Executive Function and Decision-Making in Women with Fibromyalgia

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Accepted 26 September 2008

Abstract

Patients with fibromyalgia (FM) typically report cognitive problems, and they state that these deficits are disturbing in everyday life. Despite these substantial subjective complaints by FM patients, very few studies have addressed objectively the effect of such aversive states on neuropsychological performance. In this study we aimed to examine possible impairment of executive function and decision-making in a sample of 36 women diagnosed with FM and 36 healthy women matched in age, education, and socio-economic status. We contrasted performance of both groups on two measures of executive functioning: the Wisconsin Card Sorting Test (WCST), which assesses cognitive flexibility skills, and the Iowa Gambling Tasks (IGT; original and variant versions), which assess emotion-based decision-making. We also examined the relationship between executive function performance and pain experience, and between executive function and personality traits of novelty-seeking, harm avoidance, reward dependence, and persistence (measured by the Temperament and Character Inventory-Revised). Results showed that on the WCST, FM women showed poorer performance than healthy comparison women on the number of categories and non-perseverative errors, but not on perseverative errors. FM patients also showed altered learning curve in the original IGT (where reward is immediate and punishment is delayed), suggesting compromised emotion-based decision-making; but not in the variant IGT (where punishment is immediate but reward is delayed), suggesting hypersensitivity to reward. Personality variables were very mildly associated with cognitive performance in FM women.

Keywords: Fibromyalgia; Executive functions; Decision-making; Pain; Cognition; Emotion; Personality

Introduction

Fibromyalgia (FM) is a chronic pain syndrome characterized by widespread pain, multiple tender points, and fatigue (Wolfe et al., 1990). In addition, patients with FM typically report problems with their memory, concentration, and alertness, and they also frequently state that these deficits are significantly disturbing and disabling (Glass, Park, Minear, & Crofford, 2005). Despite these substantial subjective complaints, few studies have addressed objectively the effect of such aversive states on neuropsychological functioning. Indeed, some evidence suggests that the perceived memory deficits in FM patients are disproportionately greater than their actual deficits, as determined by objective neuropsychological measures (Grace, Nielson, Hopkins, & Berg, 1999). Moreover, several studies indicate that the memory problems are perhaps the consequence of mood alterations rather than central nervous system (CNS)-related dysfunction (Landro, Stiles, & Sletvold, 1997; Rusell, 2002; Sephton et al., 2003; Suhr, 1999).
More importantly, most studies to date have focused on examination of memory processes, whereas there are only very few studies that have addressed deficits in executive functions in patients with FM. One previous study failed to show significant executive functioning deficits in FM patients (Suhr, 2003). However, results from three other studies indicate that executive functioning can be compromised in FM patients (Grisart, Van der Linden, & Masquelier, 2002; Leavitt & Katz, 2006; Park, Glass, Minear, & Crofford, 2001). Two of these studies demonstrated that impaired executive functioning might be the underlying reason for memory deficits in FM patients (Grisart et al., 2002; Leavitt & Katz, 2006). Grisart and coworkers (2002) demonstrated that FM patients had poorer involvement of executive control processes but intact contribution of automatic processes in a cued recall task. Importantly, these deficits were not explained by psychological or medication status. Similarly, Leavitt and Katz (2006) showed that FM patients had selective deficits in episodic memory and working memory tests involving resistance to interference; FM patients showed a sharper decrease of performance as a function of increased distraction. In addition, Park and coworkers (2001) revealed working memory and verbal fluency deficits in FM patients. Again, the poorer performance of FM patients was correlated with a measure of pain intensity, but not with depression, anxiety, or fatigue. Due to the discrepancy of findings, more studies are needed to address the issue of executive dysfunction in FM patients.

