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The role of cognitive content and cognitive processes in chronic pain: An important distinction?

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Abstract

Pain-related cognitive content (*what* people think about pain) and cognitive processes (*how* people think about pain; what they do with their pain-related thoughts) and their interaction are hypothesized to play distinct roles in patient function. However, questions have been raised regarding whether it is possible or practical to assess cognitive content and cognitive process as distinct domains. The aim of this study was to determine the extent to which measures that appear to assess mostly pain-related cognitive content, cognitive processes, and content and process, are relatively independent from each other and contribute unique variance to the prediction of patient function. Individuals with chronic low back pain (N=165) participating in an ongoing RCT were administered measures of cognitions, pain, and function (depressive symptoms and pain interference) pre-treatment. Analyses provided support for the hypothesis that cognitive content and cognitive process, while related, can be assessed as distinct components. However, the measure assessing a cognitive process – mindfulness – evidenced relatively weak associations with function, especially compared with the stronger and more consistent findings for the measures of content (catastrophizing and self-efficacy). Moreover, the results provide preliminary evidence for the possibility that mindfulness could have both benefits and costs. Research to evaluate this possibility is warranted.

Keywords

Cognitive content; cognitive process; chronic pain

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Introduction

Cognition – that is, mental processes, thoughts and images – has been shown to play an important role in adjustment to chronic pain[1,2]. Traditional cognitive therapy approaches seek to help patients change thoughts in order to change behavior[3]. So-called "third generation" approaches encourage acceptance and mindfulness of thoughts by encouraging a "witnessing" stance toward the content of thoughts. In this approach rather than attempting to reduce the number and frequency of "negative" or "maladaptive" thoughts, the therapeutic focus moves from *what* the patient thinks (i.e., beliefs about their pain and its impact) to *how* they regard the thoughts (i.e., understanding that their thoughts are events that pass in awareness[1,2,4]). Redirecting focus from the content of thoughts ("The pain is going to get worse") to the cognitive process itself ("This is just a thought") appears to have clinical utility[5] and is hypothesized to reduce the impact of thought on behavior and function[6].

The distinction between different types of cognitions and cognitive processes is not new to psychology. Almost 40 years ago, John Flavell drew the important distinction between cognitive phenomena and knowledge and cognitions about those cognitive phenomena, referring to the latter as metacognition.[7] Thus, the type of thought (i.e., a thought about pain specifically or a thought about that thought – a metacognitions) could influence a patient's emotional and behavioral response. For example, if the focus of attention is on a specific pain related thought such as "this pain is ruining my life," distress is maintained. On the other hand, if the individual is provided with ideas for alternative thoughts, such as metacognitions which are more affect neutral (e.g., "this is just a thought"), distress is reduced. These two type of cognitions (i.e., thoughts about pain and metacognitions regarding those thoughts) are both examples cognitive *content*. The process of shifting the focus of attention from one thought to another is an example of a cognitive *process*.

This distinction between cognitive content and process may be made even clearer with the use of a metaphor. That is, if one's goal is to eat the correct portions of healthy foods, one can achieve this goal in at least two different ways: (1) by making changes in the *content* of one's pantry (i.e., what is most easily accessible to eat) or (2) by making changes in *what one does with* that content (i.e., choose mostly the healthy options among the foods that are available and/or limit the amount that one eats). Thus, to the extent that cognitions influence function, in order to change function, we could either make changes in the content of our cognitions (i.e., thoughts about pain or metacognitions about those thoughts) or in what we do with our cognitions (e.g., ignore them, select the most useful ones to focus on, accept them without judgement, etc).

Both content and process remain within the field of cognition however, and determining whether or not it is empirically possible to assess cognitive content as at least somewhat distinct from cognitive process remains an important question. If content and process are strongly linked empirically, then the clinical utility of separately evaluating these factors can be called into question. Instead, measures could simply identify the cognitions that play the most important roles in patient function (e.g., self-efficacy beliefs, catastrophizing cognitions), and clinicians can seek to alter these with specific treatment techniques. If, on the other hand, empirical distinctions can be made between measures of cognitive content and cognitive processes and those measures are found to be valid, this would allow us to empirically evaluate theories about the relative importance of these factors as predictors of patient adjustment. Such measures would also facilitate our ability to evaluate the validity and utility of models that draw distinctions between cognitive content and process[8,9]. If supported, these models have the potential to refine our options for pain treatment.

In short, the ability to determine if therapeutic maneuvers which target cognitive processes over content actually impact cognitive process separately from content requires that it be possible to assess process and content as at least somewhat distinct domains. However, most of the measures of pain cognitions used in pain research have items that include some elements of both content and process (e.g., ruminating about, ignoring, or suppressing *what*?)[10]. Similarly, it may not be possible to assess cognitive content without referring to some process because any question about a thought that can be rated must involve a process (e.g., one must "believe", or "think", or "focus" or "have" the thought).

Items from the widely used measure of pain catastrophizing (PCS)[11] provide one example of this problem, in that the PCS includes items that assess *both* cognitive content and cognitive processes. Four of the items on the PCS Rumination scale not only ask respondents to reflect on the process of their thinking (e.g. "I *keep thinking* about how much it hurts" and "I *keep thinking* about how badly I want the pain to stop" [italics added]) but also the content of their thoughts (e.g., "…how much it hurts" or "…how badly I want the pain to stop"). Many of the other PCS items appear to measure mostly (negative) cognitive content (e.g., "It's awful and I feel I can't stand it anymore").

A second measure commonly assessed in pain research assesses pain self-efficacy, often measured using the Pain Self-Efficacy Questionnaire (PSEQ;[12]). The PSEQ items ask respondents to indicate their level of confidence in their ability to engage in activities despite pain on a 0 ("Not at all confident") to 6 ("Completely confident") scale. However, unlike the PCS, the PSEQ items appear to measure mostly cognitive content; none of the PSEQ items appear to include text about cognitive processes. However, the act of evaluating one's *confidence* in coping with pain could potentially be viewed as a type of cognitive process. Thus, even though the PSEQ items clearly reflect "mostly" specific cognitive content (i.e., beliefs about pain self-efficacy), the PSEQ scale score may also reflect an evaluation of confidence in those thoughts (i.e., a "thought about a thought", also known as a meta-cognition[13,14]) that is the result of a cognitive process.

A third cognitive domain that is of increasing interest to pain researchers and clinicians is mindfulness[6,15]. A common measure that has been used to assess mindfulness in general is the Five Factor Mindfulness Questionnaire (FFMQ;[16]). The FFMQ items are designed to assess five separate but related components of mindfulness, labeled Observing, Describing, Acting with Awareness, Nonjudging of Inner Experience, and Nonreactivity to Inner Experience. Usually, mindfulness (e.g., nonjudgmental acceptance of one's experience) is thought to be a cognitive process variable. However, like the PCS and PSEQ which assess both cognitive processes and cognitive content, some of the items of the FFMQ appear to blur process with content. For example, while the FFMQ item, "When I have distressing thoughts or images, I 'step back' and am aware of the thought or image without getting taken over by it" does appear content valid as reflecting the Nonreactivity mindfulness domain, it also refers to cognitive content (i.e., "…distressing thoughts or images").

In sum, an examination of the specific items of three measures of cognitions suggests that: (1) the PSEQ might be viewed as assessing "mostly" content; (2) the FFMQ assesses "mostly" process; and (3) the PCS items appear to reflect both process and content. Whether or not these *apparent* distinctions in what the PSEQ, FFMQ, and PCS measure are ultimately important at a practical level remains to be seen. That is, even though on the surface it appears easy to make distinctions between items and measures that assess mostly cognitive content, mostly cognitive process, or a combination of content and process, it is not yet clear if these differences matter – for example, if measures of cognitive content and cognitive process account for unique and independent variance as predictors of patient functioning. As discussed previously, however, the answer to this question has important theoretical and clinical implications.

