Greater specificity of activity memories in Chronic Fatigue Syndrome/Myalgic Encephalomyelitis: Implications for exercise-based treatment

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Abstract

Purpose

Autobiographical memory is crucial to goal attainment, thus it may influence coping with chronic illness. Autobiographical memory was investigated in Chronic Fatigue Syndrome/Myalgic Encephalomyelitis (CFS/ME) and healthy people. Two contrasting hypotheses were tested. On the basis of Williams and colleagues' model of overgeneral memories in depression, and the high co-morbidity between CFS/ME and depression, we predicted overgeneral autobiographical memories in the CFS/ME group. In contrast, on the basis of a postulated oversensitization of the central nervous system in the CFS/ME population and their amplified attention towards anything that might threaten their energy balance, such as activity, we predicted that autobiographical activity memories in CFS/ME would be more specific than in healthy controls.

Methods

We employed modified cued autobiographic recall in CFS/ME (N = 89) and healthy (N = 61) participants, who were asked to recall particular past events when they experienced happiness, pain, fatigue, or were physically active. Levels of psychological distress, rumination, and behavioural disengagement were assessed.

Results

CFS/ME participants recalled significantly more specific autobiographical memories of past physical activity, compared to healthy controls. Within the CFS/ME group, lower levels of ruminating about past activity were significantly related to greater specificity in recall of activity. Further, those CFS/ME participants who recalled more specific autobiographical activity memories reported significantly lower levels of behavioural disengagement.

Conclusion

CFS/ME individuals' autobiographical memory for activity differs both from healthy individuals and the typical pattern found in depression. The effect of specific activity memories could be utilized in exercise-based treatment of CFS/ME.

Keywords: Chronic fatigue syndrome; Myalgic encephalomyelitis; Overgeneral memory; Autobiographical memory; Physical activity; Memory specificity

1 Introduction

Chronic Fatigue Syndrome/Myalgic Encephalomyelitis (CFS/ME) is a long-term illness, characterised by extreme, disabling, persistent unexplained fatigue that is not due to exertion and not relieved by rest (Brurberg, Fonhus, Larun, Flottorp, & Malterud, 2014). The causal pathway of CFS/ME is not yet fully understood. Currently CFS/ME presents as a chronic long-term condition with fluctuating symptom levels and daily functioning (Collin, Bakken, Nazareth, Crawley, & White, 2017; Fuentes, Hunter, Strauss, & Hultsch, 2001; Sohl & Friedberg, 2008). Cognitive deficits, including memory impairments, make up one of the eight accompanying symptoms of CFS/ME according to the Fukuda criteria (Fukuda et al., 1994; Ocon, 2013), and yet few studies have investigated the nature of memory processes in CFS/ME. Symptoms of impaired memory or concentration are reported by 88.5% of people with a diagnosis of CFS/ME, who also regard memory problems as one of the most disabling symptoms (Jason et al., 1999). More recently, 62% of a sample of people with CFS/ME reported memory impairment (Cockshell & Mathias, 2013).

Cockshell and Mathias (2010) in their meta-analysis of memory deficits in CFS/ME detected impairments in aspects of verbal memory and working memory over a sustained period of time (e.g. short term memory scanning task, spatial working memory). However, while people with CFS/ME report more attention and memory difficulties than healthy controls, significant differences between these groups were not detected on a number of objective

cognitive tasks (Cockshell & Mathias, 2014). Although the specific nature of cognitive processes and their potential impairment in CFS/ME is yet to be fully understood, the empirical evidence relating to cognitive deficits points to the slowing down of information processing, leading to difficulties performing complex cognitive tasks requiring sustained effort (Cockshell & Mathias, 2010, 2013; Togo, Lange, Natelson, & Quigley, 2015).

There have been investigations into the memory deficits in CFS/ME, but studies examining memory processing biases have not so far been carried out. Memory biases have been detected in chronic pain in the form of preferential recall of pain and illness-related information by chronic pain patients (Pincus & Morley, 2001), who also tend to retrieve more autobiographical memories of pain and retrieve them faster, compared to non-pain controls (Wright & Morley, 1995). Research also showed inaccuracies and distortions in recollection of past pain levels, affected by pain intensity, duration and the time between the initial experience and the recollection (Matera et al., 2003). People with CFS/ME show similar memory distortions, a discrepancy between real time fatigue ratings and retrospective fatigue ratings (Friedberg & Sohl, 2008); and the discrepancies between perceived exertion and objective performance on physical tasks (Blackwood, MacHale, Power, Goodwin, & Lawrie, 1998; Cook et al., 2003; Fry & Martin, 1996a, 1996b).

Autobiographical memory is among the cognitive processes that have been underexplored in CFS/ME despite the long-term nature of the illness, its prolonged negative impact on one's life (Hvidberg, Brinth, Olesen, Petersen, & Ehlers, 2015), and its influence on one's sense of self, identity and life narrative (Whitehead, 2006). Understanding the nature of illness-related autobiographical memories in CFS/ME may elucidate the mechanisms behind potential biases and distortions in the perception and recollection of illness-related events.

Autobiographical memory has been defined as recall of past events that are relevant to one's sense of self, and aid in future problem solving and goal attainment (Conway & Pleydell-Pearce, 2000). Investigating the properties of autobiographical memory in CFS/ME may help our understanding of how information with regard to illness, symptoms and health is processed within the memory domain. This may provide further evidence for the cognitive models of negative illness schema in CFS/ME that serve to maintain and perpetuate CFS/ME symptoms by influencing illness-related information processing (Knoop, Prins, Moss-Morris, & Bleijenberg, 2010; Moss-Morris, 2005). Cognitive-Behavioural Therapy (CBT) and Graded Exercise Therapy (GET) aim to identify and target maladaptive cognitions and behaviours, and can be further tailored to the needs of CFS/ME by targeting maladaptive features of memory processing.

One such maladaptive feature in autobiographical memory has been identified as Overgeneral Memory (OGM), consistently observed in populations with depression and Post-Traumatic Stress Disorder (PTSD) (Kleim & Ehlers, 2008; Raes et al., 2006; Sumner, 2012; Sumner, Griffith, & Mineka, 2010). OGM involves a type of autobiographical memory where the content of recall refers to a category of similar events (I used to go for walks) or to an extended time period (when I was on holiday last year) instead of concrete details of a specific event. OGM is linked to greater depression vulnerability, predicts future depressive episodes, and is related to delayed recovery from depression (Sumner, 2012; Sumner et al., 2010).

