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Running Head: MEASURING PAIN-RELATED COGNITIVE PROCESSES

The Pain-Related Cognitive Processes Questionnaire (PCPQ): Development and Validation

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Abstract

Objective. Cognitive processes may be characterized as *how* individuals think, whereas cognitive content constitutes *what* individuals think. Both cognitive processes and cognitive content are theorized to play important roles in chronic pain adjustment, and treatments have been developed to target both. However, the evaluation of treatments that target cognitive processes is limited because extant measures do not satisfactorily separate cognitive process from cognitive content. The current study aimed to develop a self-report inventory of potentially adaptive and presumed maladaptive attentional processes that may occur when someone is experiencing pain.

Methods. Scales were derived from a large item pool by successively applying confirmatory factor analysis to item data from 2 undergraduate samples (Ns of 393 and 233).

Results. Items, which were generated to avoid confounding of cognitive content with cognitive processes, represented 9 constructs: Suppression, Distraction, Enhancement, Dissociation, Reappraisal, Absorption, Rumination, Non-Judgment, and Acceptance. The resulting 9 scales formed the Pain-Related Cognitive Process Questionnaire (PCPQ), and scale correlations produced 4 conceptually distinct composite scales: Pain Diversion, Pain Distancing, Pain Focus, and Pain Openness. Internal consistency reliabilities of the 9 scales were adequate (αs $\geq$ .70) to good, and the four composite scales had αs $\geq$ .79. Correlations with pain-related criterion variables were generally consistent with putative constructs.

Conclusions. The developed PCPQ scales offer a comprehensive assessment of important cognitive processes specific to pain. Overall, the findings suggest that the PCPQ scales may prove useful for evaluating the role of pain-related cognitive processes in studies of chronic pain.

Key Words: Cognitive Process, Chronic Pain, Assessment

Introduction

There is now compelling evidence demonstrating that the transition from acute to chronic pain entails complex structural, functional and chemical changes within the brain and central nervous system.(1, 2) Further, there is inherent overlap in the neural networks shared by these changes and cognitive factors.(3, 4) Hence, the interaction between pain and cognitions, including executive attentional function, has become an area of intensive investigation.(4, 5) A number of models hypothesizing an important role for central attentional cognitive processes in pain have been proposed, and include the Fear-Avoidance Model (FAM),(6, 7) the Neurocognitive Model of Attention,(8) the Misdirected Problem Solving Model,(9) and the Psychological Flexibility Model.(10) Stemming from these models, various treatments have been proposed, including exposure, mindfulness and acceptance-based approaches. Jensen and colleagues have proposed a key distinction between two types of cognitions: one representing cognitive *processes* (*how* individuals think about pain) and cognitive *content* (*what* individuals think).(11, 12) While there exist reliable and valid measures of pain-related cognitive content, there has been no systematic work to develop a comprehensive set of pain-specific measures that assess pain-related cognitive processes as distinct from cognitive content.

In a recent review of the measures used in pain research that could potentially be used to assess cognitive processes,(13) we identified that only 9% of retrieved measures provided a un-confounded assessment of cognitive process, and most of these were not pain-specific. Of the processes identified in these measures, results indicated an emerging conceptual framework suggesting six theoretically adaptive processes (distraction, enhancement, dissociation, non-judgment, acceptance, reappraisal), two maladaptive (absorption, rumination) and one process that has been viewed by different theories as either adaptive or maladaptive (suppression). Notably, no pain-specific measure was identified that provides a

un-confounded assessment of absorption, rumination, enhancement or non-judgment.(13) Further, many of the pain-specific measures assessing the other cognitive processes consist of only one or two items, which limits their reliability.

Theoretically, the cognitive process of distraction has been described as "divided attention" and entails diverting attention away from pain by attending to something else; the cognitive process of enhancement is distraction that involves diverting attention to positive thoughts.(4) Suppression consists of diverting thoughts by conscious suppression, and captures a form of cognitive avoidance. In contrast, dissociation (also known as "defusion" in the Psychological Flexibility Model) and reappraisal are ways of attending to pain that either distance oneself from the pain or make the pain more tolerable. Non-judgment encapsulates an open monitoring of experience (or "attention to the present" in the Psychological Flexibility Model), without conceptual overlay in the form of labels such as "good" or "bad". Similarly, acceptance is viewed as the active process of allowing experience to *be* experience, without a need for it to be different. Finally, absorption refers to an intense, hypervigilant intentional or unintentional focusing on pain sensations (emphasized in the FAM), and rumination pertains to an unintentional preoccupation with pain, and is a central tenet in the Misdirected Problem Solving Model.