In addition, it is possible that the chronic pain state associated with FM can impair emotion-based decision-making, relying on the functioning of the orbitofrontal/ventromedial prefrontal cortex (VMPFC; Bechara, Damasio, Damasio, & Anderson, 1994). The Iowa Gambling Task (IGT) was initially developed to detect deficits in this emotion-based decision-making learning in patients with lesions within the VMPFC. Advantageous performance in this task has been argued to require the development of emotional signals (somatic markers) that serve to anticipate the prospective outcomes of the different response choices (Bechara, Damasio, Tranel, & Damasio, 1997). Using the IGT, there is evidence for decision-making deficits in other chronic pain disorders such as chronic back pain (Apkarian et al., 2004), chronic complex regional pain syndrome (Apkarian et al., 2004), or migraine headache (Mongini, Keller, Deregibus, Barbalonga, & Mongini, 2005). Furthermore, neuroimaging studies support the notion that activity in the orbitofrontal cortex and the insular cortex, some of the key neural substrates of emotion-based decision-making, is significantly affected by conditions of chronic pain (Apkarian, Krauss, Fredrickson, & Szeverenyi, 2001; Apkarian, Thomas, Krauss, & Szeverenyi, 2001; Baliki et al., 2006) including FM (Deus et al., 2006). However, no previous studies have examined emotion-based decision-making in FM, although pain in FM is consistently rated as more severe than other chronic painful conditions (Boisseevain & McCain, 1991).

According to available evidence, poor scores on executive function measures in patients with FM do not seem related to depression or anxiety (Apkarian et al., 2004; Park et al., 2001; Suhr, 2003). However, several studies have revealed abnormal scores on trait measures of personality in FM, typically higher scores on neuroticism/harm avoidance and lower scores on novelty-seeking (Anderberg, Forsgren, Ekselius, Marteinsdottir, & Hallman, 1999; Cohen, Buskila, Neumann, & Ebstein, 2002). Furthermore, decision-making performance has been associated with personality traits, such as lack of premeditation, novelty-seeking, or reward sensitivity (Gonzalez et al., 2005; Zermatten, Van der Linden, d’Acremont, Jermann, & Bechara, 2005). Thus, it is important to examine whether these personality variables are related to certain measures of executive functioning in FM patients.

In this study we tested the hypotheses: (1) That women with FM would show poorer performance than controls on a multi-component measure of executive functioning, that is the Wisconsin Card Sorting Test (WCST). The WCST was selected because it is a complex task that yields information about cognitive flexibility, rule detection/abstraction, and distraction when monitoring several sources of information (e.g., failures to maintain set). (2) That women with FM would show impaired emotion-based decision-making as measured by the IGT. Optimal performance on the IGT has been linked to the development of appropriate emotional signals of reward/punishment that could be masked by pain signals in women with FM. (3) That self-reported pain experience, and clinical and personality characteristics of women with FM would be associated with the degree of executive impairments. We predicted that higher pain experience and longer duration of illness would correlate with poorer cognitive performance. Due to the lack of prior studies in FM population on associations between personality measures and executive functioning, we conducted an exploratory analysis, as opposed to testing a specific hypothesis.

Materials and Methods

Participants

Thirty-six women diagnosed with FM and 36 healthy comparison women (HC) volunteered in this study. Both groups were matched in gender, age, years of education, and socio-economic status (SES) variables (Table 1). SES was determined following guidelines from the Instituto Nacional de Estadística (Spanish National Statistics Institute, 2008).
FM patients fulfilled the criteria of the American College of Rheumatology (Wolfe et al., 1990). The diagnostic assessment was conducted by a physician. FM patients were recruited through physicians’ referrals at the Institute of Neuroscience F. Olóriz in Granada (Spain). Only women fulfilled selection criteria during recruitment. Table 1 also shows descriptive data for the main clinical characteristics of the FM group including years since symptom onset, years since diagnosis, and years of pharmacological treatment. Eighty-nine percent of the FM women were receiving prescribed pharmacological treatment including antidepressants (20%), anxiolytics (20%), antiepileptics (25%), and antipsychotics (35%). These medications were all prescribed specifically to alleviate some of the FM symptoms; none of the patients had comorbid neurological or neuropsychiatric disorders. Three percent of the FM patients were also receiving ozone therapy. In addition, 30.6% of the FM women were receiving psychological treatment. HC women were recruited by means of adverts and word of mouth communication in recreation centers and schools for the older in the same area of the city of Granada. Exclusion criteria for HC participants included presence of neurological conditions, psychiatric disorders, systemic diseases, or pain-related symptoms/disorders according to clinical reports and preliminary interviews. None of the HC participants reported pain-related symptoms or were under medical or psychological treatment for the conditions described earlier. All participants were informed of the aims of the study and signed an informed consent form. All human data included in this manuscript were obtained in compliance with regulations of the Human Participants Ethics Committee of the Universidad de Granada.

