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COGNITIVE IMPAIRMENTS IN FIBROMYALGIA PATIENTS: PSYCHOMOTOR PERFORMANCE, SELECTIVE ATTENTION AND MEMORY

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ABSTRACT

Background: Previous research suggests that those with Fibromyalgia Syndrome (FMS) have cognitive impairments The aim of this study was to investigate self-reported health in fibromyalgia patients and to test their performance on a range of psychomotor and cognitive performance tests. **Method:** Twelve fibromyalgia patients and twelve healthy controls completed two hours of computer performance tests, measuring psychomotor functioning, selective attention, free recall memory, recognition memory and logical reasoning. They also completed self-report measures of physical and psychological health: the short-form McGill Pain Questionnaire, Hospital Anxiety and Depression scale, Sickness Impact Profile 68, the state anxiety scale of State-Trait Anxiety Inventory, and a questionnaire assessing sleep quality and quantity. **Results:** Fibromyalgia patients reported significantly poorer physical and psychological health. They also displayed significantly slower reaction times in the tests of psychomotor function. However, no deficits in performance were found with the tests of memory, logical reasoning and selective attention. **Conclusions:** Fibromyalgia patients report greater pain, more somatic symptoms, greater mental health issues and more sleep problems. Objective testing revealed slower choice reaction times which probably reflect motor slowing. These measures can now be used to monitor the efficacy of the management of fibromyalgia.

KEYWORDS: Fibromyalgia, cognitive performance, psychomotor performance.

INTRODUCTION

Fibromyalgia syndrome (FMS) is primarily characterised by widespread diffuse pain with additional pain in specific tender points.[1] In addition, the illness is associated with disturbed sleep patterns.[2,3] fatigue,[4] and psychological distress.[5,6] The aetiology of FMS is still unclear. There has been a large increase in the number of studies of FMS in the last twenty years. These studies have advanced our understanding of the wide variety of physical and psychological symptoms associated with FMS. However, one aspect of the illness which has received less attention is whether the syndrome may result in deficits in psychomotor performance and cognitive functioning. This seems surprising considering the anecdotal evidence provided by patients who remark upon perceived deficits in mental performance. If there are such deficits, it would seem important to establish them so that they might act as further diagnostic aids or impact upon treatment methods.

An early study[7] used a group of fibromyalgia patients as a comparison group to study patients with Lyme encephalopathy. On tests of memory, the Lyme encephalopathy group showed significantly worse performance than the fibromyalgia group. This study, however, did not include a control group of healthy participants which made its capacity to inform on the performance of the fibromyalgia group limited. Another study[8] examined cognitive functioning in twenty-four FMS patients. They found, using a series of tests, that 71% of the patients showed some cognitive deficits. Poor performance in tests of memory, attention and information processing speed were the most common deficits. However, this study was only reported in the form of an abstract and therefore did not provide the details necessary for informed discussion. A more detailed study[9] compared a group of FMS patients with a group of controls and a group of patients with major depression. They examined information processing efficiency. The FMS and major depressed groups shared many information processing deficits, which the control group did not.

A recent meta-analysis[10] compared a sample of 964 FMS patients with 1025 age matched controls without FMS. The outcome measures included processing speed, long and short-term memory and executive functions.

Fibromyalgia was significantly and negatively associated with all the performance outcomes. The first aim of the present study was to determine whether the psychomotor slowing and deficits in the efficiency of information processing in FMS patients demonstrated in the previous research could be replicated in a smaller sample selected from an outpatient clinic. Another aim was to determine whether the self-reported health problems reported in the literature also applied to the current FMS group., and the extent to which the cognitive impairments were associated with these was also examined.

Research also suggests that some of the cognitive impairments observed in chronic fatigue syndrome (CFS) patients may also be observed in fibromyalgia patients. Several early studies have compared chronic fatigue patients and fibromyalgia patients and demonstrated some similarities in symptoms (in sleep physiology[11] depression[12] fatigue[13]). It has recently been suggested that FMS and CFS are both functional neurological disorders, with the same mechanisms underlying the impaired performance [14] A study of CFS patients with a similar design and methodology to the present one[15] showed that psychomotor slowing was the only significant effect. This is not meant to imply that other impairments do not occur, but rather that these effect sizes may be smaller and not detectable with a small sample size. This was examined here to determine the similarity of impairments found in CFS and FMS.