To various degrees, these nine cognitive processes are emphasized (to a greater or lesser extent, depending on the model) in the extant attentional pain models. However, the lack of a valid and reliable measure of these cognitive process domains limits our ability to test these models and the mechanisms of the treatments stemming from these models. Thus, to evaluate the unique role that these processes play in chronic pain coping and treatment, a valid and reliable measure of pain-related cognitive processes is needed. To address this need, the focus of the current study was to develop a measure with a replicable factor structure that assesses each of the nine cognitive process responses to pain: the Pain-Related

Cognitive Process Questionnaire (PCPQ). We hypothesized that items created for the measure would evidence a 9-factor solution, and that these factors might also load on to a smaller set of composite cognitive process scales. To more closely examine the nature of the PCPQ scales, we also investigated their association with theoretically-relevant, pain-related criterion validity variables.

Methods

Study Design. This study employed a repeated measures online survey across two undergraduate samples. The survey included the initial pool of developed PCPQ items and pain-related validity criterion scales thought to reflect adaptive responses (e.g., measures of perceived control over pain). These pain-related validity criterion scales were expected to be positively associated with the adaptive PCPQ scales (Distraction, Enhancement, Dissociation, Non-Judgment, Acceptance and Reappraisal) and negatively associated with the maladaptive PCPQ scales (Absorption, Rumination). The survey also included validity criterion scales thought to reflect maladaptive responses (e.g., pain catastrophizing, pain interference), which were expected to show the opposite pattern of associations with the PCPQ scales as the adaptive validity criterion measures. Because different theoretical perspectives identify suppression as either adaptive or maladaptive, no *a priori* hypotheses were made regarding this cognitive process.

Sample 1 was recruited from the University of Alabama and sample 2 from the University of Queensland. Participants in both samples completed the online survey, which included the initial pool of developed PCPQ items as well as pain-related outcomes and validity criterion variables. The battery of measures was completed twice by sample 1, approximately one week apart. One other measure of the behavioral inhibition and activation systems in the context of pain was concurrently developed with the data obtained from sample 1 (assessing constructs theoretically distinct from those assessed by the PCPQ

measure developed in the current study), and an article describing that measure is currently under review. The study was approved by the Institutional Review Board at the University of Alabama (sample 1) and by the Behavioural & Social Sciences Ethical Review Committee at the University of Queensland (sample 2).

Item Pool Development. Item development was informed via (1) induction from the domains of pain-related cognitive processes emerging from our content review of coping measures used in pain research (i.e., absorption, dissociation, reappraisal, distraction, suppression, acceptance, rumination, enhancement, and a non-judgmental approach (13)), and (2) deduction from theory that is closely aligned with those identified cognitive processes (e.g., theories underlying cognitive therapy theory for reappraisal, acceptance and commitment therapy for acceptance, mindfulness theory for a non-judgmental approach to pain, as well as the other models described in the Introduction). Each author wrote items designed to tap each domain until approximately 13-17 initial non-overlapping items were developed for each domain. Each item was confirmed by each member of the investigative team to capture a specific cognitive process that was not confounded by cognitive content; the only "content" of the item was specific to pain (e.g., not emotional or social response to pain or beliefs about pain).