**Instruments**

**Personality Measures**

The Temperament and Character Inventory -Revised (TCI-R; Cloninger, 1994; adapted to Spanish population by Gutierrez-Zotes et al., 2004). This inventory was developed by Robert Cloninger based on the Tridimensional Personality Questionnaire (TPQ) with the goal of assessing the seven factors of the psychobiological model of personality (Cloninger, Svrakic, & Przybeck, 1993). The TCI-R is a 240-item true/false questionnaire measuring the four dimensions of temperament: Novelty-seeking (NS, 35 items), harm avoidance (HA, 33 items), reward dependence (RD, 30 items), and persistence (P, 35 items); and three dimensions of character: self-directedness (40 items), cooperativeness (36 items), and self-transcendence (26 items). Each item is rated using a Likert scale ranging from 1 (entirely false) to 5 (entirely true). For the aims of this study, we used the raw scores from the subscales measuring the four dimensions of temperament (NS, HA, RD, P) to examine their association with cognitive performance. Means and standard deviations for the TCI-R temperament scores are shown in Table 2. Groups only differed significantly on HA, t = 2.65, p = .01, with FM participants endorsing higher levels of HA.

**Assessment of Pain Experience**

We used the West Haven-Yale Multidimensional Pain Inventory (WHYMPI; Kerns, Turk, & Rudy, 1985). This is a brief, comprehensive measure of key aspects of chronic pain experience viewed from a cognitive-behavioral perspective. It contains 52 items divided into three main sections, each containing several subscales. For the aims of the present study, we only analyzed the results from three subscales of the first section, which captured our main areas of interest with regard to cognitive performance: Pain severity, Pain-related interference, and Affective stress. Specifically, we used the pain intensity and interference scores to examine the predicted relationship between self-reported pain and cognition; and the affective distress subscale to rule out that neuropsychological performance is associated with negative mood. The WHYMPI employs a Likert scale to assess the intensity and frequency of the chronic pain experience, ranging from 0 (e.g., no pain or no
interference) to 6 (e.g., extreme pain or extreme interference). Higher scores mean more pain-related symptoms. Means and standard deviations for the three WHYMPI subscales are presented in Table 2. FM women reported significantly increased scores on the three subscales.

Neuropsychological Measures

Wisconsin Card Sorting Test (WCST; Grant & Berg, 1993)

Participants were asked to sort a series of cards that have simple stimuli characterized by three relevant categories (color, form, and number) to four reference cards. The rules for correctly sorting the cards are modified during the performance of the test (every time the participant reaches 10 consecutive hits in a certain category). The main performance indices from this test were the number of categories (raw score), the percentage of perseverative errors (T score), the percentage of non-perseverative errors (T score), and (raw score) the number of failures to maintain set (T scores were used when available in the Spanish manual). Computational models indicate that categories and perseverative errors are a measure of abstraction and mental flexibility, respectively, whereas failures to maintain set is a measure of working memory and distractibility (Kaplan, Sengor, Gurvit, Genc, & Guzelis, 2006). As some studies have suggested that cognitive deficits of patients with FM could be associated with suboptimal effort, here we also obtained indices of effort from the WCST. Specifically, we contrasted possible differences between the FM and HC groups on the number of “unique responses” given in the test (i.e., not matching any of the three categories), and on the number of “perfect match-missed” (i.e., unique responses that occur when a patient fails to correctly sort a response card that matches perfectly one of the key cards; Greve, Bianchini, Mathias, Houston, & Crouch, 2002). In addition, we analyzed the degree of consistency between obvious (e.g., number of categories) and subtle (e.g., percentage of perseverative errors) indices of performance in the test.

