recalled significantly less of the text than controls. Severity of complaints about reading problems was not related to amount of text recalled, but was related to severity of depressed mood. However, subjects were able to evaluate accurately their ability to remember the text immediately after reading it and before being tested for recall. Additionally, subjects performed a paired-associate learning task on which no significant differences between the subject groups was found. It is concluded that deficits in cognitive functioning in CFS patients are more likely to be found on naturalistic than on laboratory tasks.

INTRODUCTION

Patients with chronic fatigue syndrome (CFS) complain that fatigue affects their physical and mental functioning and typically they report problems with concentration and of absent-mindedness, including difficulties taking in written or spoken material and executing familiar sequences of events (like doing the shopping). Additionally, many patients complain that performing mental work is aversive for them, to the extent that they either stop doing it or start to experience symptoms (Wood *et al*. 1994).

A number of recent studies have looked at cognitive functioning in CFS. While methodological differences between papers make comparisons difficult, some conclusions can be drawn. First, when CFS patients are administered standard neuropsychological tests designed to screen for clinically significant deficits or abnormalities in cognitive functioning, they generally perform within the normal range on most tests (Millon *et al*. 1989; Altay *et al*. 1990; Grafman *et al*. 1993; Riccio *et al*. 1992; Sandman *et al*. 1993; Schmaling *et al*. 1994; Cope *et al*. 1995), although overall performance may be slightly impaired (Krupp *et al*. 1994; DeLuca *et al*. 1995). Secondly, several authors have noted the disparity between the degree of CFS patients' complaints about cognitive difficulties and the degree of decrement in their performance (if any) on tests of cognitive functioning (Altay *et al*. 1990; Grafman *et al*. 1993; Ray *et al*. 1993; Wood *et al*. 1994).

Various explanations for the disparity between cognitive complaints and cognitive performance have been advanced. For example, it could be the case that patients' complaints accurately reflect their every-day cognitive lapses, but that laboratory tests measure everyday cognitive functioning only poorly; on the other hand, patients may be over-estimating or mis-evaluating the extent of their cognitive failures because of depressed or anxious mood. Another possibility is that when a patient undergoes cognitive testing in a clinic or a laboratory, his or her level of arousal and motivation is quite

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different from that in everyday life. Finally, Ray *et al*. (1993) suggested that CFS patients may be able to perform normally but at the cost of extra effort that is experienced aversively as feelings of fatigue.

The present study was designed primarily to address the issue of the disparity between cognitive complaints and cognitive performance by asking CFS patients in detail about one particular area of cognitive functioning (reading), and then looking at their reading performance. CFS patients frequently complain that when reading they find themselves going over and over the text without taking it in, and that this causes difficulties for them both at work and at home. For this study, a technique was devised to measure the extent to which subjects do actually read and re-read text and to see whether there is any evidence that re-reading text is associated with poor recall. Subjects received a computerized display of text which they could step through (advance the text, repeat a piece of text or go back through the text) using the keyboard, and their keystrokes could be recorded. While the process of reading was obviously distorted to some extent by the testing situation, the reading task was somewhat more naturalistic than other laboratory memory tests, and more relevant to the complaints of CFS patients. In addition to asking CFS patients in advance about their specific concentration problems when reading, this study included a more general measure of complaints about cognitive failures, the Cognitive Failures Questionnaire (CFQ) (Broadbent *et al*. 1982), and also a measure which asked patients to evaluate retrospectively how well they had been able to concentrate on reading the text and how well they thought they would be able to remember it.

There is considerable symptomatic overlap between CFS and depression, and a significant proportion of CFS patients fulfil diagnostic criteria for depression (David, 1991). Depressed patients complain of 'mental fatigue' and there seems to be a degree of similarity between the cognitive complaints of the two groups (Wessely & Powell, 1989; Bentall *et al*. 1993). Previous studies of the cognitive functioning of CFS patients have produced scant evidence that actual cognitive performance is related to depressed mood (Grafman *et al*. 1993; DeLuca *et al*. 1993, 1995; Smith *et al*. 1993; Cope *et al*. 1995), although some tasks appear to be more susceptible to depression than others (McDonald *et al*. 1993; Krupp *et al*. 1994). On the other hand, when standard scales are used to measure the degree of cognitive complaint of CFS patients, the number and severity of complaints is correlated with measures of depressed mood, and sometimes with anxiety (Grafman *et al*. 1993; McDonald *et al*. 1993; Cope *et al*. 1995). A second aim of the present study was, therefore, to look at the contribution of depressed mood to both the level of cognitive complaints and to performance by testing two groups of CFS subjects, a depressed group and a non-depressed group, with a healthy control group for comparison purposes.