Recent evidence showed that CBT and GET help decrease fatigue and improve physical functioning in CFS/ME (P. D. White et al., 2011). Their effect has also been maintained at long-term (2.5 year) follow up (Sharpe et al., 2015). Furthermore, CBT and GET have an additional positive effect in reducing depression (P. D. White et al., 2011). In contrast, elevated depression has been demonstrated to undermine recovery from CFS/ME (Flo & Chalder, 2014). In the absence of any treatment the chances of full recovery from CFS/ME are very low, and depression is among the factors that are associated with poor prognosis (Cairns & Hotopf, 2005). Elevated fatigue is linked to depression (Arpin-Cribbie & Cribbie, 2007; Faulkner & Smith, 2008; Sohl & Friedberg, 2008), in keeping with the commonly observed high comorbidity between chronic physical illness and depression, including an increased risk of suicidal ideation (Qin, Hawton, Mortensen, & Webb, 2014; Shahar, Lassri, & Luyten, 2014). Chronic pain patients have greater incidence of OGM compared to the healthy controls and their greater OGM was associated with depression (Liu et al., 2014). OGM has been observed in anorexia nervosa in relation to positive and negative cues (Nandrino, Doba, Lesne, Christophe, & Pezard, 2006), and in Somatic Symptom disorder in response to health-related cues, positive (e.g. recover) and negative (e.g. disease) (Walentynowicz, Raes, Van Diest, & Van den Bergh, 2017). Thus, we predict that overgeneralisation of autobiographical memories will occur in CFS/ME, given the relatively high levels of depression comorbidity. Furthermore, we may expect to find in the CFS/ME group evidence of two mechanisms proposed to underpin OGM, avoidance and rumination (Williams et al., 2007).

Functional avoidance, which may reduce emotional distress in relation to past events in the short term, is proposed to be one of the mechanisms that give rise to OGM (Williams et al., 2007). Williams and colleagues, drawing upon the model of autobiographical memory of Conway and Pleydell-Pearce (2000), propose that memory retrieval stops at the generic semantic level resulting in OGM before it can reach more concrete specific sensory-perceptual memories. Negative affect is kept at bay by avoiding processing specific details of potentially traumatizing past events allowing individuals to continue effective functioning. Even positive cues may result in OGM, because they may lead to the retrieval of events with negative elements, or OGM has become a habitual processing style irrespective of the valence of the event (Dalgleish et al., 2003; Iqbal, Birchwood, Hemsley, Jackson, & Morris, 2004; Van Vreeswijk & De Wilde, 2004). Thus OGM is negatively reinforced as an avoidant coping strategy (Williams et al., 2007). Empirical evidence supports the link between OGM and avoidant coping styles (Geraerts, Dritschel, Kreplin, Miyagawa, & Waddington, 2012; Hermans, Defranc, Raes, Williams, & Eelen, 2005; Lemogne et al., 2009). People with CFS/ME may avoid engaging in activity, attempting to prevent the increase in fatigue and pain following activity, specifically the symptom of 'post-exertional malaise (Bazelmans, Prins, & Bleijenberg, 2006; Nijs et al., 2013).

Rumination in depression has been defined as repetitive and passive thoughts with a focus on one's self, symptoms and their consequences (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Rumination has also been documented in CFS/ME. A tendency to dwell on past situations, actions, and events was found to be related to an internal causal attribution of their illness by participants with CFS/ME resulting in worrying, stress, or depression (K.

White, Lehman, Hemphill, Mandel, & Lehman, 2006). To investigate a second possible underlying mechanism of memory over-generalisation in CFS/ME, this study measured the degree of rumination on memories of activity, pain, fatigue, and happy events. Taking into account the elevated levels of depression, avoidance, and rumination documented in CFS/ME, it may thus be expected that people with CFS/ME will tend to display the same pattern of overgeneral memory as found in depression.

1.1 Autobiographical memories and memory specificity

In spite of the overlapping symptoms, there are documented differences between CFS/ME and depression that lead us to propose a different hypothesis. Depression is characterised by avoidance that is of a multidimensional, cognitive and behavioural nature involving personal and social dimensions (Ottenbreit, Dobson, & Quigley, 2014), accompanied by negative cognitions about self and others, negative expectations, rumination, and high levels of distress (Moss-Morris & Petrie, 2001; Nolen-Hoeksema et al., 2008). In contrast to depression, negative cognitions in CFS/ME are constrained to the illness and its symptoms, and avoidance involves reducing engagement in activity or exercise, regarded as a coping behaviour helping control the symptoms of fatigue and post-exertional malaise (Moss-Morris & Petrie, 2001).

Furthermore, cognitive theories of the persistence of extreme fatigue in CFS/ME, which implicate negative cognitive representations of symptoms possibly arising from selective and/or impaired information processing, suggest that CFS/ME is characterised by a heightened focus on somatic sensations (Moss-Morris, 2005) as opposed to avoidance or repression of such information in order to reduce distress. Increased attentional focus on somatic symptoms like fatigue and pain may lead to perception of increased severity of these symptoms following exertion, resulting in reduction of activity (Knoop et al., 2010).

The evidence in CFS/ME so far points towards selective attention to health-threat and illness-related interpretation of ambiguous information at the later higher-level information-processing stages of elaboration, reflection and conscious effort (Hou, Moss-Morris, Bradley, Peveler, & Mogg, 2008; Hou et al., 2014; Hughes, Chalder, Hirsch, & Moss-Morris, 2017a; Hughes, Hirsch, Chalder, & Moss-Morris, 2016b; Hughes, et al., 2017b; Moss-Morris & Petrie, 2003) as opposed to the early preconscious stages of processing, where more automatic, quick orientation of attention and initial interpretation of novel information may be taking place (Martin & Alexeeva, 2010). This evidence implies that top-down processing may be taking place, where attentional focus and interpretation of somatic sensations, symptoms, and illness are directed by a higher-level negative illness schema, and that the information is filtered through this schema. Furthermore, these illness-focused processing biases appear to be independent of depression or anxiety (Hughes et al., 2016b, 2017a, 2017b) or impaired information processing and executive function, such as poor attentional control (Hughes et al., 2017a, 2017b). However, attentional control does appear to be lower in at least a subset of the CFS/ME population (Hou et al., 2014; Hughes et al., 2017a, 2017b), in accord with the evidence of impairment in information processing efficiency (Togo et al., 2015).

Consistent with the Knoop et al. (2010) proposal of attentional focus on somatic sensations as a maintaining factor in CFS/ME, empirical evidence and theories converge on the concept of sensitization of the central nervous system (CNS), as a potential causal factor of CFS/ME (Nijs et al., 2012). Nijs et al. (2012) attribute the increased responsiveness in CFS/ME towards external and internal stimuli (e.g. light, sound, temperature, pain) to CNS sensitization, which is also maintained by cognitive and emotional processes such as attention, vigilance, and stress.

Specific memories are defined as event-specific knowledge, which are constructed on the basis of the sensory–perceptual experience of a specific event, as opposed to a more abstract conceptual process underpinning recall of general memories of categories of events. According to Conway and Pleydell-Pearce (2000) such sensory-perceptual specific knowledge is retrieved spontaneously and directly in response to an internal or external cue, as opposed to a top-down search process among concepts and categories of representation that underpins the generative retrieval process of categories of events. This direct retrieval is quicker and less demanding of cognitive resources than generative retrieval. Therefore, in CFS/ME the quicker, less demanding direct retrieval route may be likely to be taken rather than generative retrieval, which requires sustained effort. This direct retrieval may also occur due to attentional vigilance towards internal and external health-related and somatic stimuli together with sensitization of the nervous system in response to environmental and internal cues.