Iowa Gambling Task (IGT)—Original Version ABCD

This is a computerized task that factors several aspects of decision-making including uncertainty, risk, and evaluation of reward and punishing events (Bechara et al., 1994; Bechara, Damasio, & Damasio, 2000). The original version of the IGT involves four decks or cards, decks A’, B’, C’, and D’. Each time a participant selects a card, a specified amount of play money is awarded. However, interspersed among these rewards, there are probabilistic punishments (monetary losses with different amounts). Two of the decks of cards (A’ and B’) produce high immediate gains, however, in the long run, these two decks will take more money than they give, and are therefore considered to be the disadvantageous decks. The other two decks (C’ and D’) are considered advantageous, as they result in small, immediate gains, but will yield more money than they take in the long run.

When administering the IGT, participants were told that the goal of the game is to make as much money as possible and to avoid losing as much money as possible. They are instructed that they may choose cards from any deck, and that they may switch decks at any time. Participants were also informed that some of the decks are better than others, and to win, one must avoid the worse decks and stick to the good decks. It is argued that emotional signals stemming from the body and body mapping brain regions (somatic markers) may bias response selection towards the advantageous decks, making this task a sound measure of emotion-based decision-making.

Each game consists of 100 card choices. Net scores for the IGT were calculated by subtracting the number of disadvantageous choices (decks A’ and B’) from the number of advantageous choices (decks C’ and D’; net IGT score). Optimal performance on the IGT requires that participants begin to learn the contingencies in each deck as the task progresses, and to
shift their strategy accordingly (choosing from advantageous decks mostly; IGT learning curve). To assess this learning curve we calculated net scores for each of the five blocks of 20 trials. The analysis of the IGT performance by blocks of 20 trials provides information about the learning capacity and strategy used by participants. Bechara and coworkers (1997) identified four learning phases corresponding to changes in awareness or understanding of the task: guess, pre-hunch, hunch, and conceptual knowledge. Performance (net scores) improves across these phases.

**Iowa Gambling Task—Variant Version (EFGH)**

The variant version of the IGT was also used for this study. This task involves decks E’, F’, G’, and H’. Again, there are two advantageous decks (E’ and G’) and two disadvantageous decks (F’ and H’). In this version of the task, each card choice results in an immediate punishment (loss of money) with delayed reward. The advantageous decks (E’ and G’) are those with high immediate punishment, but higher future reward. The disadvantageous decks (F’ and H’) are those with low immediate punishment, but lower future reward. Instructions for the participants are similar to the instructions for task ABCD, however, this time they are told that they will lose money every time they pick a card and win money once in a while. Net scores were calculated according to the formula \( (E + G) - (F + H) \) for each block of 20 trials and for the total 100 trials.

**Statistical Analysis**

We first conducted exploratory descriptive and outlier analyses to characterize the distributional properties of the data. For each set of dependent variables (WCST and IGT—original and variant versions), we removed the outlier cases (defined as “atypical values” by SPSS 14 Explore command) detected in these exploratory analyses from subsequent analyses. Normality assumptions were examined using Kolgomorov–Smirnov tests. For those variables not normally distributed (WCST number of categories and failures to maintain set) we used non-parametric tests in group comparisons.