The content and structure of these initial items was further refined via communication and consensus among the investigators, resulting in a total of 130 items in the initial item pool. The items were reviewed to ensure that each one was related to pain, did not contain double negatives to avoid confusion, and did not include complex sentence structure or passive/ambiguous language. No reverse scored items were included such that assessment was focused on what the process being assessed *is* vs. what it *is not*. We sought to initially construct scales on the basis of *a priori* item assignment to the nine different cognitive process domains. The readability of the instructions and items was considered in this initial

item development stage, with all measure content and items calculated by the Flesch-Kincaid readability statistics to be at the 3rd grade reading level. A response format indicating degree of endorsement for each pain-related cognitive process was selected to quantify how often individuals engage in each process *when in pain*, which is similar to the response format of the widely used Pain Catastrophizing Scale.(14)

Setting and Participants. The online nature of this research allowed the option for undergraduate participants across both samples to complete the assessment batteries from a location of their choosing. The study advertised that only individuals reporting chronic pain (i.e., pain most days of the month in the last 3-months) or recurrent pain (pain at least four times in the last three months or twice in the past month) were allowed to sign-up to participate. Within Sample 1, a total of 457 undergraduate students were recruited from the University of Alabama subject pool, that consisted of first to fourth year undergraduate students enrolled in psychology courses. Of those recruited, 395 participants completed the Time 1 battery and met the study eligibility criteria (see analysis section), and 393 cases were used to derive the scales after eliminating two cases with all PCPQ item data missing. A subset of these participants did not endorse chronic or recurrent pain, hence these participants were omitted from the planned validity analyses which were conducted with what is referred to henceforth as the 'pain sample' (n = 321; comprised of participants who did endorse chronic or recurrent pain). Of the participants comprising the pain sample, 146 completed the Time 2 assessment battery, and these data were used for the planned test-retest stability analyses. Sample 2 was recruited as a replication sample from the University of Queensland subject pool, which also consisted of first to fourth year undergraduate students enrolled in psychology courses. A total of 246 undergraduates were recruited for participation and 233 completed the Time 1 assessment battery and met the eligibility criteria (see analysis section). These participants (n = 233; 10 of whom did not endorse recurrent or chronic pain) were used

to test the replicability of the model derived from sample 1. Demographic information for the total sample 1 and sample 2, and pain information for the pain sample is presented in Table 1.

[Insert Table 1 about here]

Measures

Demographic and Pain Information. Participant demographic characteristics were gathered from a brief questionnaire that was developed for this research. The demographic variables of interest were race/ethnicity, age, and sex. Participants were asked to provide information pertaining to chronic and/or recurrent pain (utilized for determining inclusion/exclusion for the validity analyses), pain type, pain site, pain duration, and other medical diagnoses.

Pain Intensity. Pain intensity data were collected via the Brief Pain Inventory (BPI).(15) Pain severity scores were obtained from the mean of four items, in which respondents rate their most severe pain, least severe pain, average pain over the past week, and current pain on an 11-point Likert scale ranging from 0 = *No pain* to 10 = *Pain as bad as you can imagine*. The BPI has demonstrated excellent internal consistency and concurrent validity via its associations with other pain instruments in other samples of individuals with pain.(15) The BPI Pain Intensity scale was used as one of the criterion measure in this study, and therefore BPI data were analyzed for the pain sample only; its internal consistency in this sample was adequate (α = .78).

Pain Interference and Depression. Two Patient-Reported Outcomes Measurement Information System (PROMIS) short-form scales were used to assess pain interference and depressive symptoms.(16) The scales consist of 4 items rated on a 5-point Likert scale ranging from 1 to 5 with anchors unique to each construct. Higher scores indicate higher levels of pain interference and depressive symptoms. The PROMIS scales were developed using item-response theory and have been shown to have good construct validity and

reliability.(16) Good internal consistency for the pain interference and depressive symptom scales was demonstrated in the pain sample of the current study (αs = .86 and .89, respectively).

Life Satisfaction. The Quality of Life Scale (QOLS) assesses life satisfaction in several areas.(17) A life satisfaction score was obtained by summing the respondent's ratings on the 7 items rated on a 7-point self-report scale ranging from 1 = *Totally unsatisfying* to 7 = *Completely satisfying*. Total scores range from 7 to 49 with higher scores indicating greater satisfaction. The QOLS taps a unique construct that differs from pain or disability, as demonstrated by its only moderate correlations with distress, and weak correlations with measures of functioning and pain intensity.(17) The QOLS has been demonstrated to be internally consistent, reliable across time, and representative of a single construct.(17) The internal consistency of the QOLS in the pain sample of the current study was good (α = .84).