In the light of increased CNS sensitization, preferential processing of illness-related information, and potential information processing deficits in CFS/ME, we predict an increased memory specificity in CFS/ME. In particular, we would expect more specific memories about illness-related, somatic sensations, or symptom-related events. Most recent findings show that cognitive biases in CFS/ME occur consistently in response to specifically illness-related and CFS/ME symptom-relevant stimuli (Hughes et al., 2017a, 2017b). These more specific stimuli, cues, or prompts may be more likely to tap into the relevant illness schema in CFS/ME (Hughes, Gordon, Chalder, Hirsch, & Moss-Morris, 2016a). Therefore the current study set out to investigate particular past experiences of fatigue, pain, and physical activity. A past happy memory experience was also included in order to investigate whether participants would demonstrate a general tendency towards OGM regardless of the valence or nature of the event.

Deary (2008) proposed that in CFS/ME, the threat to health may not be the illness itself but anything that disrupts the individual's exact accommodation to their illness, for example, any increased activity. It is possible that physical activity would be regarded as one of these dangerous events that threaten this balance by depleting energy levels. Thus, we predict that greater specificity will occur for physical activity events, rather than for more general symptom-related (e.g. pain and fatigue) events or positive memories.

Memory distortions, either overgeneral or over-specific memories, may be influenced by the time lag between the event and the recollection. More recent memories may be more specific and richer in details due to the freshness of the lived experience. Conversely, participants may have difficulty recalling specific details of more distant events, thus producing more general memories. Discrepancies between the lived experience and the recollection of it, known as memory-experience gap, have been consistently observed for a range of events, pleasant and unpleasant, including illness-related, such as pain (Miron-Shatz, Stone, & Kahneman, 2009). The memory-experience gap has also been documented in CFS/ME, where retrospective ratings of fatigue intensity were significantly higher than the ratings taken during the actual experience of fatigue (Friedberg & Sohl, 2008; Sohl & Friedberg, 2008). Memory age has not been shown to be an influencing factor in OGM (Williams et al., 2007), yet it is vital to investigate whether general memories lack details because they are older and more specific memories derive from events that happened more recently.

1.2 Tests of autobiographical memory

Autobiographical Memory Task (AMT) has been validated and extensively utilized in the study of the autobiographical memories in clinical populations and has been modified to various degrees to tap into the autobiographical memories features (Dritschel, Beltsos, & McClintock, 2014; Van Vreeswijk & De Wilde, 2004). The AMT assesses the general tendency to produce either specific or general memories in relation to negative or positive stimuli. The classical AMT procedure consists of presenting to the participants a number of cue words (e.g. happy, sad) one at a time, usually alternating negatively and positively-valenced words, and asking participants to retrieve a specific memory within a specified period of time (e.g. 60 s). If the participant produces a general memory they are prompted for a specific memory again. This timed method may be able to tap into earlier stages of recollection, a quicker and more automatic response, although being asked for a specific memory again may prompt a person to engage in more elaborative processing.

As reviewed above the cognitive biases in CFS/ME tend to occur later during more elaborative stages of processing. The response time in the current study was not time-restricted allowing the participant to engage in greater conscious and thoughtful elaboration. Furthermore, in the classic AMT, participants are prompted at least twice to produce specific memory, leading to suggestions and evidence that AMT may not be sensitive enough to the occurrence of OGM in non-clinical populations (Dritschel et al., 2014; Raes, Hermans, Williams, & Eelen, 2007) and the exclusive use of such methodology in the field may be a limitation in the studies of autobiographical memory in non-depressed populations (Sumner, Mineka, & McAdams, 2013). The current study aimed to assess the autobiographical memories in two non-depressed groups, healthy and CFS/ME, attempting to tap into a more voluntary spontaneous recall of specific or general memories without additional prompts to produce specific memories.

The study explored memory types for particular events of interest, such as pain, fatigue, and physical activity as opposed to a general memory-processing disposition. Martin and Jones (2012) investigated the content of one particular event of interest (e.g. receiving important news) and prompted their participants for particular memories in relation to that event (e.g. place). Participants would be prompted to recollect how well they remembered the place where they were when they received the news. The current study investigates several particular events of interest (happy, pain, fatigue, physical activity), their content and features. Therefore it utilized the elements of the classic AMT and Martin and Jones' method.

1.2.1 Hypotheses

a) If CFS/ME have a similar cognitive processing style to depressed patients then they will show over-generalised memory for the recall of the four types of autobiographical event compared with healthy controls. If, however, as proposed here, CFS/ME is a consequence of sensitization, increased attention, and preservation of cognitive resources then CFS/ME will demonstrate over-specific memories of activity compared to the healthy control group.

b) Within the CFS/ME group, more rumination about the activity event would lead to overgeneralised autobiographical memories of activity.

c) Within the CFS/ME group more avoidant coping, such as behavioural disengagement would lead to overgeneralised autobiographical activity memories whereas less avoidant coping would be associated with more specific autobiographical activity memories.

2 Method

2.1 Demographics and illness measures

Recruitment was conducted over 18 months. The total number of people who started the survey was 607. After the primary diagnosis screening and consent procedure, and exclusion of participants with missing data, the final sample consisted of 89 CFS/ME and 61 healthy control participants, matched on gender (CFS/ME 87% women, Control 73% men), $p > .05$, educational attainment (CFS/ME 30% attained a degree, Controls 35% degree), $p > .05$, and age, $p > .05$ (see Table 1).

Table 1 Sample characteristics.

alt-text: Table 1

	CFS/ME ($n = 89$)	Control ($n = 61$)	F	p	$\eta 2$
	M (SD)	M (SD)			
Age	38.1 (11.9)	35.6 (13.6)	1.51	ns	
CFS/ME Symptom Frequency	29.95 (5.5)	15.0 (4.4)	176.5	<.001	0.60
Fatigue Severity (FSS)	6.24 (0.8)	3.16 (1.2)	358.04	<.001	0.71
Physical Function (SF-36)	38.8 (26.3)	94.5 (9.8)	250.95	<.001	0.64
Depression (HADS)	8.3 (4.3)	4.2 (3.3)	39.49	<.001	0.23
Anxiety (HADS)	8.2 (4.8)	6.5 (3.9)	4.78	.030	0.04
Combined Distress (HADS)	16.5 (7.9)	10.7 (6.6)	22.04	<.001	0.13
Behavioural Disengagement	1.3 (1.5)	0.8 (1.2)	2.84	ns	

Note. CFS/ME (Chronic Fatigue Syndrome/Myalgic Encephalomyelitis).

Physical Function of the SF36 - Short Form Health Survey.

FSS - Fatigue Severity Scale, Hospital Anxiety and Depression Scale (HADS).

COPE subscale: Behavioural Disengagement.