To examine possible differences between FM and HC women on the four indices of the WCST (Hypothesis 1) we conducted independent-samples \( t \)-tests (for percentage of perseverative errors and percentage of non-perseverative errors) and Mann–Whitney non-parametric analyses (for number of categories and failures to maintain set). We also calculated effect sizes for significant between-group differences following the formulations of Zakzanis (2001). To examine possible differences between FM and HC women on the two versions of the IGT—original and variant (Hypothesis 2), we conducted two 2 (group: FM vs. HC) \times 5 \) (IGT blocks) mixed-design analysis of variances (ANOVA). We conducted post hoc independent-samples \( t \)-tests to examine group differences on each of the five individual blocks for each task. To examine the relationship between self-reported pain experience (measured by the WHYMPI) and cognitive performance (WCST and IGT; Hypothesis 3), we conducted Spearman correlation analyses. In this case we hypothesized a negative relationship (the more pain the poorer performance) so that correlations were one-tailed. Furthermore, to explore possible relationships between the clinical and personality characteristics of the FM group and their cognitive performance (WCST and IGT; Hypothesis 3) we conducted a series of bivariate correlation analyses (Spearman). These analyses were exploratory, thus we decided not to apply corrections based on the number of contrasts.

**Results**

**Executive Function—WCST**

Data from 35 FM and 36 HC women were entered into the analyses for percentage of perseverative errors due to discarding of one outlier. All participants (\( n = 72 \)) entered into the analyses for number of categories, percentage of non-perseverative errors, and failures to maintain set. Results showed that FM women had significantly lower number of categories and greater percentage of non-perseverative errors than the HC group in this task (Table 3). In contrast, we failed to show significant group differences on the percentage of perseverative errors and failures to maintain set (Table 3). Although non-significant, differences in failures to maintain set showed a medium effect size (\( d = 0.5 \)).

To examine possible effects of poor effort on FM’s performance in the WCST, we analyzed specific indices of effort in the WCST (Greve et al., 2002). There were no significant differences between groups on the number of “unique responses” (Mann–Whitney \( U = 566.5, p = .35 \)). Moreover, only one participant from the FM group had more than one “perfect match-missed”; we re-analyzed the WCST data after removing this participant and results were unchanged. Furthermore, in the FM group there were significant correlations between subtle and obvious performance indices (percentage perseverative errors-categories, \( r = .60, p < .001 \); percentage perseverative errors-failures to maintain set, \( r = .33, p < .05 \)).
Data from 34 FM and 34 HC women were entered into these analyses after removal of outliers. The mixed-design ANOVA yielded a significant effect for the “block/C2 group” interaction $F(4, 63) = 2.74, p < .05$. Planned independent-samples $t$-tests for each individual block showed that FM women had significantly lower scores on block 3 $t(66) = 2.57, p = .01, d = 0.63$ (Fig. 1). We found no significant differences for the remaining blocks of the task. We also conducted separate repeated-measures ANOVAs for each group on the “block” variable (learning across trials). Results showed a significant effect of “block” for the control group $F(4, 33) = 2.58, p < .05$, but not for the FM group $F(4, 33) = .69, p = ns$. As illustrated in Fig. 1, these results indicate that there is a learning curve in the HC group (especially for blocks 1–3), but it is flat in the FM group. No significant differences were found in the total net score $t(66) = 0.68, p = 0.51$.

Correlations between Self-Reported Pain Experience and Neuropsychological Performance

We found significant correlations between self-reported pain intensity and WCST number of categories $r(n = 72) = -.23, p = .03$ and IGT block 3 net score $r(n = 68) = -.25, p = .02$, and between self-reported pain interference and WCST number of categories $r(n = 72) = -.25, p = .02$ and IGT block 3 net score $r(n = 68) = -.25, p = .02$. We found no significant correlations between self-reported pain variables and other neuropsychological indices. Correlations between affective distress and neuropsychological indices were also non-statistically significant: WCST number of categories $r(n = 72) = -.20, p = .09$, WCST percentage of perseverative errors $r(n = 72) = .13, p = .29$, IGT block 3 net score $r(n = 68) = -.09, p = .22$. 