METHOD

The study was approved by the local, regional ethical committee and carried out with the informed consent of the participants.

Participants

The FMS patients were recruited from the outpatient clinic of a Rheumatology Unit. Patients were given a complete medical examination. A diagnosis of fibromyalgia was made if they had: a six-month history of musculoskeletal pain without other diagnosed illnesses, at least three tender spots[1], and no other detectable diagnoses (as measured by blood tests). Additional inclusion criteria were that they were over 18 years of age, had a good understanding of English and had had no other major illnesses or treatments in the previous year.

Once the inclusion criteria were satisfied, patients were told about the study by a researcher at the Rheumatology Unit and given an information sheet. A few days later, they were contacted by phone and asked whether they would like to take part in the study. Thirteen consecutive attendees who fulfilled the recruitment criteria were invited to participate in the study. Twelve of these patients gave written consent to take part. One patient declined because attending the performance test appointment was difficult due to work commitments.

Twelve control participants, who reported not suffering from FMS or any other major illnesses, were recruited from a volunteer database. They were matched with the FMS subjects on gender, age, education, and scores on the National Adult Reading Test[16]. The sample sizes were considered large enough to detect any gross abnormalities in the FMS group, although it was acknowledged that smaller deficits might not be detected.

Demographics

All the participants, 12 FMS patients and 12 controls were female. It has been estimated that 90% of FMS sufferers are female[17]. So, the 100% dominance of female fibromyalgia sufferers in the sample of 12 is in line with expected frequencies.

The mean age of the fibromyalgia group was 51.0 (range 36-73), and the mean age of the control group was 50.6 (range 35-71). Of the patients, 25.0 % were single, 58.3% married or living with a partner, and 16.7% widowed, divorced or separated. Of the controls, 8.3% were single, 66.7% were married or living with a partner, and 25.0% were widowed, divorced, or separated.

Measures

Questionnaires completed during the performance test appointment.

Anxiety at the time of the performance tests was measured using the state anxiety scale of the State-Trait Anxiety Inventory (STAI)[18]. General levels of anxiety and depression over the previous month were assessed using the Hospital Anxiety and Depression Scale (HADS)[19]. The Short-Form McGill Pain Questionnaire (SF-MPQ)[20] was also used. For brevity, two sub-scores are reported here: the sum of the intensity of all 15 descriptors of pain and the visual analogue scale (VAS).

Questionnaires completed after the performance test appointment.

In the first set of questionnaires, volunteers were asked how many hours a night they slept on average. The Sickness Impact Profile 68 (SIP68) [21] was also administered. A questionnaire measuring demographic information was also used.

National Adult Reading Test (NART)

The NART was used as a measure of intelligence. Volunteers were required to pronounce aloud 50 words. The experimenter recorded the number of incorrect pronunciations. This test was administered during the performance test appointment.

Psychomotor Tasks

All of the tasks were presented on an IBM compatible PC. Participants were able to perform the tasks appropriate to the test using a response box that was connected to the PC and measured reaction times to the nearest millisecond.

Five-choice serial response task[22] Participants were shown five red buttons on the response box in front of them. Each button contained a light that could be lit up to distinguish it from the other buttons. The task was to press whichever button had been lit. As soon as they pressed the button, the light would "jump" randomly to another button, and so on. This task lasted three minutes.

Simple reaction time (SRT)[22]. Participants were shown a box on the visual display unit (VDU) of the computer. At intervals of between 1-8 seconds, a white square would appear within the box. Whenever this target square appeared, they were required to press a key on the response box to signal their detection of the square. The mean time taken to react to the appearance of the squares was recorded. This test lasted three minutes.

Choice reaction time (CRT)[23] In the two selective attention tasks described in the next section, CRT was measured (the time taken to react to a choice of two stimuli). These tests also indicated if deficits were due to difficulties in encoding or response organisation.