Advertisements for the CFS/ME volunteers were placed on social media (Facebook pages of CFS/ME support groups); in monthly newsletters of UK-based CFS/ME support groups; UK-based online health forums; participants' recruitment web sites (http://www.clinpsy.org.uk/); and recruitment advertisement webpages of UK universities (Oxford, Warwick, University College London). The healthy controls were recruited from the same recruitment advertisement webpages of UK universities (Oxford, Warwick, University College London). Participation was voluntary and was not reimbursed.

Inclusion criteria specified a primary CFS/ME diagnosis by a qualified medical practitioner (GP or specialist physician) and report of the current CFS/ME symptoms according to the revised Fukuda et al. (1994) criteria. Diagnosis of CFS/ME by a medical practitioner was self-reported by the participants. They were administered the Fukuda et al. (1994) criteria to verify that they met the diagnostic criteria for CFS/ME. Participants reported the presence of persistent fatigue in the past six months, not relieved by rest, not due to exertion and interfering significantly with functioning; and rated their symptom frequency in the past six consecutive months (Eight symptoms according to the Fukuda/CDC criteria) on a scale from 1 (never experience) to 5 (experience all of the time). To meet the inclusion criteria for CFS/ME group participants would need to have a minimum of 4 symptoms that they experienced frequently during the past 6 months, giving them a minimum score of 16 and a maximum of 40. Participants were excluded from the study if they reported a primary medical or psychiatric diagnosis that was not CFS/ME.

Inclusion criteria for the healthy control group specified not currently having an acute or chronic medical or psychiatric diagnosis. Healthy control group volunteers were excluded during screening if they reported any current diagnosis. Fukuda diagnostic criteria for CFS/ME were administered to the healthy control group to ascertain that they do not currently meet the criteria for CFS/ME, which included measures of persistent physical symptoms, in addition to the measures of fatigue severity and interference, and physical functioning. Healthy controls did not report having CFS/ME diagnosis in the past.

2.2 Power analysis

Calculations of the required sample size were performed based on the planned statistical tests: chi-square, ANOVAs for group means comparisons and multiple regressions, using G*Power version 3.1.3 (Faul, Erdfelder, Buchner, & Lang, 2009; Faul, Erdfelder, Lang, & Buchner, 2007). Sample size of 122 was required for chi-square tests with maximum 3 degrees of freedom for a medium effect size $w = 0.30$ (per Cohen's convention), alpha 0.05, power 0.80; and 1091 for a small effect size 0.10.

2.3 Questionnaires

Fatigue severity and impact were assessed by the 9-item *Fatigue Severity Scale (FSS)* (Krupp, LaRocca, Muir-Nash, & Steinberg, 1989). The participants rated the items on a scale from 1 (completely disagree) to 7 (completely agree) in response to the questions about their fatigue, and its interference with daily functioning. Mean scores based on the nine items were calculated. Higher scores reflect greater fatigue, with scores above 5 indicating severe fatigue

impact (Lerdal, Wahl, Rustoen, Hanestad, & Moum, 2005). The scale has good validity and internal consistency, reporting Cronbach's α in the range of 0.84–0.95, and test-retest reliability value of 0.94 (Whitehead, 2009). In the current sample Cronbach's α was 0.95.

Level of functioning was measured by the 10-item *Physical Functioning subscale* of the Medical Outcomes Study - RAND 36 Short-Form Health Survey – SF-36 (Ware & Sherbourne, 1992). In the current sample Cronbach α was 0.97. The Physical functioning subscale has been shown to be a valid measure of the physical aspects of health in CFS/ME (Deale, Chalder, Marks, & Wessely, 1997; Fulcher & White, 1997). Raw scores on all items were recoded into scores that range from 0 reflecting poorest health and no functioning to a 100, reflecting good health and extremely high functioning. Score of 70 has been considered as a cut-off score for the CFS/ME population (Reeves et al., 2005).

Avoidant coping strategies were assessed using a 2-item *Behavioural Disengagement subscale* from Brief COPE (Carver, 1997). The subscale consists of two items (Cronbach α = 0.66 in the current sample): 1) 'I've been giving up trying to deal with it'; 2) 'I've been giving up the attempt to cope.' The responses are provided on a 4-point scale ranging from 0 (I haven't been doing this at all) to 3 (I have been doing this a lot). The measure can be utilized for the assessment of general and specific stressful situations. In the current study, CFS/ME group was asked to assess their coping in relation to their illness. The behavioural disengagement subscale has been previously used in CFS research (Antoni et al., 1994; Ax, Gregg, & Jones, 2001; Moss-Morris, Petrie, & Weinman, 1996; Ray, Jefferies, & Weir, 1997).

Hospital Anxiety and Depression Scale (HADS) consists of 14 items that aim to measure anxiety and depression in populations with non-psychiatric medical conditions, such that the scores are not affected by the physical symptoms a patient experiences as part of their medical condition (Zigmond & Snaith, 1983). The scores range 0–21 for each subscale, with higher scores indicating greater severity. The developers suggest the following classification of cases based on the scores: normal range (0–7), mild (8–10), moderate (11–15), severe (16 or higher). For people with CFS, a cut-off score of 9–10 has been recommended to distinguish patients with elevated anxiety or depression (Morriss & Wearden, 1998). The scale showed good reliability in CFS/ME population: Anxiety subscale Cronbach's α = 0.87; Depression subscale Cronbach's α = 0.79 (Mccue, Buchanan, & Martin, 2006) and has been validated in different medical settings (Bjelland, Dahl, Haug, & Neckelmann, 2002; Mondolo et al., 2006). In the current sample, Cronbach's α was 0.83 for Depression and 0.87 for Anxiety. Confirmatory factor analysis of the HADS scale suggested there is a general Distress factor accounting for 70% of the common variance, thus indicating it may be more appropriate to calculate an overall Distress score, as opposed to the two separate subscales of anxiety and depression (Norton, Cosco, Doyle, Done, & Sacker, 2013). Both methods were used in the study and included in the analysis for comparison with the previous studies in literature. HADS Distress score was calculated by summing the scores on each item, range from 0 to 63, where higher score reflects greater distress.

2.4 Autobiographical memory retrieval task

The task is a measure of autobiographical memory modified from the Autobiographical Memory Test (AMT) (Williams & Broadbent, 1986) and a memory perspective and vantage point task (Martin & Jones, 2012). Participants were instructed that they would be asked to remember four different specific events in their life and answer some questions about each memory. Then participants were asked: Please remember a particular occasion when ... The four occasions were: 1) you felt happier than usual; 2) when you felt physical pain; 3) when you felt very tired; 4) when you were more physically active than usual.

Each occasion type was presented alone in the following order: happy, pain, fatigue, physical activity. Participants were prompted to provide a description of the event, then a short title. Right after describing their particular memory they were asked how long ago that event occurred (measured in months). After that the memory rumination was measured by asking participants to rate how frequently they thought about the memory on a 5-point scale ranging from 1 (1–5 times) to 5 (101 or more times).

Participants had to type their memories on a computer. They could take as much time as needed to produce a memory, and return to the previous page if they wished to add something to the description of their memories. All participants were presented with the same order of memory prompts (happy, pain, fatigue, physical activity) due to the limitations of the online testing software.