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Table 3. Comparison between patients with fibromyalgia (FM) and healthy controls (HC) on the different indices of the Wisconsin Card Sorting Test (WCST)

<table>
<thead>
<tr>
<th>WCST indices</th>
<th>FM</th>
<th>HC</th>
<th>$t/U$</th>
<th>$p$</th>
<th>$d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. categories</td>
<td>3.08 (2.14)</td>
<td>4.36 (1.71)</td>
<td>414</td>
<td>.007**</td>
<td>.66</td>
</tr>
<tr>
<td>% Perseverative errors (T score)$^a$</td>
<td>38.49 (15.89)</td>
<td>36.53 (10.71)</td>
<td>.61</td>
<td>.54</td>
<td>.15</td>
</tr>
<tr>
<td>% Non-perseverative errors (T score)$^a$</td>
<td>46.71 (14.52)</td>
<td>40.72 (9.68)</td>
<td>2.05</td>
<td>.04*</td>
<td>.49</td>
</tr>
<tr>
<td>Failures to maintain set</td>
<td>1.06 (1.02)</td>
<td>0.62 (0.74)</td>
<td>521.5</td>
<td>.13</td>
<td>.5</td>
</tr>
</tbody>
</table>

Note: $^aN$ for the FM group = 35.

$^*p < .05$.

$^{**}p < .001$. 

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Fig. 1 Comparison between performances of patients with fibromyalgia (FM) and healthy controls (HC) across the different blocks of the Iowa Gambling Task (original version-ABCD). Data points represent net scores for each block of 20 trials.

Decision-Making—IGT ABCD Original Version

Data from 34 FM and 34 HC women were entered into these analyses after removal of outliers. The mixed-design ANOVA yielded a significant effect for the “block x group” interaction $F(4, 63) = 2.74, p < .05$. Planned independent-samples $t$-tests for each individual block showed that FM women had significantly lower scores on block 3 $t(66) = -2.57, p = .01, d = 0.63$ (Fig. 1). We found no significant differences for the remaining blocks of the task. We also conducted separate repeated-measures ANOVAs for each group on the “block” variable (learning across trials). Results showed a significant effect of “block” for the control group $F(4, 33) = 2.58, p < .05$, but not for the FM group $F(4, 33) = .69, p = ns$. As illustrated in Fig. 1, these results indicate that there is a learning curve in the HC group (especially for blocks 1–3), but it is flat in the FM group. No significant differences were found in the total net score $t(66) = -0.68, p = 0.51$.

Decision-Making—IGT EFGH Variant Version

All participants (36 FM and 36 HC women) entered this analysis. The mixed-design ANOVA showed no significant effects of block $F(4, 67) = .50, p = ns$; group $F(1, 70) = .18, p = ns$; or the “block x group” interaction $F(4, 67) = .50, p = ns$ in this task (Fig. 2). No significant differences were found in the total net score either $t(70) = .42, p = .50$. 

Correlations between Self-Reported Pain Experience and Neuropsychological Performance

We found significant correlations between self-reported pain intensity and WCST number of categories $r(n = 72) = -.23, p = .03$ and IGT block 3 net score $r(n = 68) = -.25, p = .02$, and between self-reported pain interference and WCST number of categories $r(n = 72) = -.25, p = .02$ and IGT block 3 net score $r(n = 68) = -.25, p = .02$. We found no significant correlations between self-reported pain variables and other neuropsychological indices. Correlations between affective distress and neuropsychological indices were also non-statistically significant: WCST number of categories $r(n = 72) = -.20, p = .09$, WCST percentage of perseverative errors $r(n = 72) = .13, p = .29$, IGT block 3 net score $r(n = 68) = -.09, p = .22$.
Correlations between Personality and Clinical Variables and Neuropsychological Performance in the FM Group

We found significant correlations between the WCST number of categories and the TCI-R subscale of persistence, and between WCST percentage of non-perseverative errors and the TCI-R subscale of reward dependence. For gambling tasks scores, EFGH IGT net score was significantly correlated with TCI-R indices of persistence and reward dependence, whereas this task was related to novelty-seeking in controls. Importantly, we found no significant correlations between affective distress and neuropsychological performance (Table 4). For clinical variables, we only found significant relationships between the global net score of the EFGH IGT and years since diagnosis \(r(n = 36) = .40, p = .01\); and between EFGH IGT and duration of pharmacological treatment \(r(n = 36) = .34, p = .04\).