Given these considerations, the primary aim of the current study was to determine if assessing cognitive content and process as distinct from one another matters at a practical level, as indicated by their ability to predict independent variance in measures of patient function; and if it they do predict independent variance in function, if they predict similar amounts of unique variance, of if one predicts more than the other. Specifically, we sought to determine the extent to which measures that appear to assess mostly pain-related cognitive content (e.g., a measure of self-efficacy, the PSEQ), cognitive processes (e.g., a measure of mindfulness, a short form version of the FFMQ), and both content and process (e.g., a measure of catastrophizing, the PCS), are relatively independent from each other and contribute unique variance to the prediction of patient function. If cognitive content and processes are empirically distinct, then we would expect four findings to emerge with respect to these measures. First, using an exploratory factor analysis, the items from the three scales should cluster into separate domains which are distinct from one another. Second, the measure representing mostly cognitive content (the PSEQ scale score) and the measures representing primarily cognitive processes (the FFMQ scale scores) should be relatively weakly correlated with one another. Related to this second hypothesis, we would also expect that while the measure assessing both content and process (PCS) might be distinct from the other measures, it would also be expected to have stronger associations with both the PSEQ and FFMQ scales than the latter two measures have with each other. Third, the measures of pain self-efficacy, mindfulness, and catastrophizing should evidence significant and unique associations with measures of patient function (pain interference, depressive symptoms) when controlling for the other measures. Finally, we also sought to explore whether the three measures assessing cognitive content and processes interact with each other in the prediction of patient function, as hypothesized by theoretical models which argue that cognitive processes influence the impact of beliefs on function[1,6].

Methods

Participants

Participants (N=165) were individuals recruited for a large and ongoing RCT that will examine the mechanisms of psychosocial pain treatments for low back pain. The questionnaire and demographic information reported herein was collected from participants during a baseline assessment session prior to participants' randomization to one of the treatment conditions. Participants were recruited through referrals from staff at the University Pain Center, Midwest Orthopedic Clinic and Neurosurgery Clinic at Rush University Medical Center, and at Outpatient Clinics of the Duke University Medical Center. All procedures were approved by the respective IRBs at the Rush and Duke sites. Inclusion criteria were: (1) significant daily chronic pain intensity (at least 4 on a 10-point scale; see below) and interference in performing daily activities due to pain (at least 3 on a 6-point scale; see below) for at least 6 months; (2) musculoskeletal pain of the low back and/or leg pain that may be related to history of degenerative disk disease, spinal stenosis, or disk herniation (radiculopathy subcategory), or muscular or ligamentous strain (chronic myofascial pain subcategory); and (3) age between 18 and 75 years. Exclusion criteria were: (1) met criteria for alcohol or substance abuse problems; (2) met criteria for past or present psychotic or bipolar disorders; (3) inability to understand English well enough to complete questionnaires or to participate in therapy; (4) active suicidal ideation with intent; and (5) pain due to malignant conditions (eg, cancer, rheumatoid arthritis), migraine or tension headache, or complex regional pain syndrome.

Inclusion and exclusion criteria were assessed by review of medical records by study physicians and a brief psychosocial history – including administration of relevant items from the Mood Disorder, Psychotic Screening and Substance Use Disorders Modules of the Structured Clinical Interview for DSM-IV Axis I Disorders - Non-Patient Edition (SCID-IV/NP[17]) by study research assistants. Table 1 presents descriptive statistics for the demographic information and the questionnaire measures used in this study. As can be seen, the mean age of the study sample was 53.15 years, and women (57%) comprised approximately half the sample. A plurality of the sample were Black (48%), with White-Non Hispanic (32%) and White-Hispanic (13%) making up most of the remainder. The majority of the sample (59%) reported that they had pain primarily in their low back.

Measures

Pain and function criterion measures: Pain intensity, pain interference, and depression—Pain intensity was measured with a 0–10 numerical rating scale of average pain for the past week[18]. The Pain Interference Subscale of the West Haven-Yale Multidimensional Pain Inventory[19] was used to assess disruption in ability to perform typical daily activities. The Cronbach's alpha for the pain interference items collected in our sample was 0.91. Depressive symptoms were assessed with Center for Epidemiologic Studies–Depression Scale short form (CESD;[20]). The Cronbach's alpha for CES-D items collected in our sample was 0.81.

Cognitive content and cognitive process—Cognitive content was assessed with the Pain Catastrophizing Scale (PCS;[11]). The Cronbach's alpha for PCS items collected in our sample was 0.93. The Pain Self-Efficacy Questionnaire was also used to assess cognitive content[12], and the Cronbach's alpha for the PSEQ items collected in our sample was 0.93. Cognitive process was assessed with the Five Facet Mindfulness Questionnaire-short form[21]. The Cronbach's alphas for the items collected in the current sample for the Observing, Describing, Acting with Awareness, Non-Judging, and Non-Reactivity subscales were 0.58, 0.71, 0.68, 0.78, and 0.74, respectively.

Data Analysis

We first computed descriptive statistics (means and SDs, or percentages, as appropriate) to describe the sample and the primary study variables. Next, we performed exploratory principal components analyses of the items from the three study scales, to test the hypotheses that the items from the three scales would load on distinct factors. We used an oblique rotation, because we anticipated that the cognitive domains assessed by the PSEQ, PCS, and FFMQ would evidence at least some association with each other. We then computed Pearson correlation coefficients between the study variables to (1) evaluate the associations among the cognition variables (PSEQ scale score, PCS total score, FFMQ scales scores) in order to test the hypothesis that these coefficients would be relatively weak and (2) examine the zero-order relationships between the cognition predictor variables and criterion measures (assessing pain intensity, pain interference, and depressive symptoms). Third, we performed regression analyses for each of the pain intensity, pain interference and depressive symptoms criterion variables with the PSEQ, FFMQ, and PCS scale scores as predictor variables entered simultaneously. These analyses were intended to examine unique and shared variance of the predictor variables. Finally, to explore whether cognitive content and cognitive process interact to predict the criteria variables, we conducted a series of additional hierarchical regressions. First, we tested whether PSEQ and the five FFMQ factors interacted as predictors of each of the criterion measures by entering the (centered) main effect terms in the first step (forced entry) followed by the PSEQ × FFMQ interaction terms (computed by multiplying PSEQ and FFMQ factor scores) in the second step[22]. Second, we tested whether catastrophizing and mindfulness interacted using the same procedures. In the event of significant interactions, the procedure described by Preacher, Curran, and Bauer[23] for dissecting interaction terms for two continuous variables was used.

Results

Description of the study variables and assumptions testing

The means, standard deviations, skewness, and kurtosis of the study variables the all of the study variables are presented in Table 2, as are their correlation coefficients. As can be seen, none of the distributions were substantially skewed (skewness range, −0.88 to 0.54) or kurtotic (range, −0.89 to 0.21). Moreover, none of the correlation coefficients among the predictors we planned to enter into the regression analyses (PSEQ total score, PCS total score, and FFMQ scale scores) had absolute values that were equal to or larger than .70 (*r*s range, −.55 to .37; results of correlations presented in Table 3), indicating that multicollinearity would not bias the regression results[20]. The strongest associations were between the PCS and PSEQ total scores ($r = -.52$) and the PCS total score and the FFMQ Non-Judging scale score ($r = -.55$). In short, the variables met all of the assumptions required for the principal components analysis and regression analyses.