2.5 Memory classification

Each description was coded by one of the researchers as Specific or General according to established criteria (Williams et al., 2007; Williams & Broadbent, 1986). Specific referred to an event lasting no longer than one day, including a mention of date, location, or name, e.g. 'when I ran 7 miles for charity the Sunday of the May bank holiday'. General referred to a series of similar or regularly occurring events (e.g. Pain – back pain after overdoing things) or an extended unspecified period of time (e.g. Activity - swimming on vacation in Spain). In addition, an independent judge, blind to the purpose of the experiment, coded the memory data. Inter-rater reliability for all memory types was high: Happy $K = 0.82$, Pain $K = 0.96$, Fatigue $K = 0.87$, and Activity $K = 0.93$.

2.6 Design and equipment

The study was a survey conducted via the Internet. The survey was administered via Survey Monkey software, a web-based platform for data collection. Each participant accessed the survey through the URL sent to them in an

email or via a link in the recruitment advertisement. Clicking on the link took them to the first page of the survey containing information about the study procedure, ethics and confidentiality, screening questionnaire and consent form. The study was reviewed and approved by Oxford University Medical Sciences Ethics Committee (MSD/IDREC/C1/2009/111).

2.7 Study procedure

Participants answered screening questions (about their medical and psychiatric diagnoses) and completed the online consent form. The study procedure is presented below.

1. Information about you (gender, age, education)
2. Information about your health (medical/psychiatric/CFS/ME diagnoses, questions about illness duration, past and current treatment).
3. CFS Checklist (CDC/Fukuda criteria (1994)
4. Fatigue Severity Scale (presented at the beginning, so that a participant's perception of their fatigue level is not influenced by possible tiredness from completing the questionnaires)
5. SF36 – Physical Functioning subscale (during the past four weeks)
6. Memory Retrieval Task
7. Coping scale
8. HADS Anxiety/Depression

3 Results

Mean time since CFS/ME diagnosis was 9.5 years ($SD = 7.1$), mean duration of symptoms 12.6 years ($SD = 8.8$) and mean CFS/ME symptom frequency (in the past 6 months) was 29.9 ($SD = 5.5$) (Table 1).

3.1 memory specificity

Specificity across the different memory types was investigated in a 3-way contingency table of Memory Classification (Specific, General) by Memory Type (Activity, Pain, Fatigue, Happy) by Group (CFS/ME, Control) using log-linear analysis. It revealed a significant 3-way interaction between Memory Classification, Memory Type and Group, $G^2_{10} = 68.84$, $p < .0001$ as well as a 2-way interaction between Memory Classification and Memory Type, $G^2_3 = 61.9$, $p < .0001$.

Specificity for the two groups was explored further in two separate Memory Classification by Memory Type 2×4 contingency tables. These revealed significant results for both groups – for the CFS/ME group, Yates $\chi^2_3 = 36.82$, $p < .0001$, Cramer's $V = 0.322$; and for the Healthy Controls, Yates $\chi^2_3 = 28.23$, $p = .0001$, Cramer's $V = 0.338$ (see Fig. 1).

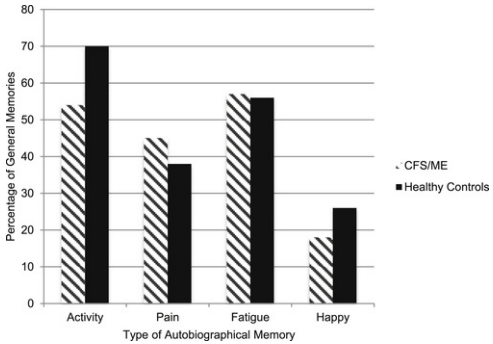

Fig. 1 Percentage of general autobiographical activity, pain, fatigue and happy memories for CFS/ME and healthy control groups.

alt-text: Fig. 1

The CFS/ME and control groups differed on Depression, Anxiety, and Distress (see Table 1). A binary logistic regression analysis was conducted for each Memory Type separately with Group as a categorical and Depression,

Anxiety, and Distress as continuous predictors, to account for a potential effect of psychological distress on memory specificity. The analysis for Pain, Fatigue, and Happy memory types did not show significant effects of mood or group membership on memory specificity, all $p > .30$.

For the Activity memory, Depression $b = 0.051$ and Anxiety $b = 0.027$ were not significant predictors of memory specificity, for both Wald $\chi^2 < 1$, $p > .30$. Adding the group factor significantly increased the predictive power of the model χ^2 (1) = 5.72, $p = .017$, $R^2 = 0.043$ (Cox & Snell), 0.059 (Nagelkerke). The parameter estimates showed that only the group factor significantly predicted whether a participant would recall a specific or general Activity memory, $b = 0.943$, Wald χ^2 (1) = 5.47, $p = .019$. The odds ratio 2.57, 95% CI [1.165–5.661] indicated that the odds of producing a specific Activity memory as opposed to a general Activity memory were 2.57 times as large for a CFS/ME participant as for a control participant (see Fig. 2). The binary logistic regression analysis was repeated with HADS Distress alone and added to HADS Anxiety and HADS Depression. The results were replicated. Only the group factor was a significant predictor of memory specificity $b = 0.910$, Wald χ^2 (1) = 5.61, $p = .018$, but not HADS Distress, $p > .10$.

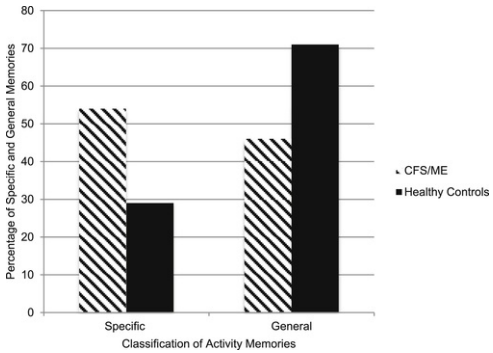

Fig. 2 Percentage of specific and general autobiographical activity memories for CFS/ME and healthy control groups.

alt-text: Fig. 2

3.2 Memory rumination and specificity

An analysis of variance (ANOVA) factorial design 2 (Group: CFS/ME, Control) x 4 (Memory Type: Activity, Pain, Fatigue, Happy) was conducted, with group as the between subjects measure, memory type as the within subjects measure, and Rumination as the dependent variable. A significant main effect of memory type $F(3, 438) = 11.29$, $p < .001$, $\eta_p^2 = 0.072$ revealed that Happy memories were ruminated upon more ($M = 34.08$, $SE = 3.31$) than Fatigue ($M = 16.78$, $SE = 2.48$) and Activity ($M = 18.78$, $SE = 2.53$), both $ps < 0.002$, but not Pain memories ($M = 26.17$, $SE = 2.87$), $p > .10$. However, the significant Group*Memory Type interaction $F(3, 438) = 3.61$, $p = .019$, $\eta_p^2 = 0.024$ suggested that group differences in rumination depend on memory type (see Fig. 3). This was underpinned by group differences in rumination on Activity memories $F(1, 148) = 14.13$, $p = .001$, $\eta_p^2 = 0.087$ with CFS/ME group ruminating significantly more ($M = 28.00$, $SD = 38.04$) than Controls ($M = 9.19$, $SD = 10.65$).