As a focus of the study was to determine whether a naturalistic task would be more sensitive to the cognitive problems of CFS patients than laboratory memory tasks have proved to be, a comparison with a standard laboratory memory task was indicated. Subjects therefore performed a paired associate learning test, a task which is considered to be a fairly 'pure' measure of memory (Larrabee *et al*. 1983), but one which nevertheless has occasionally been performed less well by CFS patients than controls (Riccio *et al*. 1992; Grafman *et al*. 1993; Sandman *et al*. 1993). Finally, a body of recent research suggests that performance on 'cognitively effortful' tasks that require much attentional capacity is likely to be impaired in depression (Hartlage *et al*. 1993). If the cognitive problems of CFS patients were due to depression, one might therefore expect to find more of a performance decrement with respect to controls on a cognitively effortful free recall test than on a less effortful cued recall test (Weingartner, 1986). Accordingly, in this study, free and cued recall of both text and paired associates were measured.

METHOD

Subjects

CFS subjects were hospital out-patients who fulfilled the criteria for CFS agreed by Sharpe *et al*. (1991). They had all recently joined a treatment trial for CFS and had received a baseline assessment for the trial. All patients joining the trial during the 8-month recruitment period for this study were asked to participate

and none refused, although one patient was unable to complete the test because she was dyslexic. Patients were tested within 1 week of their baseline assessment for the treatment trial. A total of 50 CFS patients completed the tests.

CFS patients were allocated to two groups, depressed and non-depressed. The baseline measurements for the treatment trial included an assessment of psychiatric status, which was carried out by the first author. After completion of a battery of questionnaires, which included the Hospital Anxiety and Depression Scale (HAD; Zigmond & Snaith, 1983), patients were interviewed in accordance with a structured research interview, the revised Clinical Interview Schedule (CIS-r; Lewis *et al.* 1992). Patients whose responses to the CIS-r indicated the presence of depressed mood or anhedonia, or both, were then asked supplementary questions to determine whether they fulfilled DSM-III-R criteria for a major depressive episode, or depressive disorder not otherwise specified. Patients were assigned to groups immediately after baseline assessment and before they undertook the tests described here.

In order to achieve a control group matched to patients for age and educational status, control subjects were recruited from people attending the hospital with patients – mainly spouses or partners. People were first asked if they were suffering from tiredness, depression or a disabling illness, and if not, if they would like to participate in the study. Completion of the measures described below revealed that some of the control subjects did in fact have borderline levels of depressed mood or anxiety symptoms, and two people were suffering from arthritis.

All subjects could read and write English. Subjects were given an explanation sheet that briefly described the procedures to be used and the group design of the study. All subjects gave written consent to participate in the study.

Preliminary measures

All subjects completed the following forms: (i) the Hospital Anxiety and Depression Scale (HAD; Zigmond & Snaith, 1983); (ii) the 14-item Fatigue scale (Chalder *et al.* 1993), scored traditionally to produce a physical fatigue score from 0–8, a mental fatigue score from 0–6, and a combined total fatigue score from 0–14; (iii) the Cognitive Failures Questionnaire (CFQ; Broadbent *et al.* 1982); and (iv) a short demographic information questionnaire.