Discussion

The main finding of this study is that patients with FM showed poorer cognitive performance on measures of abstraction and distractibility (number of categories and percentage of non-perseverative errors on the WCST), and emotion-based decision-making (original IGT). Self-reported pain intensity and pain interference were significantly associated with WCST number of categories and block 3 of the original IGT. In contrast, cognitive performance was not associated with measures of negative mood (i.e., affective distress) or duration of pharmacological treatment, and very mildly associated with personality characteristics.
In the WCST, FM patients performed poorer than controls on the indices of number of categories and percentage of non-perseverative errors (showing medium effect sizes) but not on percentage of perseverative errors. Groups did not differ on failures to maintain set but FM women had more errors, a pattern reflected by a medium effect size. The WCST is a multi-component task that simultaneously taps on rule detection, flexibility, and working memory skills. Lower number of categories indicate compromised rule detection, whereas increased non-perseverative errors and failures to maintain set are related to increased distractibility (Kaplan et al., 2006), which has been previously reported in FM patients (Leavitt & Katz, 2006). In contrast, FM patients seem to have preserved flexibility, as revealed by non-significant differences on the perseveration index. Some of our results stand in contrast with those of Suhr (2003), who found no differences between FM patients and controls in several WCST indices. Both studies failed to show significant relationships between mood ratings and WCST performance. In addition, Suhr did not find correlations between fatigue and WCST scores. Therefore, it is likely that other differences in sample composition, for example gender distribution (the Suhr sample included 9% of men in the FM group, 19% of men in the control group), education (the Suhr sample had higher years of education), or FM pain severity (the Suhr study employed a different measure of pain experience) could account for discrepancy of findings. For example, Park and coworkers (2001) found that ratings of pain functional affect were negatively correlated with performance on executive function measures, thus supporting the role of pain intensity on disruption of executive skills. In a similar vein, Karp and coworkers (2006) demonstrated a significant association between pain intensity and executive dysfunction in a sample of older adults. Another possibility is that there could be different subtypes of FM with different patterns of neurocognitive deficits. This is true, for example, of several other conditions, such as substance abuse (Bechara, Dolan, Hindes, 2002) and schizophrenia (Beninger, Wasserman, Zanibbi, Charbonneau, Mangels, & Beninger, 2003). These findings emphasize the importance of more research aimed at characterizing different clinical conditions, such as FM, in terms of neurocognitive criteria as well, which may prove critical for designing more effective strategies for treating or managing the condition.

Patients with FM also showed altered ability to make advantageous choices on an emotion-based decision-making task. FM women had altered learning curve in the original IGT, which was reflected by significantly lower scores on block 3, considered to be the “hunch period” of the task (Bechara et al., 1997), and lack of significant learning across the five blocks of the task. The lack of significant differences on blocks 4 and 5 (“conceptual period”) is probably due to a decrement of performance in the control group, but not to increased learning in the FM patients. Importantly, the drop in controls’ performance does not imply that they are impaired on blocks 4 and 5, because they stay within adaptive scores (above 0). These results suggest that FM patients are less able to develop an advantageous decision-making strategy in the IGT. One previous study demonstrated that pain intensity negatively affected IGT performance in chronic back pain patients (Apkarian et al., 2004). Considering that pain ratings in FM are higher than in other chronic pain conditions (Boissevain & McCain, 1991), it is reasonable to speculate that in FM patients pain intensity can interfere with the development of the somatic markers necessary for adaptive decision-making. We reason that the potential interference of these pain signals would particularly affect the “hunch” phase of the task, where preferences are more based on emotional signals than on conceptual knowledge. This is supported by the specific correlation between ratings of pain affect and block 3, which did not appear for the other blocks or the total net scores. This is consistent with neuroimaging evidence showing that chronic pain can compete with other cognitive and affective processes for the recruitment of brain regions involved in emotion processing and decision-making (Baliki et al., 2006). Furthermore, a recent functional magnetic resonance imaging study has shown that FM patients have more prolonged insular activation to pain stimulation (Deus et al., 2006); the insula is a key area for development of emotional signals according to the somatic marker model (Bechara et al., 2000). Nonetheless, this point should be taken with caution, because we did not directly test this hypothesis in the current study; future studies in FM patients should include pain intensity assessments during actual decision-making performance to clarify this issue.