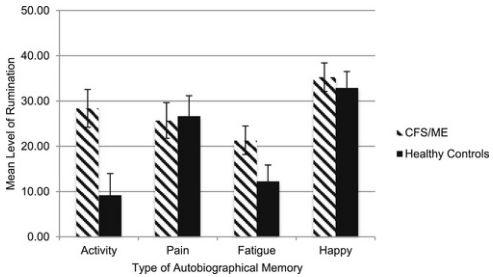

Fig. 3 Mean rumination scores for CFS/ME and healthy control groups for autobiographical activity, pain, fatigue and happy memories. Data are presented as mean ± standard error of the mean.

alt-text: Fig. 3

An ANCOVA was conducted, with Depression, Anxiety, and Distress as covariates, to investigate whether the higher depression/anxiety scores in CFS/ME group contribute to increased rumination. When the effect of mood on rumination was accounted for, the interaction group*memory type remained significant $F(3, 429) = 2.85$, $p = .037$, $\eta_p^2 = 0.020$. Depression, Anxiety, or Distress had no significant effect on memory rumination, all $Fs < 1$. To investigate

the significant interaction while controlling for anxiety and depression, ANCOVAS were conducted separately for each group and memory type. The significant interaction was again underpinned by group differences in rumination on Activity memories $F(1, 145) = 8.63$, $p = .004$, $\eta_p^2 = 0.056$. CFS/ME group ruminated significantly more ($M = 28.00$, $SD = 38.05$) on activity events than Controls ($M = 9.29$, $SD = 10.71$). This effect was not present for Fatigue, Pain or Happy memories, all $p > .10$.

To investigate how memory specificity is linked to rumination a separate ANOVA was conducted for each group and memory type. Memory specificity was the between group variable (Specific, General) and Rumination was the dependent measure. The CFS/ME group ruminated significantly less on specific Activity memories ($M = 15.43$, $SD = 23.87$) than on general ($M = 38.89$, $SD = 44.41$), $F(1, 86) = 8.99$, $p = .004$, $\eta_p^2 = 0.097$. An ANCOVA with Depression, Anxiety, and Distress as covariates produced comparable results $F(1, 84) = 7.73$, $p = .007$, $\eta_p^2 = 0.084$. The analysis for the other Memory Types (Happy, Pain, Fatigue) in CFS/ME and all Memory Types in the controls did not yield significant results, all $p > .20$.

3.3 memory age

It is possible that memory specificity is related to how long ago the events occurred, that is more general memories produced by the healthy controls may be due to the fact that they occurred a longer time ago. An ANOVA factorial design 2 (Group: CFS/ME, Control) x 4 (Memory Type: Activity, Pain, Fatigue, Happy) was conducted, with group as between subjects variable, Memory Type as within subjects variable, and Memory Age (in months) as the dependent measure. Neither the difference in Memory Age between groups nor the interaction group*Memory Type were significant, all $p > .10$.

3.4 Memory specificity and behavioural disengagement

A hierarchical regression analysis conducted separately for each group (CFS/ME, Control) investigated whether Memory Specificity (summed over the four memory types: Activity, Pain, Fatigue, Happy into a measure with scores ranging 0 – General to 4 – Specific) would predict Behavioural Disengagement. Depression and Anxiety covariates were entered at step one (Model 1), and Memory Specificity was entered at step two (Model 2). In CFS/ME group each model predicted a significant amount of variance in behavioural disengagement. Model 2 explained a significant 34.4% of variance, $R^2 = 0.344$, $F_{change} = 4.14$, $p = .045$, where greater depression and lower memory specificity predicted higher Behavioural Disengagement scores (see Table 2). For the controls $R^2 = 0.185$, $F_{change} = 0.054$, $p = .817$, memory specificity was not a significant predictor of behavioural disengagement, only higher depression score was associated with more behavioural disengagement.

Table 2 Hierarchical Regression Predicting Behavioural Disengagement from Memory Specificity in CFS/ME and Healthy Control groups.

alt-text: Table 2

Variable	Behavioural Disengagement				
	B	S.E.	*p*	CI	
CFS/ME (n = 89)					
Step 1					
Depression	0.14	0.04	<.001	0.07	0.22
Anxiety	0.07	0.03	.046	0.00	0.14
R^2	0.31				
F	18.98		<.001		
Step 2					
Depression	0.14	0.04	<.001	0.07	0.22
Anxiety	0.06	0.03	.091	−0.01	0.13
Memory Classification	−0.28	0.14	.045	−0.56	−0.01
R^2	0.34				

F change	4.14		.045		
Healthy Controls (n = 60)					
Step 1					
Depression	0.11	0.05	.051	0.00	0.21
Anxiety	0.05	0.04	.266	−0.04	0.14
R^2	0.18				
F	6.24		.004		
Step 2					
Depression	0.11	0.05	.053	0.00	0.22
Anxiety	0.05	0.05	.262	−0.04	0.14
Memory Classification	−0.03	0.14	.817	−0.31	0.25
R^2	0.18				
F change	0.05		.817		

Note. S.E., standard error; CI, confidence interval.

Higher score on Memory Classification represents Specificity.

The regression analysis rerun with HADS Total Distress showed comparable results, greater Distress $b = 0.096$, $p > .001$, 95% CI [0.062–0.130], and lower memory specificity $b = -0.291$, $p = .037$, 95% CI [-0.565 to −0.019] were significantly associated with higher behavioural disengagement in the CFS/ME group.

ANOVAs conducted within CFS/ME group to investigate whether a particular memory type was responsible for the strength of the relationship with Behavioural disengagement showed that CFS/ME individuals who recalled specific Activity memories were less likely to use Behavioural Disengagement strategies ($M = 0.79$, $SD = 1.28$) than those who recalled general Activity memories ($M = 1.63$, $SD = 1.57$), $F(1, 88) = 7.12$, $p = .007$, $\eta_p^2 = 0.060$.

3.4.1 Correlations with illness measures

No significant correlations were detected between the duration of illness (years since diagnosis and years since symptoms started) and memory specificity of happy, fatigue or physical activity memories, all $p > .05$. A significant negative correlation between the specificity of pain memories and years since diagnosis, $r(88) = -0.25$ $p = .027$ showed that longer time since diagnosis was associated with less specific pain memories. CFS/ME symptom frequency, fatigue impact or physical functioning were not significantly correlated with memory specificity for any memory type.