Study measures

All subjects completed the following measures as part of the experimental testing session. (i) The National Adult Reading Test-revised (NART; Nelson, 1982; Nelson & Willison, 1991). Scores on the NART have been shown to be a good predictor of scores on the Wechsler Adult Intelligence Scale-revised (WAIS-R; Wechsler, 1981; Nelson & Willison, 1991). (ii) The Concentration questionnaire, this short questionnaire was devised especially for this study, to obtain a description of the problems experienced by CFS patients and others when reading. The questionnaire contained one open ended question, which appeared first and asked patients to describe their concentration problems in their own words. There then followed a set of questions answered on a five-point scale. Subjects were asked about the frequency of mind-wandering, distraction, not being able to take in material, forgetting material, needing to re-read and 'going blank' (the distinction between 'mind-wandering' and 'going blank' having been drawn by Watts & Sharrock (1985) and Watts *et al.* (1988)), and they were also asked to rate the extent to which their concentration problems affected their ability to read. (iii) Visual analogue scales were used to enable subjects to assess and predict their performance on the reading test. Subjects were asked to indicate on four lines how well they felt they had been able to concentrate on the text they had just read, how well they thought they understood it, how well they remembered it, and how tiring they found it to perform the task. The lines ranged from complete dysfunction to no difficulty (for example, the concentration line ranged from 'completely unable to concentrate' to 'could concentrate perfectly').

Experimental procedures

The paired associates test and the reading test were controlled by an IBM compatible computer programmed in Turbo Pascal.

1 Experimental paired associate test

Twelve pairs of one-syllable, four letter nouns were presented on a computer screen. There were six 'easy' pairs consisting of words that

https://doi.org/10.1017/S0033291796004035 Published online by Cambridge University Press

were commonly associated (e.g. frog–toad, rain–snow), and six 'hard' pairs of unassociated words, (e.g. lamb–nail, ring–step). Each pair appeared twice, in a quasi-random order, so that pairs never appeared twice in succession. Subjects were instructed simply to read each pair of words out loud as it appeared on the screen, and to try to remember it. Subjects were then given three answer sheets to fill in one after the other. The first sheet asked them to write down all the words they could remember, in any order (free recall – item), the second to write down all the word-pairs they could remember (free recall – pairs), and the third sheet gave them the first word of every pair and asked them to provide the second (cued recall).

2 Reading test

The text used was *Circle Island*, a short story that has been used in similar studies with depressed patients (Watts & Sharrock, 1985; Watts & Cooper, 1989), and which has been broken down into 37 propositional units (Bowers, 1986). For the computerized presentation of the story, it was broken up into 13 short pieces of approximately equal length. After receiving a standard introduction including instructions about the use of the keyboard, subjects pressed the spacebar to start the procedure. The first piece appeared on the computer screen for 7·5 s. When the piece disappeared, the subject had the choice of either re-reading the same piece of the story, by pressing the 's' key and causing that piece to reappear for 7·5 s, or moving on to the next piece of the story, by pressing the 'n' key. After piece 2 had been presented, and for all subsequent pieces, there was the additional option of going back to the previous piece, by pressing the 'p' key. Subjects were thus able to step through the story, reading it for as long as they liked by using the s, n and p keys. Keystrokes were recorded, thus providing a record of how subjects stepped through the story and the total amount of time spent on it. After reading the story, subjects completed the visual analogue scales. They were then asked to say everything they could remember about the story, their replies were recorded and later transcribed verbatim. One prompt 'Do you remember anything else?' was given. Finally, subjects were asked 15 simple questions about the story and their replies recorded.

RESULTS

Description of subjects

In order to achieve equal sized CFS-depressed and CFS non-depressed groups roughly matched for age and years of post-16 education, two CFS subjects were discarded solely on the basis of age, post-16 education and HAD scale scores. This left 48 CFS patients; 24 in the depressed group and 24 in the non-depressed group. Eighteen control subjects were also tested. Between group differences have been analysed using analysis of variance with Student–Newman–Keuls' *post-hoc* comparisons; where distributions of scores did not allow this, nonparametric statistics (Kruskal–Wallis ANOVA and Mann–Whitney *U* tests) have been used. Differences on categorical variables were examined using Pearson's chi-square. In subsequent text and tables, the three subject groups will be referred to as CFS-D (CFS-depressed), CFS-ND (CFS non-depressed) and CON (controls).