In the variant version of the IGT, FM patients showed adaptive performance similar to that of controls. Although within-groups analyses showed no significant effect of block, both groups have advantageous performance (above 0) across all blocks of the task. This decision-making pattern (i.e., impaired performance on the original IGT and intact performance on the variant IGT) has been previously interpreted as reflecting hypersensitivity to reward, coupled with a relative insensitivity to punishment (Bechara et al., 2002). Hypersensitivity to reward in FM patients might reflect the fact that they are craving for reward to compensate for chronic pain. In support, one recent study has demonstrated reduced presynaptic dopamine uptake in the limbic system of FM patients (Wood, Patterson II, Sunderland, Tainter, Glabus, & Lilien, 2007), which is consistent with a reward deficiency. Interestingly, performance on the variant IGT was positively correlated to higher scores on personality indices of persistence and reward dependence in FM patients but not in controls (indeed, the control group performance in this task was associated with novelty-seeking). Although there is not a straightforward relationship between these personality dimensions and cognitive performance on reward-based tasks, this correlation points to a specific link between personality variables and reward-based choices in FM patients that should be addressed in future studies.
To summarize decision-making findings in the original IGT, FM women showed altered learning curve. Furthermore, in a variant version of the IGT, FM women showed a preference for decks that yielded higher immediate punishment coupled with higher delayed reward. Hence, similar to controls, FM patients were able to tolerate increased punishment in order to obtain higher reward in this variant IGT task.

Poorer cognitive performance can be due to several manifestations of the FM syndrome, including mood alterations, sleep problems, fatigue, side effects of medication, pain intensity, and personality characteristics. In our study, we specifically addressed the influence of self-reported pain experience and personality variables. We showed a significant association between higher self-reported pain intensity and pain interference and poorer performance on two of the cognitive indices that discriminated between groups. Previous research has also demonstrated that pain intensity is significantly associated with executive deficits in chronic pain disorders (Apkarian et al., 2004; Park et al., 2001). Therefore, pain intensity seems to be an influential variable for cognitive alterations in FM. However, future studies should further analyze the affect of acute pain intensity during actual cognitive performance (see Apkarian et al., 2004) and brain-related activation (Deus et al., 2006). On the other hand, we found very mild correlations between a number of personality indices and cognitive performance in FM women. In this case correlations were positive, suggesting that certain personality traits are associated with enhanced performance in cognitive measures. In addition to personality, results show that negative mood or effort (at least on the WCST) are not significantly related to cognitive performance in this sample. Previous studies have also ruled out a significant association between mood or fatigue and executive functioning in FM (Apkarian et al., 2004; Park et al., 2001; Sühr, 2003). We have also shown that cognitive performance is not related to the duration of pharmacological treatment in our FM patients, although the effect of treatment itself was not examined, and we acknowledge that this constitutes an important limitation of this study. Some of the drugs prescribed for FM have potential affect on cognition, and the fact that the control group had specific exclusionary criteria concerning medication emphasizes this limitation. Nonetheless, post hoc analysis splitting the FM group into medicated versus non-medicated women did not show discrepancies in cognitive performance (data not shown). In any case, future studies should address this confound. It is also important to determine if the observed cognitive alterations are characteristic of FM or common to different central or peripheral pain conditions. Hence, due to the limitations of the current design, we cannot determine the underlying substrates of the cognitive patterns reported. However, the current study should provide a basis for pursuing all these important questions in future studies. It is possible that these clinical variables, which we did not assess, play key roles in determining the patterns of neurocognitive alterations observed in FM patients. In turn this may help explain and reconcile inconsistent findings reported in earlier studies.

Funding

This study was supported by internal funds from the Institute of Neurosciences F. Olóriz, Universidad de Granada, Granada, Spain.

Conflict of Interest

None declared.

References