Pain Catastrophizing. The Pain Catastrophizing Scale (PCS) was used to assess patient report of catastrophic thinking.(14) The total score of the 13-item measure was used, and asks respondents to rate, using a 5-point Likert scale ranging from 0 = *Not at all* to 4 = *All the time*, the degree to which they have certain thoughts and feelings when experiencing pain. The raw scores are summed and higher scores indicate greater use of catastrophic thinking. The PCS has exhibited strong internal consistency, concurrent and discriminant validity, and high test-retest reliability over a 6-week period.(14, 18, 19) Excellent internal consistency for the PCS total score in the pain sample was shown (α = .93).

Activity Engagement & Need for Pain Control. The Chronic Pain Acceptance Questionnaire-8 item (CPAQ-8) was used to measure acceptance of pain.(20) Participants rate the extent to which the eight statements about pain acceptance are true for them on a Likert scale ranging from 0 = *Never true* to 6 = *Always true*, and higher scores indicate greater levels of acceptance. The CPAQ-8 consists of two subscales originally labelled

Activity Engagement and Pain Willingness. However, given a recent evaluation determined that *all* of the item content assessing "pain willingness" reflects a perceived need or desire for pain control (not a willingness to experience pain) it was recommended that the labels Activity Engagement and Pain Control be used by researchers.(21) In the current study, to distinguish the latter scale from other measures of adaptive beliefs assessing perceived control over pain (e.g., (22)), we use the label "Need for Pain Control", which taps a maladaptive approach to chronic pain. The CPAQ-8 has demonstrated adequate-good internal reliability (α = .77 to .89), strong convergent validity, and good concurrent criterion validity.(20, 23) Good internal consistency was found in the pain sample for the current study for the Activity Engagement subscale (α = .81), and internal consistency was adequate for the Need for Pain Control subscale (α = .67).

Pain Control Beliefs. The Survey Of Pain Attitudes (SOPA) was used to assess pain control beliefs.(24, 25) Each of the five pain control belief items are rated on a 5-point scale ranging from 0 = *This is very untrue for me* to 4 = *This is very true for me*. Higher scores indicate greater endorsement of pain control beliefs. The SOPA pain control beliefs scale has been shown to provide a reliable and valid assessment of this domain.(24, 25) In the pain sample, the SOPA pain control beliefs scale showed adequate internal consistency (α = .65).

Procedures. Participants located at both universities learned about the study through the Psychology Subject Pool website, and if they chose to sign up for study participation they were provided access to the online study link. Upon accessing the link (through Qualtrics), potential participants were asked to read a Participant Information Sheet, which informed them about the study procedures and their rights as a participant. If they agreed to participate, they were then asked to complete each of the Time 1 survey questionnaires. At Time 2, one week later, the sample 1 participants were emailed a link to respond to the same assessment battery as that completed at Time 1, minus the demographic and pain questions.

Participants were given course credit and were provided with a debriefing sheet at completion of each survey. Each of the measures in the assessment batteries was presented in a randomized delivery format to control for potential method bias; individual item administration for the PCPQ items was also random, although the items of all other measures were delivered in the order in which they were validated in their respective measures.

Statistical Analyses

Statistical analyses were accomplished with SPSS version 22 and Mplus version 7.4.(26) SPSS was used primarily for assessment of scale reliabilities, whereas Mplus analyses included exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) with weighted least squares mean and variance adjusted (WLSMV) estimation for ordered categorical item data and robust maximum likelihood (MLR) estimation for continuous data (more than five values or ordered categories). MLR corrects the chi-square test and standard errors of parameter estimates for non-normality.(26) Mplus uses all available information for analysis but does eliminate cases when data are missing for an exogenous variable or for an entire case. A few cases were excluded beforehand because they were missing all or most data for the PCPQ items. Mplus handled missing data with full information maximum likelihood (FIML) estimation, whereas analyses with SPSS used listwise deletion. Cases with a completion time of less than 15 minutes were also excluded, as below 15 minutes was more than 2 SDs below the mean time of completion, suggesting a random, or otherwise biased response pattern.