The characteristics of the members of the three groups are given in Table 1. The three groups were well matched for age, post-16 education and NART error score. They were well separated on the variables intended to distinguish between the groups, except that on the HAD anxiety scale, the CFS-ND and the CON groups did not differ ($U = 193{\cdot}5$, $P = 0{\cdot}565$), and on the physical fatigue scale, the two CFS groups did not differ ($U = 240{\cdot}5$, $P = 0{\cdot}131$).

Concentration questionnaire

Three questionnaires had some replies missing. The replies of CFS and control subjects differed significantly for frequency of concentration problems when reading ($\chi^2 = 24{\cdot}35$, df = 2, $P < 0{\cdot}01$,) and for extent to which concentration problems affected their ability to read ($\chi^2 = 36{\cdot}5$, df = 2, $P < 0{\cdot}01$), and in both cases, *post-hoc* analyses revealed that the two CFS groups differed significantly from the controls but not from each other at the $P < 0{\cdot}05$ level. Scores on the six questions relating to frequency of concentration problems were highly intercorrelated across all subjects at between $r = 0{\cdot}425$, $P < 0{\cdot}01$ and $r = 0{\cdot}756$, $P < 0{\cdot}01$, with the exception of the question on external distraction which correlated less highly with all the other

Table 1. *Description of groups*: *means* (*standard deviations*)

	CFS-D $N = 24$	CFS-ND $N = 24$	CON $N = 18$	Overall statistics	Group comparison
Sex	19 f 5 m	13 f 11 m	12 f 6 m	$\chi^2 = 3{\cdot}4$ $P = 0{\cdot}18$	—
Age	42·18 (10·9)	42·00 (10·2)	41·72 (13·1)	$F[2, 63] = 0{\cdot}06$ $P = 0{\cdot}99$	—
Years post-16 education	2·0 (2·2)	2·4 (2·1)	2·1 (2·2)	$F[2, 63] = 0{\cdot}26$ $P = 0{\cdot}77$	—
Months since illness onset	44·2 (37·7)	40·2 (26·9)	—	$U = 28{\cdot}5$ $P = 0{\cdot}89$	—
NART error score	19·1 (9·0)	16·2 (7·9)	18·5 (11·0)	$F[2, 63] = 0{\cdot}66$ $P = 0{\cdot}52$	—
HAD anxiety	11·8 (3·8)	6·0 (3·3)	6·3 (4·2)	$\chi^2 = 25{\cdot}4$ $P < 0{\cdot}01$	CFS-D *v.* CFS-ND and CON, $P < 0{\cdot}01$
HAD depression	11·7 (2·5)	5·9 (2·2)	2·2 (2·6)	$\chi^2 = 49{\cdot}5$ $P < 0{\cdot}01$	$P < 0{\cdot}01$
Physical fatigue	7·9 (0·4)	7·6 (0·8)	0·4 (1·2)	$\chi^2 = 50{\cdot}9$ $P < 0{\cdot}01$	CFS-D and CFS-ND *v.* CON, $P < 0{\cdot}01$
Mental fatigue	5·9 (0·4)	5·2 (1·0)	0·3 (0·8)	$\chi^2 = 49{\cdot}3$ $P < 0{\cdot}01$	All groups, $P < 0{\cdot}01$
CFQ	68·3 (16·7)	56·1 (14·4)	37·6 (14·3)	$F[2, 63] = 20{\cdot}82$ $P < 0{\cdot}01$	All groups, $P < 0{\cdot}01$

Table 2. *Mean* (*standard deviation*) *scores on four visual analogue scales of the three groups of subjects*. '*Self-evaluation*' *score is the sum of the scores on the concentration*, *remembering and understanding scales*