Principal Components Analysis

Using the Kaiser criterion, the scree test, and interpretability of the PCA results, seven factors emerged from the principal components analysis of the FFMQ, PCS, and PSEQ items, which accounted for 63% of the total variance in the items. The structure matrix resulting from this analysis is presented in Table 2. As can be seen, for the most part, the items loaded onto components consistent with what would be expected if each item was representative of the construct it was designed to assess. Specifically, for every item, the largest loading was associated with a component made up of other items on the same scale; the 13 PCS items loaded together on a single component, and all of the loadings were .59 or greater (range, .59 – .85). All 10 of the PSEQ items loaded together on a single component (loadings range, .56 – .88). In addition, the 15 FFMQ items loaded onto five components, consistent with the five original FFMQ scales. These findings also support the decision to score the PCS items into a single total score (assessing catastrophizing), the PSEQ items into a single score (assessing self-efficacy), and the FFMQ items into five subscale scores in this sample.

With respect to whether potential overlap exists between the PCS, PSEQ, and FFMQ items and the domains these items assess, findings suggest little overlap. Among the few exceptions, some overlap was found between the PCS items and the PSEQ component (and vice versa), and between the catastrophizing domain and the FFMQ Non-Judgmental component.

Zero-Order Correlations Among the Study Variables

Results of correlation analyses among the PCS, PSEQ, FFMQ scale scores, pain intensity, WHYMPI Pain Interference and CES-D scores are presented in Table 3. Correlations among the PSEQ and five FFMQ scores were weak to moderate (*r*s range, 0.01 to 0.31). The PCS total score evidenced weak to moderate associations with four of the FFMQ scales (*r*s range = 0.06 to −.30). However, the association between the PCS Total score and FFMQ Non-Judging score was strong ($r = -0.55$). Similarly, the association between the PCS and PSEQ Total scores was strong ($r = -0.52$). Of note, the intercorrelations among the five FFMQ factor scores were low. In general, these results are consistent with results of the principal components analysis, suggesting distinctions among the cognitive content and process domains, and suggesting distinctions among the five FFMQ factor scores.

The PSEQ and PCS scales were related significantly to all three criterion variables, with Pearson correlations ranging from .26 to .58 for the PCS and −.19 to −.58 for the PSEQ. Five of the 15 correlations among FFMQ factor scores and the criterion variables were significant; of note, none of the five FFMQ factor scores were correlated significantly with pain intensity (range *r*'s = −.03 to .10).

Multiple Regressions to Assess Unique and Shared Variance

The results of multiple regressions to assess the degree to which the cognitive variables predicted unique variance in the criterion variables are presented in Table 5. For pain intensity, only the PCS score accounted for a significant portion of unique variance (β to enter = .28 [$p = .007$]). Comparison of the zero-order correlation between PCS scores and pain intensity (*r* = .26; see Table 3) to the semi-partial correlation between these two variables with the other factors controlled (*sr* = .21) suggests that of the variance accounted for in pain intensity by PCS score, little was shared with the PSEQ and FFMQ scores.

For pain interference, the PCS and PSEQ scores accounted for significant portions of unique variance (βs to enter = .25 [p = .003] and −.47 [$p < .001$], respectively), whereas the FFMQ scores did not. Comparing respective zero-order correlations with semi-partial correlations with the other factors controlled, results showed a decrease of *r* = .51 to *sr* = .18 for PCS and a decrease of *r* = −.58 to *sr* = −.39 for PSEQ. These results suggest that much of the variance accounted for in pain interference by PCS scores was shared with PSEQ scores, but not vice versa (i.e., the decrease in variance accounted for when other measures were controlled was larger for the PCS than the PSEQ).

With respect to the prediction of CES-D scores, both the PCS and PSEQ scores made significant unique contributions (βs to enter = .31 [p < .001] and −.25 [p < .001], respectively). In addition, two FFMQ scale scores accounted for significant unique variance in the prediction of depressive symptoms (Acting with Awareness (β to enter = −.19 [p = .004]) and Non-Judging (β to enter = −.15 [p = .033]), with higher mindfulness scores on these scales associated with lower depressive symptoms. Again, comparing the zero-order correlations to the semi-partial correlations, results showed a decrease of *r* = .58 to *sr* = .28 for the PCS score, a decrease of *r* = −.50 to *sr* = −.21 for the PSEQ score, a decrease of *r* = −.36 to *sr* = −.17 for the Acting with Awareness score, and a decrease of *r* = −.45 to *sr* = −.12 for the Non-Judging score. These results suggest that much – but not all – of the variance accounted for in depressive symptoms by the cognitive variables was shared across the four variables.

Multiple Regressions to Assess Interaction Effects

The results of the hierarchical regressions performed to test whether PSEQ scores interacted with the five FFMQ factors and/or whether PCS scores interacted with the five FFMQ factor scores to predict pain intensity, pain interference and CES-D scores are presented in Table 6. As can be seen, the PSEQ × Non-Judging interaction predicted significant variance in pain intensity (R^2 change = .03, β to enter = −.18, p = .019). To dissect the interaction, we used the procedure described in Preacher and colleagues[21], which computes slopes for hypothetical PSEQ and Non-judging values that are +1 SD and −1 SD from their means. In addition, we computed a regression equation for each of these values to generate predicted pain intensity values for the four hypothetical scores. Results are depicted in Figure 1. As can be seen, the simple slope for high Non-judging values (+1 SD) was significant (b = −.06; p < .001), whereas the simple slope for low Non-Judging values was not (b = .0004; p > .10). An inspection of Figure 1 reveals that those with *both* high levels of PSEQ scores and high levels of Non-judging values reported the lowest levels of pain intensity.

The PSEQ × Non-Reactivity interaction predicted significant variance in pain interference (R^2 change = .02, β to enter = −.16, p = .012). To dissect and illustrate the interaction, we used the procedures described above. Results are depicted in Figure 2. The simple slope for high Non-Reactivity values (+1 SD) was significant (b = −.06; $p < .001$), as was the simple slope for low Non-Reactivity values (b = −.04; $p < .001$). An inspection of Figure 2 reveals the lowest levels of pain interference among those with high levels of self-efficacy, regardless of the level of Non-reactivity. On the other hand, among those with low levels of self-efficacy, differences in pain interference emerged as a function of Non-reactivity; those endorsing more Non-reactivity reported more pain interference than those endorsing less Non-reactivity.

The PCS × Non-Reactivity interaction predicted significant variance in pain intensity (R^2 change = .03, β to enter = −.30, $p < .001$). The results of analyses to illustrate this interaction are depicted in Figure 3. The simple slope for high Non-Reactivity values (+1 SD) was significant ($b = .09$; $p < .001$), whereas the simple slope for low Non-Reactivity values were not ($b = .02$; $p > .10$). An inspection of Figure 3 reveals that low PCS values and high non-reactivity values predict the lowest pain intensity, and high levels of PCS and high levels of Non-reactivity predict the highest pain intensity.

The PCS × Acting with Awareness interaction also predicted significant variance in pain intensity (R^2 change = .05, β to enter = −.23, $p = .004$). The results of analyses to illustrate this significant interaction are depicted in Figure 4. The simple slope for high Acting with Awareness values (+1 SD) was nonsignificant ($b = .02$; $p > .10$), whereas the simple slope for low Acting with Awareness was significant ($b = .10$; $p > .001$). An inspection of Figure 3 reveals that low levels of PCS and high levels of Acting with Awareness predict high pain intensity, and low levels of PCS and low levels of Acting with Awareness are linked to the lowest pain. High levels of PCS and low levels of Acting with Awareness and high levels of PCS and high levels of Acting with Awareness predict near-identical levels of pain intensity.