Cognitive Tasks

As with the psychomotor tasks, the following tests (apart from the Stroop test) were presented using the PC.

Selective attention: Stroop colour-word task [24]. Participants were given three cards on which were written: the names of colours printed in black ink (card A), the names of colours each printed in a conflicting-coloured ink (e.g. red printed in blue ink, card B), colour patches (card C). They were instructed to read out aloud the words on card A (black words condition), followed by the colours on card B (colours condition), the colours on card C (coloured patches condition) and finally, the words on card B (coloured words condition). They had to do this as quickly as possible, and the time they took to complete each condition was recorded. A measure of Stroop interference was calculated by subtracting the time taken to call out the words in the coloured patches condition from the time taken to name all the colours of the irrelevant words in the condition of the colour (e.g. the word red printed in blue, correct response = blue).

Selective attention: Focused attention task and Categoric search tasks. Two tests were used to assess aspects of selective attention: a focused attention task and a search task. The focused attention task required participants to select the letters A or B presented in the centre of the VDU. Distractors that agreed or disagreed with the target, and were close to or far from the target, were presented on some trials. The categoric search task required subjects to search for an A or B in an unknown position on the VDU. Again, the targets were in the centre or periphery and, on some trials, were accompanied by a distracting digit. Each test consisted of 320 trials and lasted approximately 10 minutes.

Free recall memory test[22] Participants were shown a list of 20 words presented at a rate of one word every two seconds. They were then required to write down in two minutes as many words as they could remember from the list. This test was administered at the start of the test session.

Recognition memory test[22] At the end of the session, a recognition memory test was conducted. Participants were required to select the twenty words they had been shown at the start of the test session from a list of forty words presented on the VDU screen.

Working memory: Logical reasoning task[25] Working memory was assessed with a logical reasoning test. Participants were shown statements about the order of the letters A and B. Each statement was followed by the letters AB or BA. For example, a typical statement might read "B follows A", after which was written "AB" or "BA". They had to decide whether the statement was true or false. So, in the example, if the letters "AB" had followed the statement, then the statement would have been true. They had 3 minutes to respond to as many statements as they could. The sentences varied in syntactic complexity from a simple active (e.g., A follows B) to a passive negative construction (e.g., A is not followed by B).

Procedure

Once the person had agreed verbally to participate, an appointment was made for them to attend the laboratory. At this appointment, they gave written consent to take part in the study. They then completed a battery of performance tests. The tests took approximately two hours to complete. Four of the FMS subjects were unable to complete all of the tests due to fatigue and pain (which in itself could be seen as an indicator of poor day-to-day performance). Therefore, only the tests which they all completed are reported here. These tests were outlined in the previous section. In addition, they completed the following self-report questionnaires: state anxiety (STAI), HADS, SF-MPQ.

On finishing the tests, they were given a questionnaire booklet to complete at home the following day and returned in a Freepost envelope. This booklet contained the following questionnaires, which are being reported here: a demographic questionnaire, a sleep questionnaire and the SIP68.

Statistical Analysis

Student two-sample *t*-tests were used to compare the FMS group and control group on their scores on the questionnaires and performance tests. A Levene's test for equality of group variances was used for each variable. When inequality of variance was found, the Welch t-test was reported, which does not require equality of variance.

RESULTS

Self-reported physical and psychological health

All the measures of physical health showed that the fibromyalgia group were in significantly poorer health than the controls (see Table 1). The fibromyalgia patients reported greater levels of pain (SF-MPQ), shorter duration of sleep and greater functional disability (SIP68).

The HAD scale showed that the fibromyalgia group were significantly more depressed than the controls, which replicates previous research[5] and also more anxious. However, it is important to note that the measure of state anxiety (STAI) at the time of the performance tests showed no difference in anxiety levels between the groups at that time point. This suggests that any differences in performance cannot be accounted for by the influence of high state anxiety during the testing session.

Table 1: Means and standard deviations of scores on the self-report questionnaires.