	CFS-D	CFS-ND	CON	Overall statistics	Group comparison
Concentration scale	6·6 (2·0)	5·5 (2·3)	4·2 (2·1)	$\chi^2 = 11{\cdot}3$ $P < 0{\cdot}01$	CFS-D *v.* CON, $P < 0{\cdot}01$
Remembering scale	6·2 (2·2)	5·5 (2·1)	4·7 (1·9)	$\chi^2 = 5{\cdot}4$ $P = 0{\cdot}07$	CFS-D *v.* CON, $P = 0{\cdot}03$
Understanding scale	5·7 (2·3)	3·8 (2·8)	3·0 (2·2)	$\chi^2 = 12{\cdot}3$ $P < 0{\cdot}01$	CFS-D *v.* CFS-ND and CON, $P \leqslant 0{\cdot}01$
Tiring scale	6·3 (2·1)	5·6 (2·5)	2·3 (2·2)	$\chi^2 = 22{\cdot}2$ $P < 0{\cdot}01$	Both CFS *v.* CON, $P < 0{\cdot}01$
Self-evaluation	18·5 (5·9)	14·7 (6·3)	11·8 (5·2)	$\chi^2 = 11{\cdot}7$ $P < 0{\cdot}01$	CFS-D *v.* CFS-ND $P < 0{\cdot}05$, CFS-D *v.* CON, $P < 0{\cdot}01$

questions, at between $r = 0{\cdot}233$, $P = 0{\cdot}06$ and $r = 0{\cdot}570$, $P < 0{\cdot}01$. Factor analysis of the responses of CFS subjects alone yielded two factors. The questions relating to mind going blank, being unable to take in material, needing to re-read and forgetting material loaded highly (at between 0·838 and 0·683) on the first factor, while only the questions about mind-wandering and external distraction loaded highly (at 0·798 and 0·889) on the second factor. Accordingly, scores on these two sets of questions were summed to produce two scores, a score for 'blanking' and a 'mind-wandering' score. The mean (standard deviation) 'blanking' scores for

https://doi.org/10.1017/S0033291796004035 Published online by Cambridge University Press

Table 3. *Mean (standard deviation) number of units recalled on free recall and cued recall of text. Mean (standard deviation) number of items and pairs recalled on paired associate learning test*

Subject groups	Text recall		Paired associates learning				
			Free recall		Cued recall		Ratio cued/free recall
	Units free recall	Units cued recall	Items	Pairs	Easy pairs	Hard pairs	
CFS-D	7·08 (4·94)	17·67 (7·10)	9·9 (4·1)	3·5 (2·3)	4·0 (1·5)	1·7 (1·6)	1·78 (0·53)
CFS-ND	11·39 (5·65)	23·00 (5·92)	10·2 (2·9)	4·4 (2·2)	4·0 (1·6)	2·1 (1·7)	1·39 (0·43)
CON	11·47 (6·15)	22·33 (5·52)	11·1 (3·0)	4·5 (1·5)	4·4 (1·3)	2·1 (1·3)	1·54 (0·47)
Overall statistics	$F[2, 63] = 4·68$ $P = 0·01$	$F[2, 63] = 4·99$ $P = 0·01$	$F[2, 63] = 0·70$ $P = 0·51$	$F[2, 63] = 1·47$ $P = 0·24$	$F[2, 63] = 0·47$ $P = 0·63$	$F[2, 63] = 0·46$ $P = 0·63$	$F[2, 60] = 3·84$ $P = 0·03$
Group comparisons	CFS-D *v.* CFS-ND and CON, $P < 0·05$	CFS-D *v.* CFS-ND and CON, $P < 0·05$	—	—	—	—	CFS-D *v.* CFS-ND, $P < 0·05$

the three groups of subjects were: CFS-D 11·62 (3·70), CFS-ND 11·04 (2·33), CON 5·19 (2·01) ($F[2, 61] = 27·84$, $P < 0·01$), and the mean 'mind-wandering' scores were: CFS-D 5·70 (1·76), CFS-ND 5·88 (2·09), CON 3·28 (1·60) ($F[2, 63] = 12·16$, $P < 0·01$). *Post hoc* analysis showed that in both cases the two CFS groups did not differ significantly from each other, but that they both differed from the controls at the $P < 0·05$ level.

Reading test

Stepping through the text

Records of subjects' keystrokes showed the option of going back to an earlier part of the text using the 'previous' choice was used infrequently by all subjects. The mean number of 'same' choices (i.e. choosing to re-read a piece of text that they had just read) for subjects in both CFS groups was 9·3, while the control subjects pressed the 'same' key 7·1 times on average ($\chi^2 = 1·16$, df = 2, $P = 0·56$,) The mean total number of pieces read (hereafter called 're-reading') was: CFS-D, 25·8; CFS-ND, 25·3 and CON, 22·8. ($\chi^2 = 1·59$, df = 2, $P = 0·45$).