Discussion

The findings from the current study provide support for the conclusion that the three measures assessing cognitive content (*what* people think) and cognitive processes (what they *do with* their thoughts) evaluated in this study are empirically distinct. Specifically, we found that (1) items from the three scales designed to assess cognitive content and processes loaded on separate factors in an exploratory principal components analysis; (2) measures whose items reflect primarily cognitive content (the PSEQ, assessing self-efficacy beliefs), cognitive processes (FFMQ scales, assessing five mindfulness domains) and a combination of cognitive content and cognitive process (the PCS, assessing rumination on negative thoughts about pain) were relatively weakly correlated with one another. Moreover, and as predicted, (3) the overlap between the items and scales from cognitive content measure (PSEQ) and the cognitive process scales (FFMQ) was less than that between either of these with a measure assessing a combination of cognitive content and process (PCS); (4) the measures of pain self-efficacy, mindfulness, and catastrophizing evidenced statistically significant relationships with measures of patient function; (5) the measures showed some significant unique relationships with the measures of patient function when controlling for the other measures. These five findings are all consistent with the study hypotheses, and have important research and clinical implications.

Measures of cognitive content and process as psychometrically distinct

Despite the fact that recent models of pain argue that cognitive content can at least theoretically be distinguished from cognitive process[1,6], questions have been raised regarding whether it is possible or practical to attempt to assess these two categories of cognitive activity as distinct from one another[10]. The findings from the current study provide support that such assessment efforts are possible. The cognitive measure that measures "mostly" cognitive content –the PSEQ[12] – was shown to be psychometrically distinct from the multiple mindfulness domains assessed by a measure classified as measuring "mostly" cognitive processes – the FFMQ[16]. Specifically, there was virtually no overlap in item loadings between the PSEQ and FFMQ items in the factor analysis, supporting a marked psychometric distinction between the scale scores derived from these two measures.

Moreover, and consistent with the idea that cognitive measures can exist which assesses both content and process, the factor analysis results indicated that the factor that represented "catastrophizing" not only had all 13 PCS items loading on it, but also had (1) eight of the 10 PSEQ items loading on it (with one of these loadings [−.54] being very strong) and (2) all three of the items on the FFMQ Nonjudging scale loading on it (with one of these loadings as high as .43). These findings of overlap between the PCS scale/items and some of those from both the PSEQ and FFMQ are consistent with the conclusion that the PCS items assess both cognitive content and process – in particular the cognitive process of "judging," as reflected by the FFMQ items with which the PCS is associated. We might have also expected significant loadings between the PCS items and a measure of the cognitive process of rumination, had such a measure been included in the study.

A recent content review of cognitive process measures used in pain research identified eight distinct cognitive process domains that could potentially influence pain and adjustment to pain[10]. At the same time, these authors noted that measures of cognitive processes which both (1) are pain specific and (2) include items not confounded substantially by cognitive content, existed for only a very small subset of these domains. For example, even though the FFMQ assesses five distinct cognitive processes, the FFMQ items assess a tendency to respond mindfully in general, rather than a tendency to respond mindfully to pain or pain-related thoughts in particular. Thus, in order to determine if pain treatments which target pain-related cognitive processes, such as ACT[6], Mindfulness-Based Stress Reduction[24], and Mindfulness-Based Cognitive Therapy[25] are beneficial *because* of their effects on pain-related cognitive processes over and above pain-related cognitive content, measures which assess "mostly" pain-related cognitive processes are needed[10]. The findings from the current study supporting a psychometric distinction between the measures of cognitive content and cognitive processes examined here provide encouragement that the development of such measures is possible.

Cognitive content and process as contributing distinctly to patient function

We also hypothesized that if cognitive content and cognitive could be assessed distinctly – reflecting perhaps distinct effects on patient function – measures of these domains should evidence unique associations with key pain-related pain and function domains when controlling for each other. This hypothesis was partly supported. Consistent with the large body of research showing that both catastrophizing and self-efficacy beliefs play an important role in pain and patient function[26–28], catastrophizing and self-efficacy evidenced significant associations with all three criterion domains (pain intensity, pain interference, depressive symptoms), underscoring their potential importance as treatment targets.

On the other hand, only five of the 15 correlations among FFMQ factor scores and the criterion variables were significant. Indeed, none of the five FFMQ factor scores were correlated significantly with pain intensity (range r's = −.03 to .10). Given the much larger correlations among the measures tapping cognitive content and patient adjustment factors, these findings call into question the relative importance of targeting mindfulness dimensions in the clinical setting. These largely null findings, however, may be due to the FFMQ being a measure of general mindfulness rather than pain-specific mindfulness, in contrast to the pain-specific self-efficacy and catastrophizing, measures we used. There is also evidence that the FFMQ Describe scale items may be misinterpreted by respondents to be referring to how one describes one's experiences *to others* rather than about how one describes inner experiences to oneself (e.g., the item "I'm good at finding words to describe my feelings" could potentially refer to finding words to describe feelings to others, even though the intent of the item is that it refer to how well the respondent describes feelings to themselves[29]). This could also have weakened the associations between the MMFQ Describe scale and function in the current study. These possibilities again raise the issue of the importance of developing valid, reliable, and pain-specific cognitive process measures in order to make it possible to evaluate their role in chronic pain patient function and treatment outcome.

With regard to unique variance contributions, a case for distinction among measures would be strong if the three cognitive measures accounted for substantial amounts of variance in the criterion measures, relative to the shared variance, when controlling for the other cognitive measures. The PCS accounted for significant unique variance in pain intensity, pain interference and depressive symptoms while controlling for the other cognitive measures. The PSEQ also accounted for significant unique variance in pain interference and depressive symptoms while controlling for the other cognitive measures. It should be noted, however, the formerly large zero-order correlation between PCS scores and pain interference decreased to a small semi-partial correlation with the other factors controlled ($r = .51$ to $sr = .18$). This finding suggests that the variance predicted by pain catastrophizing in pain interference was also predicted by the other cognitive factors; most likely pain self-efficacy. With respect to depressive symptoms, both the PCS and PSEQ scores made significant unique contributions, as did two of the FFMQ factors. Again, however, when the original zero-order correlations were compared to the semi-partial correlations, results showed substantial decreases (e.g., $r = .58$ to $sr = .28$ for PCS). These results suggest that much of the variance accounted for in depressive symptoms by the cognitive variables, especially by the mindfulness factors, was shared across the four variables. Thus, on one level, the fact that we found several statistically unique contributions to the prediction of adjustment variables after controlling for the other cognitive variables supports the distinction of, in particular, the PCS and PSEQ. That is, these measures did not predict the exact same variability in the adjustment measures. On another level, particularly for depressive symptoms, cognitive content and process variables predicted a substantial amount of the same variance, implying some degree of a common core underlying content and process.

Cognitive content and process as mechanistically distinct

Although the majority of the study findings are consistent with the study hypotheses, and the measures assessing cognitive content and processes interacted with each other in the prediction of patient function, the nature of the interactions found was not consistent with the study hypotheses. Specifically, they suggest that more mindfulness (as indicated by being more non-judgmental, more non-reacting, and more acting with awareness) did not always buffer or decrease the effects of pain-related beliefs on function. Investigators have hypothesized that by teaching and encouraging mindful responses to pain and pain-related cognitions, the influence of pain and of pain-related cognitions on function can be reduced[1,6]. Thus, rather than teach patients strategies for evaluating and then replacing negative cognitive content with more adaptive content[3], clinicians could teach patients cognitive process strategies (such as acceptance of thoughts and images without a need to judge or react to those thoughts and strategies) which could potentially reduce or eliminate the negative impact of thoughts and images on function. Based on this model, we had hypothesized weaker associations between catastrophizing and self-efficacy scores and the study criterion variables for those scoring higher in mindfulness scales, relative to those scoring lower in mindfulness. The findings that emerged did not support a buffering hypothesis.