4 Discussion

As far as we are aware, this is the first study to demonstrate over-specific autobiographical memory in people with CFS/ME, compared with healthy controls. This over-specificity fits well with cognitive theories of increased attentional focus on somatic sensations and health-threat, maintaining CFS/ME symptoms (Fry & Martin, 1996a, 1996b; Knoop et al., 2010; Moss-Morris, 2005). It is also in line with evidence of selective attention towards illness- and symptom-related information at the elaborative stages of processing, and the somatically-focused interpretation of ambiguous information demonstrated in CFS/ME (Hou et al., 2008; Hou et al., 2014; Hughes et al., 2016b, 2017a, 2017b; Moss-Morris & Petrie, 2003). The interpretive bias may be of particular interest with regard to memory and how a particular type of recall is generated. Physical activity is somatic in its nature, however it may be interpreted as health-related (e.g. engaging in physical activity makes me fit) or as illness-related in the context of CFS/ME (engaging in physical activity will lead to severe fatigue and post-exertional malaise). In relation to the current findings of possibly enhanced processing of physical activity stimuli, it would be informative to investigate the interaction between memory and interpretation processes, whether such health-focused (positive) or illness-focused (negative) interpretation would result in more general memories (more depressive cognition) or more specific memories (illness-focused cognition). Recent findings indicated that interpretive bias may have a direct effect on memory processing.

For example, inducing a negative interpretation bias in a non-clinical population led to negative memory bias, and the same valence-related congruity was observed for the positive interpretation (Tran, Hertel, & Joormann, 2011). Different types of interpretation bias could be induced in CFS/ME, allowing investigation of a potential causal effect that an interpretive bias may have on memory biases, memory distortions in symptom-reporting, or symptom perception. Future research could elucidate the mechanisms underpinning the memory-experience gap (Miron-Shatz et al., 2009), such as one demonstrated in CFS/ME with regard to fatigue ratings (Friedberg & Sohl, 2008; Sohl & Friedberg, 2008). Once again, borrowing from the depression literature, a combined effect of the attentional, interpretive and memory processes on symptom experience and symptom-reporting, and furthermore, on the momentary experiences while engaging in physical activity and the later retrospective recall of physical activity could be investigated using already developed and validated methods utilized in depression research (Everaert, Tierens, Uzieblo, & Koster, 2013; Mathews & Mackintosh, 2000).

Similarly, the current finding is in line with the evidence of higher awareness of patterns of activity and resulting fatigue in CFS/ME (Evering, Tonis, & Vollenbroek-Hutten, 2011; Evering, van Weering, Groothuis-Oudshoorn, & Vollenbroek-Hutten, 2011). If activity is regarded as a health-threat upsetting the carefully maintained energy balance (Deary, 2008), then the enhanced processing of activity events, in this case the more specific activity memories, would be expected due to higher monitoring of activity and energy levels in order to prevent escalation of symptom severity. Furthermore, the potential hypersensitivity of the CNS, which would be more responsive to internal and environmental stimuli according to Nijs et al. (2012), may underpin such attentional vigilance towards physical activity and somatic sensations following that activity, and would make sensory-perceptual aspects of activity memories more salient.

Over-specificity of activity memories could also fit the Conway and Pleydell-Pearce (2000) model which postulates that direct retrieval, an automatic, involuntary, and spontaneous process, tends to produce more specific memories at the sensory-perceptual level of processing. Direct retrieval is less taxing on cognitive resources in comparison to generative retrieval, which is a top-down, intentional and conceptual process driving recall of general memories (Conway & Pleydell-Pearce, 2000). In accordance with the evidence of impaired information processing efficiency (Togo et al., 2015), people with CFS/ME may opt for such direct retrieval, which would tap into their concrete, sensory-perceptual experience and produce specific memories of physical activity.

Higher specificity of activity memories may also be the result of the degree of self-relevance of the cues. That is also in accordance with recent evidence that CFS/ME-relevant, illness specific cues would be more likely to tap into their negative illness schema (Hughes et al., 2016a), thus allowing detection of cognitive biases in response to CFS/ME-related stimuli (Hughes et al., 2017a, 2017b). In non-patient populations, Sumner, Griffith, and Mineka (2011) reported that the higher people rated cue words on self-relevance the more specific were their memories in response to those cues. Activity events may be highly self-relevant for CFS/ME individuals because their symptoms and physical functioning are linked to their concept of activity and their levels of activity. Activity events may be a source of great distress to them due to the perceived negative consequence of activity, namely increased symptom severity. Thus activity memories would be more specific in CFS/ME individuals. The specificity of activity memories could be confounded, in principle, if the age of memories differed between groups. However, there was no significant difference in memory age between the groups and thus cannot explain why the CFS/ME group's activity memories are more likely to be specific.

The lack of difference in the specificity of happy memories between the two groups suggests that the pattern of memory recall in CFS/ME is different from that of people with depression, who consistently demonstrate OGM (Sumner et al., 2010). Despite the current CFS/ME group having higher levels of depression, compared to controls, they did not produce overgeneralised memories. It is possible that in CFS/ME, depressed mood is not underpinned by the same kind of negative schema that is found in depression (Gotlib & Joormann, 2010). This is also supported by evidence of different cognitive patterns in CFS/ME and depression (Moss-Morris & Petrie, 2001) and the independence of the cognitive illness-focused biases in CFS/ME from levels of depression and anxiety (Hughes et al., 2016b, 2017a, 2017b). Even though the current evidence is in line with previous findings, the lack of a depression comparison group in our study prevents making stronger claims with regard to the cognitive differences between CFS/ME and depression until future investigations replicate these results. Furthermore, there remains the issue of CFS/ME and depression comorbidity and the difficulty of diagnosing depression in people with CFS/ME. Other diagnostic criteria for CFS/ME, such as the Oxford criteria (Sharpe et al., 1991), do not exclude patients with depression. Having an additional group diagnosed using the Oxford criteria would allow a comparison between CFS/ME patients with and without comorbid depression. Such a comparison may elucidate further the differences and similarities between CFS/ME and depression.

We investigated rumination as one of the mechanisms underlying OGM, and predicted in accordance with the OGM model that within the CFS/ME group greater rumination would accompany more general memories. Indeed, those individuals who ruminated more on activity memories reported more general activity memories whereas those who ruminated less on activity memories reported more specific activity memories. While this is in line with the previous research on OGM and ruminative tendencies, the limitations of our measure of ruminations prevents us from making any conclusive claims. How often people think about particular past events may be indicative of a tendency to dwell on a memory, however that should be supported by also measuring disposition towards rumination and worry.

Functional avoidance is another mechanism proposed to underlie the OGM effect in depression (Williams et al., 2007). In line with this and with the evidence for behavioural avoidance in CFS/ME (Nijs et al., 2013), we found a similar pattern where overgeneral memories were associated with greater behavioural disengagement. For the CFS/ME group (but not for the healthy group) greater memory specificity, particularly more specific activity memories, were associated with lower behavioural disengagement. This suggests a potential protective function of memory specificity, which may lead to a lower likelihood of engaging in avoidant behaviour and possibly preventing depression.

OGM in CFS/ME, similar to depression, may be a vulnerability factor in developing future depression.