	FMS mean (N=12)	FMS s.d.	Control mean (N=12)	Control s.d.	Student's *t*-test *t*, p
Physical health					
SF-MPQ Total current level of pain	17.00	11.14	0.75	1.60	5.00, p = 0.0004
SF-MPQ VAS current level of pain	4.53	2.31	0.26	0.67	6.15, p = 0.0000
Average hours of sleep a night	5.83	1.95	7.17	0.58	-2.28, p = 0.04
SIP68	18.67	11.24	4.42	4.85	4.03, p = 0.001
Psychological health					
State anxiety (STAI)	40.50	7.55	37.00	8.53	1.01, p = 0.33
HADS - anxiety	10.00	5.08	5.42	3.20	2.64, p = 0.01
HADS - depression	7.75	4.03	3.08	2.15	3.54, p = 0.002

Intelligence

The NART has been shown to be a good indicator of intelligence and therefore it was thought important that the scores should be similar in both groups so that intelligence did not act as a confounding variable in the analyses performed. Out of 50 words in the NART test, the fibromyalgia group had a mean score of 19.9 errors (s.d. 4.1), and the control group had a mean score of 18.3 errors (s.d. 11.6). A Welch t-test showed no significant difference in NART scores between the groups (t -0.44, p = 0.66).

Psychomotor performance

The tests of psychomotor performance indicated a significant slowing of reaction times in the fibromyalgia group.

Five Choice Serial Response Task

In the five-choice serial response task, the fibromyalgia subjects were able to complete significantly fewer presses of the lights than the controls (FMS mean = 260.9, s.d. 72.8, control mean = 321.0, s.d. 42.7, *t* -2.34, p = 0.03). However, there was no significant difference in accuracy between the groups (FMS % correct = 99.8, s.d. 0.42, control % correct = 99.9, s.d. 0.16, *t* -0.68, p = 0.52).

Simple Reaction Time Task

The simple reaction time task also indicated that the FMS group took longer to react to the stimuli presented (FMS mean = 818 msec, s.d. 497, control mean = 434 msec, s.d. 75, *t* 2.64, p = 0.02). The large standard deviation displayed by the FMS group was due to the very slow reaction times showed by some of the FMS group (range of FMS scores 292.0 - 1642.0 msec, range of control scores 344.0 - 594.0 msec) and thus is an indicator of the great deficits in psychomotor performance which were displayed.

Focused Attention and Categoric Search Choice Reaction Time Tasks

Choice reaction time measured in the two selective attention tasks was significantly slower in the fibromyalgia group: focused attention task (FMS mean = 612 msec, s.d. 111, control mean 492 msec, s.d. 75, *t* 3.06, p = 0.006), and the search task (FMS mean = 726 msec, s.d. 88, control mean 643 msec, s.d. 108.12, *t* 2.07, p = 0.05). There were no significant differences in the accuracy scores for these tasks.

Encoding of New Information

Speed of encoding of new information was measured by the difference in reaction time to new stimuli (alternations from the previous trial) and repetitions of the same stimulus. This was measured in both the focused attention and categoric search task.

Speed of encoding new information was not significantly different between the two groups: focused attention task - FMS mean = 18 msec, s.d. 30, control mean = 7 msec, s.d. 26, *t* 0.86, p = 0.40, and the search task - FMS mean = 14 msec, s.d. 44, control mean = -15 msec, s.d. 33, *t* 1.87, p = 0.07.

Response Organisation

In the Categoric Search task, the letter A was responded to with the left hand and B with the right hand. Stimulus-response compatibility, a measure of response organisation, could be measured by subtracting compatible responses (letter A on the left-hand side of the screen; letter B on the right-hand side of the screen) from incompatible responses, which required more organisation (letter A on the right, letter B on the left). This measure of response organisation showed no differences between the groups (FMS mean = 18msec, s.d. 27, control mean = 24 msec, s.d. 28, *t* -0.48, p = 0.64). Therefore, the psychomotor slowing shown by the slow reaction times in the FMS group was not due to problems with encoding or response organisation, suggesting that the slowing was at the motor output side of the process.

Tests of Selective Attention and Memory

Stroop Colour-Word Interference

The FMS group showed greater interference on the Stroop colour-word task than the controls. However, the difference did not reach the 5% significance level (FMS interference mean = 38.6 sec , s.d. 15.2, control mean = 30.3 sec, s.d. 13.4, *t* 1.42, p = 0.17).