Visual analogue scales

Scores were obtained by measuring the point at which subjects marked the line and converting this to a score out of 10, with higher scores representing greater difficulty. Across all subjects, scores on all pairs of these four visual analogue scales were highly inter-correlated, at between $r = 0·629$, $P < 0·01$ and $r = 0·743$, $P < 0·01$. Scores on the questions relating to concentration, remembering and understanding were summed to produce a total score, hereafter called the 'self-evaluation' score. Table 2 shows that both groups of CFS subjects produced more negative evaluations of their performance than did controls, but only the evaluations of the depressed CFS subjects differed significantly from those of the controls.

Free recall

Subject's free recall of the *Circle Island* story was scored by comparing the transcripts of their replies with the original text of *Circle Island*, and deciding whether each propositional unit was correctly recalled or not. Each unit was then scored 1 or 0. A partial recall of a propositional unit was scored if it contained the main idea of the unit; any units which were recalled incorrectly did not score. The transcripts were first scored by the first author and later by a second rater who was uninvolved with this project and blind to the group membership of the subjects. These two sets of ratings differed slightly from each other (rater one gave consistently higher scores than rater two), but were very highly correlated. Correlation coefficients were calculated for absolute values and ranked data (Pearson's $r = 0·916$, $P < 0·01$; Spearman's $r = 0·958$, $P < 0·01$). Because of the high degree of correlation of the two sets of ratings, the mean ratings, given in Table 3, were used in the analysis.

Table 3 shows that there was a large difference between the two CFS groups in mean number of propositional units recalled, with the depressed patients recalling significantly fewer units than the non-depressed. The performance of the CFS-ND patients did not differ significantly from that of the control subjects.

https://doi.org/10.1017/S0033291796004035 Published online by Cambridge University Press

Table 4. *Relations between questionnaire measures and performance measures for CFS patients, Pearson product moment correlation coefficients (two-tailed)*

	HAD anxiety	CFQ	Blanking	Mind-wandering	Self-evaluation	Free recall text	Cued recall text	Re-reading
HAD depression	**0·559** ***P* < 0·01**	**0·364** ***P* = 0·01**	0·141 *P* = 0·34	−0·006 *P* = 0·97	**0·353** ***P* = 0·01**	**−0·548** ***P* < 0·01**	**−0·520** ***P* < 0·01**	0·009 *P* = 0·95
HAD anxiety	—	0·279 *P* = 0·06	0·140 *P* = 0·35	0·145 *P* = 0·33	0·231 *P* = 0·11	**−0·312** ***P* = 0·03**	−0·259 *P* = 0·08	0·108 *P* = 0·47
CFQ		—	**0·550** ***P* < 0·01**	0·091 *P* = 0·54	**0·490** ***P* < 0·01**	−0·065 *P* = 0·66	−0·066 *P* = 0·67	0·137 *P* = 0·35
Blanking			—	0·193 *P* = 0·19	**0·416** ***P* < 0·01**	−0·094 *P* = 0·53	0·018 *P* = 0·90	0·271 *P* = 0·06
Mind-wander'g				—	0·128 *P* = 0·39	0·007 *P* = 0·96	0·054 *P* = 0·72	−0·027 *P* = 0·86
Self-evaluation					—	**−0·620** ***P* < 0·01**	**−0·537** ***P* < 0·01**	**0·482** ***P* < 0·01**
Free recall text						—	**0·855** ***P* < 0·01**	**−0·406** ***P* < 0·01**
Cued recall text							—	**−0·347** ***P* < 0·02**

Bold type indicates correlation reached significance at $P < 0{\cdot}05$.

Cued recall

Answers to the question about the text were recorded and scored by the first author. Each answer was classified as 'wrong', 'partially correct' or 'correct' and assigned a score of 0, 1 or 2. The mean scores for each group are given in Table 3. The data for cued recall follow a similar pattern to the free recall data, with the CFS-D patients recalling significantly fewer items than either the CFS-ND or the CON subjects.