In all of the interactions effects that emerged, the "benefits" of mindfulness were not entirely clear. For example, we found a trend for those with higher acting with awareness to report more pain intensity *regardless of how much they catastrophize*; the lowest levels of pain intensity were reported by those who endorsed low levels of both acting with awareness and catastrophizing (Figure 3). In addition, we found that more nonreactivity was associated with a *stronger* association between pain intensity, and pain catastrophizing was not significantly associated with pain intensity among those who endorsed low levels of nonreactivty (i.e., those "reacting" more to their thoughts) (see Figure 4). Moreover, the role of self-efficacy as being negatively associated with pain interference was slightly enhanced – and not reduced, as predicted – with more nonreactivity, although this effect was weak and of questionable clinical significance (see Figure 2). The role that nonjudging plays in the association between self-efficacy and pain intensity was stronger, and perhaps more clinically meaningful, even if the direction of the effect indicating *stronger* (and not weaker) associations between beliefs and outcome was not in the predicted direction (see Figure 1).

As a group, the findings regarding interaction effects raise some very interesting questions with respect to the role that cognitive processes may play in affecting outcomes. Most importantly, they are inconsistent with the hypothesis that more mindfulness reduces the impact of beliefs on pain and function. If anything, they suggest the possibility that being more mindful may increase the positive effects of self-efficacy on pain intensity and pain interference. In addition, the moderating influence of the mindfulness domains on the associations between catastrophizing and the criterion variables suggested that high levels of mindfulness domains could potentially erode positive effects of low catastrophizing or potentially magnify the detrimental effects of high catastrophizing. As emphasized in the limitations section, however, these conclusions should be viewed as tentative and in need of confirmation, given the relatively weak interaction effects and the cross-sectional nature of the study.

Limitations

There are a number of possible explanations for the finding that mindfulness did not weaken the associations between cognitive content and the criterion measures of pain and pain interference. First, it is possible that one or more of these effects might have emerged by chance alone; only 4 of 30 (13%) interaction terms tested were statistically significant. Second, the effect sizes for the significant interactions (R^2 change range, .02 to.05) were all in the weak range[30]. Third, as already mentioned, evidence indicates that some of the items on the FFMQ Describe scale can be misinterpreted by respondents to refer to how they describe their experiences of mindfulness to others rather than themselves[29], which could have weakened potential buffering effects for the Describe scale. Replication of the current analyses, in particular studies with larger sample sizes and perhaps also using alternative measures of mindfulness, would be needed to more definitively evaluate the reliability of the current findings. Importantly, however, the findings raise some interesting (and perhaps counterintuitive) ideas regarding the role that mindfulness plays in the experience of pain; ideas which warrant further investigation.

An important limitation of the current study is the use of a cross sectional design. Thus, it is not possible to draw causal conclusions from the significant associations found. For example, we do not know if the significant negative associations found between the mindfulness domains of acting with awareness and non-judging and the criterion variable of depressive symptoms is due to the beneficial effects of these mindfulness domains on depression, the possibility that depression might suppress these mindfulness domains, that mindfulness and depression have little influence on each other and that association found is due to some third confounding variable that influences both, or some combination of these possibilities. Experimental or clinical trial research where mindfulness is targeted and manipulated to both (1) identify significant effects on pain and function and (2) determine that the benefits of treatment are due to changes in mindfulness, specifically, is needed to evaluate causal effects. Although there are a large (and growing) number of randomized controlled trials which have demonstrated that training in mindfulness can result in improvements in pain[31–33], disability[25,31,32], and psychological function[33,35], relative to control conditions, relatively few studies have examined the extent to which these improvements were due to changes in mindfulness per se, and if so, which mindfulness domains play the most important role(s). In a trial comparing Mindfulness-Based Stress Reduction (MBSR) to an attention control condition in individuals with fibromyalgia, pre- to post-treatment increases in a measures of mindfulness were shown to be significantly associated with pre- to post-treatment improvements in a variety of outcomes for both the MBSR and attention control conditions (i.e., the improvements were not specific to MBSR; [35]). In another MBSR trial, Baer and colleagues[36] reported that early-treatment changes in mindfulness during MBSR were related significantly to pre- to post-treatment changes in stress among a sample that included people with chronic pain. Also, some researchers have identified changes in "pain acceptance" and "psychological flexibility" as mediators for at least some of the benefits of improvements that have been found with Acceptance and

Commitment Therapy[37,38]. However, the measures assessing these pain acceptance and psychological flexibility in these studies contain items which assess factors other than (and in addition to) cognitive processes. These promising findings, when considered in light of the current results indicate that more research to examine the mediating effects of mindfulness and other cognitive processes in treatment outcome is warranted.

Another limitation is the possibility that the mental skill required to usefully (clinically) or meaningfully discriminate between cognitive content and process may require some practice on the part of the patients and non-psychologically oriented clinicians. Thus, as the participants in this study were not (yet) treated, asking someone naïve to the notion of ‘watching’ their thoughts (as opposed, implicitly, to being caught in their content) to report on this distinction may be more (or perhaps only) meaningful after some instruction and practice. Thus, it would be useful to examine the extent to which significant interactions that emerge with baseline data replicate in the same sample of patients after treatment, especially after treatment that teaches patients skills in mindfulness.

Finally, it should be noted that these analyses used baseline data from an ongoing clinical trial that had specific inclusion and exclusion criteria. The nature of the participants in terms of ethnicity (e.g., 32% White, Not Hispanic or Latino; 48% Black/African American/ Caribbean) likely differs from the nature of patient groups seen in other clinics or parts of the country. Although we see no theoretical reason why ethnic group would moderate the associations between content/process predictors and patient function, it is possible that this sample possesses unique characteristics that may have influenced the findings in ways that we cannot determine. Thus, it would be important to replicate these findings in other populations. Third, and as already discussed, several factors make us hesitant to conclude that the moderation effects found for mindfulness – effects that were generally inconsistent with the idea that more mindfulness buffers the effects of cognitive content on function –are necessarily reliable. Research to replicate these findings in other populations is needed to evaluate their generalizability and reliability.

Summary and conclusions

Despite the study’s limitations, the findings provide new and important information regarding the potential roles of cognitive content and cognitive processes in adjustment to chronic pain. First, the findings are consistent with the hypothesis that cognitive content and cognitive process, while related, can be assessed as distinct components. These findings mean that it should be possible to determine the relative role that each of these factors play in chronic pain treatment – in particular in treatment designed to target one over the other as a treatment recommendation. The lack of importance of the mindfulness domains in predicting function, especially compared with the stronger and more consistent findings for the measures of catastrophizing and self-efficacy was striking. This finding supports the need to evaluate more closely the role of mindfulness in adjustment to chronic pain – in particular perhaps by using measures of mindfulness that are more pain specific and that are not confounded by items that also reflect cognitive content and coping[10]. In fact, the findings provide preliminary evidence for the intriguing possibility that mindfulness could have both benefits and costs. Research to evaluate this potential phenomena is warranted.