However, if we follow the line of argument that increased memory specificity is a sign of enhanced processing of illness-related information in CFS/ME, activating the negative illness schema, we would expect to see higher behavioural disengagement associated with greater specificity, similar to how cognitive biases in CFS/ME are positively associated with fear beliefs and avoidance behaviour in response to illness (Hughes et al., 2017a). It is important to note, however, that Hughes and colleagues measured a range of cognitions and behaviours in response to illness. The measure of behavioural disengagement in this study has not been developed to measure specifically illness-related behaviours. Instead it taps into a more general tendency to avoid dealing with problems (Carver, Scheier, & Weintraub, 1989). It appears that symptom-related fear cognitions and avoidance behaviours in CFS/ME are complex and multidimensional and, as the current evidence may suggest, are unlike those found in depression. People with CFS/ME may not avoid thinking about physical activity in the past, but they do avoid engaging in physical activity in the present. Thus, maladaptive cognitive patterns may arise and act independently of maladaptive behaviours. Mediation analyses investigating the mechanisms of Cognitive-Behavioural and Graded Exercise treatments in CFS/ME provide support for the independence of cognitive and behavioural influences on CFS/ME symptoms. The analyses showed that a decrease in fatigue symptoms is underpinned by a change in cognition (i.e. decrease in symptom-focus, catastrophic thinking, and fear avoidance (Chalder, Goldsmith, White, Sharpe, & Pickles, 2015; Wearden & Emsley, 2013)), rather than a change in behaviour (i.e. increase in activity (Moss-Morris, Sharon, Tobin, & Baldi, 2005; Wiborg, Knoop, Prins, & Bleijenberg, 2011; Wiborg, Knoop, Stulemeijer, Prins, & Bleijenberg, 2010)). Future investigations of memory processing biases in CFS/ME should include assessment of multiple dimensions of avoidance, specifically CFS/ME-related fear cognitions, catastrophic thinking, fear of movement, and different types of avoidance, such as embarrassment avoidance, pain avoidance, and failure avoidance.

The above discussion of the potential relationship between cognitive processing and avoidance in CFS/ME may have clinical implications with regard to CFS/ME treatments. Cognitive Behavioural and Graded Exercise Therapies for CFS/ME attempt to change the perception of activity as being harmful while gradually increasing activity level to counteract physiological deconditioning in order for a patient to achieve a desired level of functioning, encompassing mental and physical activity (Surawy, Roberts, & Silver, 2005; P. D.; White et al., 2011). Exploration of mechanisms of treatment seems to suggest that CFS/ME treatments should aim to decrease activity-related avoidant and catastrophic thinking in order to help the patient engage with exercise-based treatment and gain confidence that gradual increase in activity would not result in post-exertional malaise and resurgence of symptoms. Further investigation of the memory specificity effect may have implications for such interventions where restructuring of the current perception of activity and increasing the likelihood of consequent engagement in activity may be achieved by exploring memories of past activity experiences in order to identify and set future activity goals. Furthermore, not only memories may affect how physical activity is perceived and performed, but the structure of the physical activity itself may affect memory processes in a way that can benefit the patients. Zenko, Ekkekakis, and Ariely (2016) report that the order of intensity decrease or increase during a single exercise session affects retrospective recall of the pleasantness/unpleasantness of the activity. If exercise intensity is decreasing through the session people report afterwards and predict in the future greater pleasure from physical activity, compared to an exercise session where intensity increases through the session. Graded exercise treatments for CFS/ME could harness this effect to target both exercise tolerance and fear avoidance cognitions.

From a clinical perspective more specific activity memories in CFS/ME may be beneficial leading to lower levels of behavioural disengagement. For those CFS/ME patients who do show OGM, addressing such memories may be beneficial. Treatments such as Memory Specificity Training (MEST) may benefit those individuals with CFS/ME who demonstrate vulnerabilities, such as OGM, towards developing depression.

The results of the present study point to the potential importance of the role of autobiographical memory in CFS/ME. One advantage of the current study is that it was conducted on the Internet giving the opportunity for a wider range of people to take part, not restricted to a level of mobility in CFS/ME or a geographical area. However, the use of a web-based study limited access to the medical records of the CFS/ME participants and controls. Thus we relied on the diagnostic criteria for CFS/ME together with the accuracy of self-reported diagnosis. Additionally, the scores on Fatigue Severity Scale (FSS) and physical function (SF-36) of the CFS/ME group were comparable to CFS/ME groups in the literature (Friedberg & Sohl, 2009a, 2009b; Neu et al., 2008; Olson, Ambrogetti, & Sutherland, 2003; Packer, Foster, & Brouwer, 1997; Plioplys & Plioplys, 1997; Reeves et al., 2005; P. D.; White et al., 2011). Although the FSS is not used frequently in the CFS/ME population and it does not capture all the fatigue dimensions, it does focus on the fatigue impact and its interference with daily activities, the most relevant fatigue factors for our study.

The memory task in the current study differs from the classical AMT, and has not been utilized in autobiographical memory research before. However, the use of the original AMT is likely to lead to even more specific memories in CFS/ME patients, because they receive prompts to recall specific memories. The current study demonstrated that CFS/ME patients already produce specific memories without prompts.

Another key difference is that the classic AMT is time-limited when used in laboratory conditions and our task was not. However, this allowed us to tap into less time-limited, more elaborate memory processing.

There is a slightly elevated level of anxiety in our healthy control sample that might have had an effect of producing overgeneral memories in the control group. However, OGM is disorder specific (e. g. depression or post-traumatic stress syndrome) and has not been found in anxiety (Watkins & Teasdale, 2001; Wessel, Meeren, Peeters, Arntz, & Merckelbach, 2001; Williams et al., 2007). The somewhat higher anxiety levels among the controls may be due to recruitment from among university students and staff, a population that is likely to have elevated anxiety (Cooke, Bewick, Barkham, Bradley, & Audin, 2006; Hunt & Eisenberg, 2010; Mark & Smith, 2012; Stallman, 2010). Additionally, depression and anxiety in the current sample were assessed by the Hospital Anxiety and Depression scale criticized for not representing the constructs of depression and anxiety clearly enough (Norton et al., 2013). Thus, the recommended HADS Distress score was calculated and confirmed that CFS/ME had significantly higher distress levels than healthy controls.

This investigation into the autobiographical memory in CFS/ME showed that the CFS/ME group reported more specific memories of physical activity compared to healthy controls, who reported more general activity memories. The results also point towards unique cognitive patterns in CFS/ME, which may be different from those found in depression in a significant way. Despite its limitations, the study delves into the currently under-explored area of autobiographical memory in CFS/ME, suggests possibilities for improving activity and exercise-based treatments for CFS/ME, and points towards future research.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.mhpa.2017.12.003.

Conflicts of interest

None to declare.

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Appendix A. Supplementary data

The following is the supplementary data related to this article:

Multimedia Component 1

Data Profile

alt-text: Data Profile

Highlights

- Autobiographical memory was investigated in CFS/ME and healthy controls.
- CFS/ME recalled more specific autobiographical activity memories than healthy controls.
- Greater memory specificity was linked to less behavioural disengagement in CFS/ME.
- First study to show increased specificity of autobiographical memories of activity in CFS/ME.