Recall, Recognition and Working Memory

The results of the other tests of cognitive performance are shown in Table 2. No significant differences were found between the FMS group and control group on the free recall memory test or the recognition memory test. The logical reasoning task showed that the FMS subjects answered fewer questions than the controls, although this difference did not reach the 5% significance level. The percentage of correct responses was extremely similar in both groups.

Correlations between performance tests and self-report questionnaires

Correlations examined whether the psychomotor deficits in the FMS were associated with the high levels of pain and functional disability, or the high psychological distress and low mean hours of sleep also shown by the group. Exploratory Pearson product-moment correlations were carried out to test for relationships in the FMS group between the psychomotor tests and the self-report questionnaires. No significant relationships were found between the psychomotor test variables and the self-report questionnaires (SF-MPQ, SIP68, HADS anxiety, HADS depression and mean hours of sleep a night).

Table 2: Means and standard deviations of scores on the cognitive performance tests.

	FMS mean (N=12)	sd	Control mean (N=12)	s.d.	*t*-test *t*, p
Free recall memory test					
% words correctly recalled	31.25	1.91	35.00	1.86	-0.97, p = 0.34
Number of words incorrectly recalled	0.33	0.49	0.58	1.17	-0.68, p = 0.50
Recognition memory test					
% words correctly recognised	67.90	4.30	73.35	2.67	-0.74, p = 0.47
Verbal reasoning					
Number of questions done	32.83	10.58	42.25	14.94	-1.78, p = 0.09
% of correct responses	75.82	17.91	74.88	20.02	0.12, p = 0.90

DISCUSSION

The FMS group reported significantly more depression, anxiety, functional disability, pain, and less sleep than the controls, confirming the physical and psychological health profile commonly associated with fibromyalgia.

The FMS group also showed deficits in tasks measuring reaction time, namely simple reaction time and three choice reaction time tasks (five-choice serial response task, focused attention and categoric search task). The focused attention and categoric search tasks demonstrated that the slowed reaction times were not due to difficulties in encoding information or the organisation of a response. It is suggested that the deficits can be attributed to a decline in the motor performance needed to produce a response. These results confirm findings from a recent study with CFS patients [15] and support the view that FMS and CFS should be interpreted in terms of a functional neurological disorder.[14] Indeed, the authors of this approach have even suggested a plausible underlying mechanism, namely that pain or fatigue produces a decrease in externally directed attention, which increases susceptibility to distraction and slows information processing. Routine cognitive processes then require extreme effort. There may be a switch from an automatic to a less efficient controlled or cognitive mode, a mechanism that has also been suggested for impaired motor control in functional neurological disorders.

The study did not find significant deficits in tests of Stroop interference, free recall, recognition memory, verbal reasoning and selective attention. So, FMS was associated with a general slowing of reaction times but not a decline in cognitive faculties, which replicates earlier work.[9] that also demonstrated a general slowing in information processing in FMS subjects. The hypothesis that the FMS group would also show deficits in the accuracy of performing cognitive tasks was not upheld. There are two possible conclusions: first, these FMS patients may differ from those in other studies and

not show cognitive deficits, or two, that the study was not sensitive enough to demonstrate any, perhaps more subtle, cognitive deficits. Further studies with increased sample sizes and thus increased power could address the issue.

The exploratory correlations showed that the poor performance was not related to the experience of pain rather than lack of sleep or high levels of anxiety and depression or functional disability. Again, it is suspected that the small sample size may have contributed to these inconclusive findings.

CONCLUSION

To conclude, fibromyalgia was associated with high levels of pain and functional disability and high levels of depression and anxiety and a short duration of sleep. Additionally, significantly slowed reaction times on tests of simple and choice reaction time were found in the FMS patients. These findings add to previous research and demonstrate reliable impairments despite the small sample sizes. It is suggested that these are probably the "tip of the iceberg" and that further research should be conducted in this area to bring about a fuller picture of the impact of FMS on its sufferers.

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