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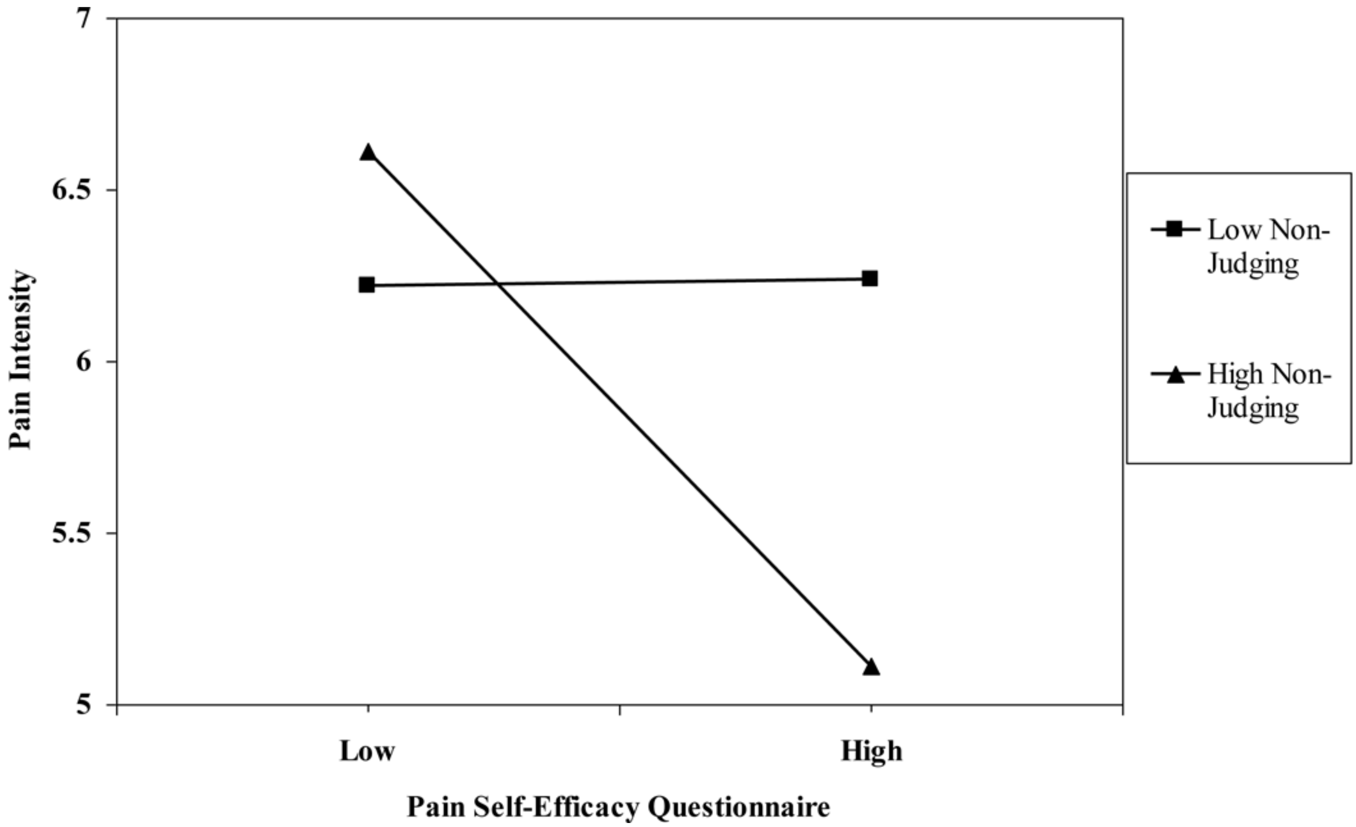

Figure 1.

Graphic representation of the significant Pain Self-Efficacy Questionnaire × Non-Judging interaction effect.

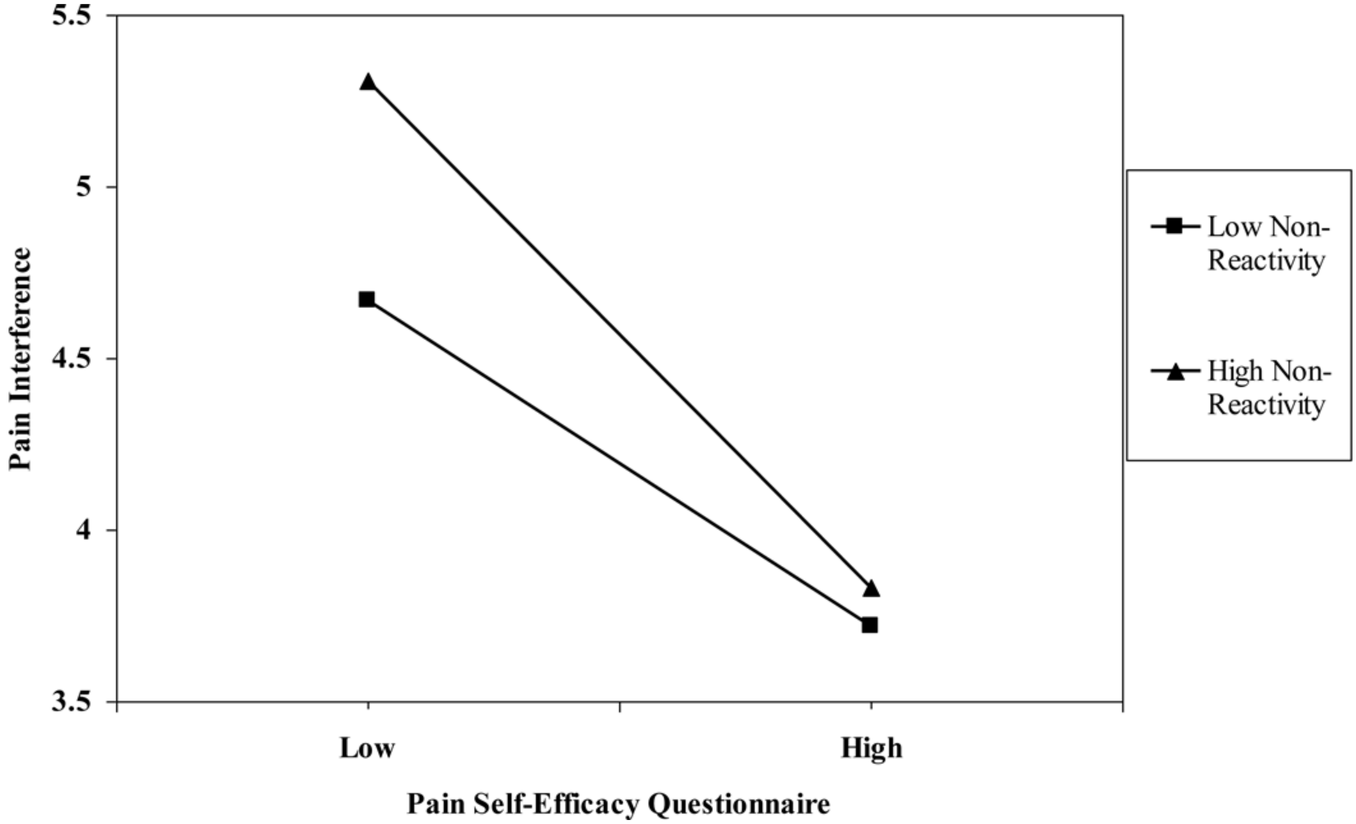

Figure 2.
Graphic representation of the significant Pain Self-Efficacy Questionnaire × Non-Reactivity interaction effect.