Paired associate tests

There was no significant difference between the groups on any of the paired associate outcomes, except that the ratio of the total number of pairs recalled in the cued test to the total number of pairs recalled in the free recall, was significantly higher in the CFS-D group than in CFS-ND group (Table 3).

Relations between questionnaire measures and performance measures on the reading test

Table 4 shows correlation coefficients for the various subject and performance measures for CFS subjects. Those correlations reaching significance at the level of $P < 0{\cdot}05$ are emboldened. Across all subjects, scores on the HAD depression scale were correlated with performance on the reading test (e.g. the correlation between HAD depression score and free recall of text was $r = -0{\cdot}4494$, $P < 0{\cdot}001$), and for CFS subjects only, this relationship was stronger (Table 4). The relationship between the HAD anxiety scale score and text recall was weaker than that for depression, not reaching statistical significance across all subjects. When the correlations were repeated separately for the two CFS subject groups, the relationship between depression and poorer free recall of text was stronger in the CFS-ND group, ($r = -0{\cdot}556$, $P < 0{\cdot}01$) than in the CFS-D group ($r = -0{\cdot}313$, $P = 0{\cdot}14$), possibly because the performance of some patients who were not depressed enough to receive a diagnosis of depression was, nevertheless, impaired by depressed mood. Additionally, in the CFS-D group, a correlation between anxiety and re-reading the text emerged ($r = 0{\cdot}517$, $P = 0{\cdot}01$).

For CFS subjects taken as a whole, there were no relations between CFQ scores or 'blanking' and 'mind-wandering' scores and recall of text or the total amount of time spent reading the text. If the two CFS groups are analysed separately, there is a moderate correlation between 'blanking' and re-reading text in the CFS-ND group ($r = 0{\cdot}415$, $P = 0{\cdot}04$). On the other hand, across all CFS subjects, there is a strong correlation between retrospective self-evaluation and text recall (for free recall, $r = -0{\cdot}620$, $P < 0{\cdot}01$), which persists when the two CFS groups are analysed separately (CFS-D, self-evaluation and free recall $r = -0{\cdot}627$, P

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$< 0{\cdot}01$; CFS-ND, self-evaluation and free recall, $r = -0{\cdot}530$, $P < 0{\cdot}01$). Across all CFS subjects, and in the CFS-ND group separately, there was a moderate negative relationship between 're-reading' and text recall (that is, re-reading of the text was associated with poorer recall), but this relationship was not present in the CFS-D group, possibly because depressed subjects gave up and did not bother going back over the text.

Table 1 shows that there was some degree of depressed mood and anxiety in the control group. When the data from the control group were analysed separately for comparison purposes, scores for HAD-depression and anxiety, CFQ, blanking and mind-wandering were all positively inter-correlated at between $r = 0{\cdot}478$ ($P = 0{\cdot}05$) and $r = 0{\cdot}800$ ($P < 0{\cdot}01$), but there were no significant correlations between any of these indicators and text recall. In contrast to the CFS patients, there was also no relation between retrospective self-evaluation of performance and text recall.

In summary, CFS subjects' performance at text recall was related to depressed mood. It was not related to what they said prospectively about their general cognitive performance or about their reading problems, but was related to how they evaluated their concentration and memory after having read the text. Finally, for CFS subjects, there was no significant correlation between any of the paired associate measures and scores on the HAD depression scale, CFQ scores or any of the concentration questionnaire measures.

DISCUSSION

The first major finding of this study was that when CFS patients were tested on the free and cued recall of text, it was only those subjects with concurrent depression who recalled significantly less than healthy control subjects, with non-depressed CFS performing at a similar level to controls. Differences between groups on an experimental paired associates learning test were smaller and did not reach statistical significance. Secondly, the relative difference between free and cued recall performance was broadly similar across groups and on both tasks. Thirdly, while CFS-D patients recalled text less well than CFS-ND patients, both groups of patients said that they had concentration problems when reading and there was no relation between scores on the concentration questionnaire and recall performance. In contrast, there was a moderately strong correlation between how subjects evaluated their performance after they had read the text and their ability to recall it.