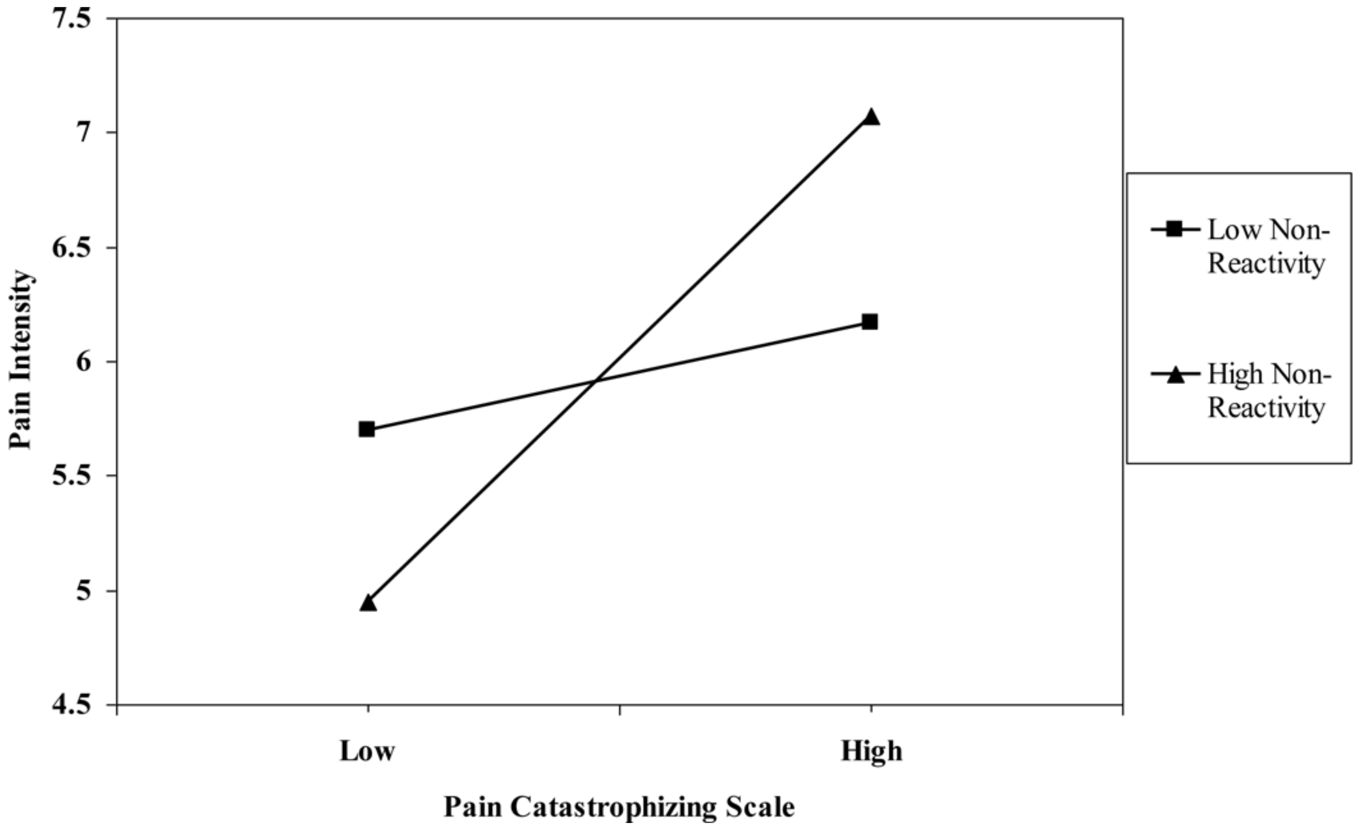

Figure 3.
Graphic representation of the significant Pain Self-Efficacy Questionnaire × Non-Reactivity interaction effect.

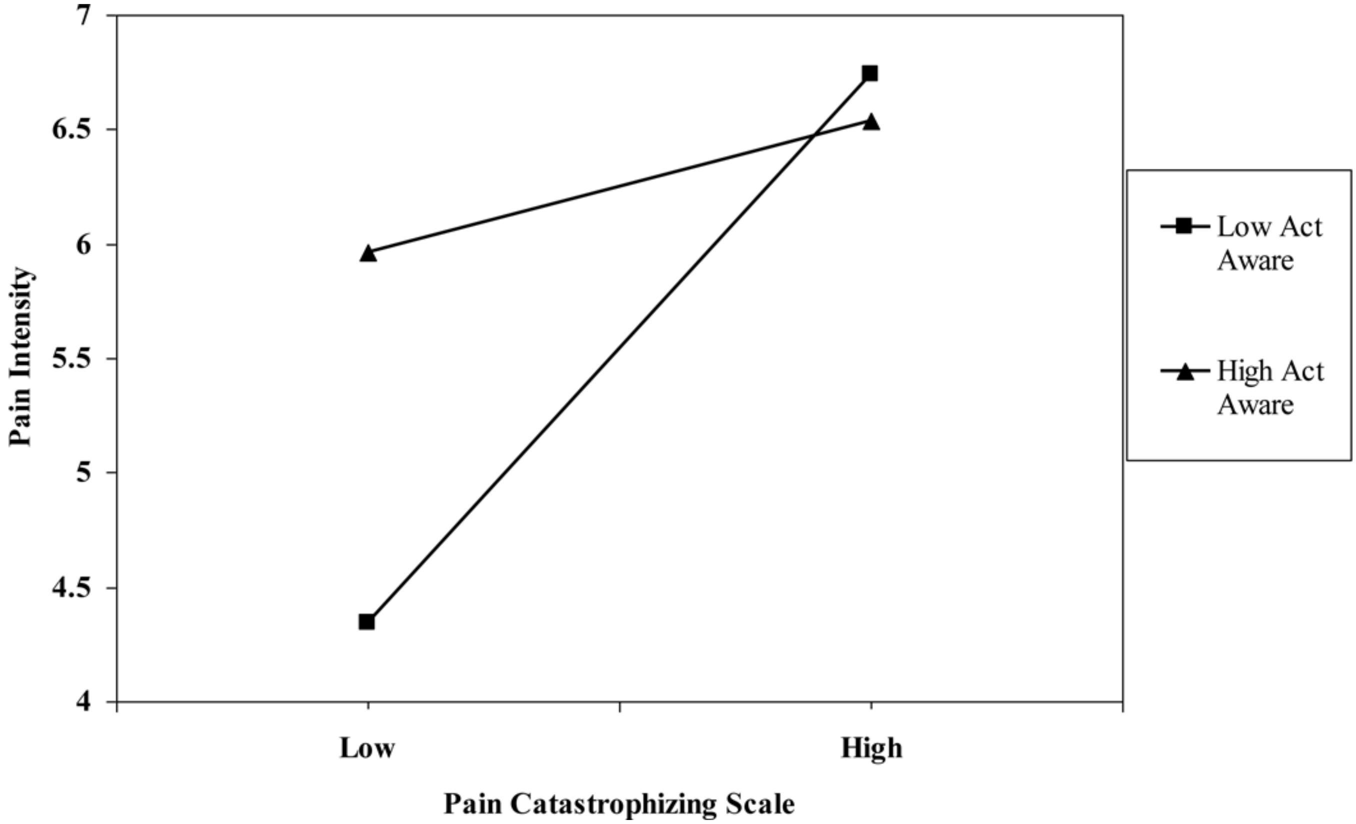

Figure 4.
Graphic representation of the significant Pain Self-Efficacy Questionnaire × Acting with Awareness interaction effect.

Table 1

Demographic variable descriptives.

Variable	Mean (SD)	N (%)
Age	53.15 (10.03)	
Sex		
Men		74 (44%)
Women		96 (57%)
Race/Ethnicity		
Black/African American/Caribbean		82 (48%)
White – Not Hispanic or Latino		54 (32%)
White – Hispanic or Latino		13 (7%)
Asian		4 (2%)
American Indian/Alaska Native		1 (1%)
More than one race/ethnicity		12 (7%)
Other race/ethnicity		4 (2%)
Primary pain location		
Low back		100 (59%)
Leg(s)		17 (10%)
Neck		8 (5%)
Shoulder(s)/Arm(s)		5 (3%)
Abdomen		2 (1%)
Mid back		1 (1%)
More than three sites		36 (22%)

Table 2

Study variable descriptives.