Most previous studies of the cognitive performance of CFS patients which have taken concurrent measures of depressed mood have found no relation between test performance and depression (DeLuca *et al.* 1993; Grafman *et al.* 1993; Smith *et al.* 1993; Schmaling *et al.* 1994) although on the basis of a comparison of the neuropsychological profiles of CFS and depressed subjects, DeLuca *et al.* 1995 concluded that CFS patients shared with depressed patients a 'mild deficit in effortful cognition'. Krupp *et al.* (1994) found that differences in performance between CFS patients and healthy controls were related to depression on the WMS-r (Wechsler, 1987) Logical Memory test, which is a test of story recall, but not on other tests. These results from previous studies could be due to a lack of variance in test scores or depression scale scores, or to the fact that some of the tasks used in previous work have not been particularly sensitive to the effects of depression. In the present study, depressed mood had an effect only on the reading task (c.f. Watts & Sharrock, 1987). This may have been because the reading task was simply more difficult than the paired associate task, and thus more sensitive to changes in performance (Chapman & Chapman, 1973; Baron & Treiman, 1980), or because it was relatively complex, in that subjects had not only to read the text but also to make choices about stepping through the text. Additionally, the reading task requires subjects to concentrate for longer.

In the present study, the relative performance on free and cued recall of text was similar across subject groups. Additionally, for each of the paired associate measures taken individually, there was no statistical difference between groups. No pattern of results emerged to differentiate the groups on hard *versus* easy pairs. Depressed CFS patients did however recall less on free recall of pairs relative to their cued recall performance than did members of the other groups. To the extent that free recall can be considered more effortful than cued, and

recalling hard paired associates more effortful than easy, this study provides only slight evidence that CFS patients, whether depressed or not, are differentially impaired on effortful tasks.

This study has supported the finding that when CFS patients are asked about their general cognitive functioning, the replies that they give are related to their mood, with scores on various measures of every-day memory and attention correlating with depression scale scores. To date, it has been difficult to demonstrate any convincing correlation between what subjects say about their cognitive functioning (that is their level of cognitive complaints) and their actual test performance. Even when, as in the present study, CFS patients are asked specifically about an area of cognitive functioning with which they say they have difficulty, there is only a weak relation between what they say about their functioning and their actual performance. However, this finding should not be taken as evidence that CFS subjects are peculiarly unable to evaluate their own performance as CFS subjects were quite good (and better than control subjects) at evaluating their performance on the reading task after they had read the text and before they performed the recall test. They do not, therefore, suffer from an inability to evaluate their performance retrospectively or from a distorted perception of their performance on a task; in fact, on the basis of the present study, it could be argued that CFS subjects display heightened sensitivity to how they have performed.

The disparity between cognitive complaints and cognitive performance in CFS patients is similar to that found in other groups. In the elderly, for example, scores on self-report questionnaires of memory function, although reflecting what people think about their memory skills, may not accurately predict performance on objective tests of memory function (Sunderland *et al.* 1986). Rabbitt & Abson (1990), who studied a non-clinical population of people aged over 50, found that CFQ (Broadbent *et al.* 1982) scores correlated with scores on the BDI (Beck, 1987) but not with laboratory tests results (see also O'Connor *et al.* 1990; Bolla *et al.* 1991; Jorm *et al.* 1994). Likewise, Vermeulen *et al.* (1993) found only a weak relationship between complaints of memory problems and test performance in two groups of epileptic patients.

The present study has produced only weak relations between aspects of what CFS patients say and aspects of what they do. It does, however, show that it is possible to find performance deficits in some CFS patients (those who are depressed) on a task about which they complain (reading) and which affects their everyday life, if a task which is fairly naturalistic is used. On a more standard memory test, a paired associate learning task, the same patients perform at near-normal levels. This study suggests therefore that a way forward for future work would be to use more naturalistic tasks to explore the cognitive functioning of CFS patients.

This study was undertaken while the first author was working in the Department of Psychiatry, University of Manchester and was supported by a grant from the Linbury Trust.

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