Variable	Mean (SD)	Skew	Kurtosis
Average pain intensity (NRS)	5.98 (2.18)	−0.08	−0.71
Catastrophizing (PCS)	25.92 (12.17)	−0.10	−0.77
Self-Efficacy (PSEQ)	31.90(13.04)	−0.12	−0.89
Non-Reactivity (FFMQ)	9.02 (3.39)	−0.27	−0.77
Act with Awareness (FFMQ)	11.51 (2.51)	−0.51	−0.09
Non-Judging (FFMQ)	12.06 (2.73)	−0.88	0.17
Observing (FFMQ)	9.72 (3.05)	−0.44	−0.28
Describing (FFMQ)	10.96 (2.59)	−0.19	−0.62
Pain interference (WHYMPI)	4.24 (1.15)	−0.68	0.21
Depressive symptoms (CES-D)	15.94 (5.53)	0.54	−0.20

Note: PCS = Pain Catastrophizing Scale; PSEQ = Pain Self-Efficacy Questionnaire; FFMQ = Five-Factor Mindfulness Questionnaire; NRS = 1 – 10 Numerical Rating Scale; WHYMPI = West Haven-Yale Multidimensional Pain Inventory; CES-D = Center for Epidemiologic Studies Depression Scale.

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Table 3

Pearson correlation coefficients among the study variables.

	PCS	PSEQ	FFMQ					NRS	WHYMPI
Scale	Catastro-phizing	Self-Efficacy	Non-React	Act-Aware	Non-Judge	Observing	Describing	Pain Intensity	Interference
Cognition measures									
Self-Efficacy	−.52***								
Non-React	.06	.06							
Act-Aware	−.25**	.13	−.14						
Non-Judge	−.55***	.26**	−.08	.30***					
Observing	.12	.01	.37***	−.13	−.13				
Describing	−.30***	.31***	.14	.28***	.19*	.23**			
Pain intensity	.26**	−.19*	−.03	.06	−.10	.03	.00		
Pain interference	.51***	−.58***	.06	−.13	−.31***	−.16*	−.12	.35***	
Depressive symptoms	.58***	−.50***	.01	−.36***	− .45***	.03	−.33***	.23**	.46***

* p < .05,

** p < .01;

*** p < .001

Note: FFMQ = Five-Factor Mindfulness Questionnaire; PSEQ = Pain Self-Efficacy Questionnaire; PCS = Pain Catastrophizing Scale.

Table 4

Structure matrix: Results of the principal components analysis of the cognitive measures.

Scale and item	Catastro-phizing	Self-Efficacy	Non-React	Act-Aware	Non-Judge	Observing	Describing
PCS 1	**.69**	−.35			−.31		
PCS 2	**.66**	−.36					
PCS 3	**.74**	−.42					
PCS 4	**.80**	−.42					
PCS 5	**.78**	−.36					
PCS 6	**.74**						
PCS 7	**.66**				−.41		
PCS 8	**.70**						
PCS 9	**.78**	−.41			−.32		
PCS 10	**.83**	−.36					
PCS 11	**.85**	−.38					
PCS 12	**.59**						
PCS 13	**.72**				−.32		
PSEQ 1	−**.54**	**.70**					
PSEQ 2	−.42	**.79**					
PSEQ 3	−.43	**.76**					
PSEQ 4	−.45	**.75**					
PSEQ 5		**.73**					
PSEQ 6	−.32	**.80**					
PSEQ 7		**.56**					
PSEQ 8	−.40	**.88**					
PSEQ 9	−.45	**.86**					
PSEQ 10	−.42	**.79**					
FFMQ 5			−**.71**				
FFMQ 10			−**.78**				
FFMQ 15			−**.85**				
FFMQ 3				**.65**	−.34		
FFMQ 8				**.81**			

Scale and item	Catastro-phizing	Self-Efficacy	Non-React	Act-Aware	Non-Judge	Observing	Describing
FFMQ 13				**.85**			
FFMQ 4	.38				**−.85**		
FFMQ 9	.41				**−.79**		
FFMQ 14	.43				**−.75**		
FFMQ 1						**.72**	
FFMQ 6						**.58**	
FFMQ 11			−.37			**.65**	
FFMQ 2							**−.81**
FFMQ 7				.36			**−.71**
FFMQ 12							**−.78**

Note: FFMQ = Five-Factor Mindfulness Questionnaire; PSEQ = Pain Self-Efficacy Questionnaire; PCS = Pain Catastrophizing Scale. Only loading of .50 or greater (bold face) or .30 – .49 are shown.

Table 5

Results of the linear regression analyses predicting pain intensity, interference and CES-D scores from PSEQ, PCS and the FFMQ subscales.

Variable	R^2	R^2 change	*F* change	*B* to enter	p
Pain intensity					
Overall model	.09	.09	2.41*		
Catastrophizing (PCS)				.28	.007
Self-efficacy (PSEQ)				−.09	.330
Observing (FFMQ)				.01	.881
Describing (FFMQ)				.07	.401
Acting with Awareness (FFMQ)				.11	.189
Nonjudging (FFMQ)				.03	.720
Nonreacting (FFMQ)				−.04	.628
Pain interference					
Overall Model	.42	.42	17.05***		
Catastrophizing (PCS)				.25	.003
Self-efficacy (PSEQ)				−.47	< .001
Observing (FFMQ)				.10	.149
Describing (FFMQ)				.08	.260
Acting with Awareness (FFMQ)				.01	.897
Nonjudging (FFMQ)				−.06	.402
Nonreacting (FFMQ)				.02	.718
Depressive symptoms					
Overall Model	.42	.42	17.05***		
Catastrophizing (PCS)				.31	< .001
Self-efficacy (PSEQ)				−.25	< .001
Observing (FFMQ)				−.03	.622
Describing (FFMQ)				−.08	.263
Acting with Awareness (FFMQ)				−.19	.004
Nonjudging (FFMQ)				−.15	.033
Nonreacting (FFMQ)				−.01	.942

Table 6

Results of the hierarchical regression analyses predicting pain intensity, interference and CES-D scores from interactions among PSEQ, PCS and the FFMQ subscales.

Step and Variable	R^2	R^2 change	*F* change	*B* to enter	p
		Pain intensity			
Step 1:	.04	.04	3.37*		
PSEQ				−.18	.025
Non-Judging				−.05	.520
Step 2:	.07	.03	5.39*		
PSEQ × Nonjudging				−.99	.021
		Pain interference			
Step 1:	.35	.35	44.70*		
PSEQ				−.59	.001
Non-Reactivity				.10	.128
Step 2:	.37	.02	4.51*		
PSEQ × Non-Reactivty				−.53	.035
		Pain intensity			
Step 1:	.07	.07	6.23*		
PCS				.26	.001
Non-Reactivity				−.05	.530
Step 2:	.11	.04	6.73*		
PCS × Non-Reactivity				.62	.010
		Pain intensity			
Step 1:	.08	.08	7.65*		
PCS				.29	.001
Acting Aware				.13	.083
Step 2:	.13	.05	8.31*		
PCS × Acting Aware				−1.03	.004

Note: PCS = Pain Catastrophizing Scale; PSEQ = Pain Self-Efficacy Questionnaire; FFMQ = Five Factor Mindfulness Questionnaire.