Model fit in Mplus analyses was judged by the chi-square goodness-of-fit test and by fit indices. The goodness-of-fit test provides the statistical significance of the deviation of the model-generated covariance from the actual covariance matrix, but it is sensitive to sample size, because the power to detect differences increases with sample size. Fit indices, which were chosen based on recommendations of Brown (27) and Hu and Bentler,(28) were the

root-mean-square error of approximation (RMSEA) and the comparative fit Index (CFI) for all analyses, and the standardized root mean square residual (SRMR) was computed for MLR analyses. RMSEA ≤ .06 and CFIs ≥ .95 represent good fit, according to the research of Hu and Bentler,(28) but Brown (27) suggests that values of CFI ≥ .90 and RMSEA ≤ .08 are often considered to indicate acceptable fit. An SRMR ≤ .08 is indicative of adequate fit.(27, 28)

Results

Statistical analyses were used first to derive a set of nine PCPQ scales from the initial pool of 130 items and then to evaluate the nine scales in relation to published scales that were deemed relevant to the concurrent validity of the PCPQ scales. The data from sample 1 who had taken 15-minutes or longer to complete the tests (n = 393) were used to construct the PCPQ scales and determine their internal consistency. The data from participants in sample 2 who completed the survey in ≥ 15 minutes (n = 233) were used to investigate replicability of the factor structure. The concurrent validity analyses were conducted only on a subsample of sample 1 participants – the pain sample – which consisted of 321 students (249 women and 72 men), who were predominantly Caucasian (83%), and 18 to 23 years of age (M = 18.84, SD = 0.96). A smaller subset of the pain sample completed the Time 2 assessment battery, and these data were used to examine the one-week test-retest stability of the scales (n = 146); this subsample was mostly female (n = 111), Caucasian (86%), with a mean age of 18.9 (SD = .91).

Derivation of the Nine PCPQ Scales

Because the large number of initial items made Mplus analysis with WLSMV intractable, the item data for the prospective nine scales were split into two parts (5 scales and 4 scales) for separate analyses, and 393 participants were randomly assigned to a derivation sample (N = 194) and a cross-validation sample (N = 199). CFAs with items assigned

according to *a priori* theoretical specification to oblique factors were conducted on the two sets of prospective scales in the derivation sample, and items with low loadings or large cross-loadings were excluded until adequate model fit was achieved. The two models, one with five factors and the other with four, were applied to the data in the cross-validation sample to assess shrinkage, which was deemed reasonable. The two models with a reduced number of items were then combined to form nine factors, and further modifications were made to improve model fit in the full sample (N = 393) until each of the nine scales had 5-6 items. The final nine-factor model fit the data well. Fit indices were respectable (RMSEA = .038, CFI = .95), but the goodness-of-fit test was significant, $\chi^2(1289, N = 393) = 2037.16$, $p < .001$. However, sample 2, was available to assess fit shrinkage in replication. As expected, model fit in replication was reduced, but indices suggested an adequate fit (RMSEA = .046, CFI =.92). The goodness-of-fit statistic was significant, $\chi^2(1289, N = 233) = 1914.65$, $p < .001$.

Table 2 shows items for the nine PCPQ scales with standardized factor loadings from CFAs for the final model with the full derivation sample (sample 1: N = 393) and the replication sample (sample 2: N = 233). Factor correlations ranged from -.39 between Rumination and Enhancement to .89 between Rumination and Absorption in sample 1 and from -.50 between Rumination and Enhancement to .87 between Distraction and Enhancement in sample 2.

[Insert Table 2 about here]

Correlations between the nine scale scores (average item scores) for sample 1 are shown in Table 3, which also gives the means, SDs, and internal consistency reliabilities (α coefficients). The α coefficients in sample 1 had a median of .84 with Rumination having the highest reliability and Acceptance having the lowest. Reliabilities for sample 2 were similar to those in sample 1 and varied from .90 for Rumination to .66 for Acceptance (median =

.84). With the exception of the Acceptance scale, reliabilities were adequate ($\alpha \geq .70$) in both samples, and the Rumination scale had the highest degree of internal consistency ($\alpha = .90$) in both samples.

[Insert Table 3 about here]

Derivation of Composite PCPQ Scales

The nine PCPQ factor scales proved to have adequate psychometric properties for the most part, but correlations between scales were often high, indicating that broader (second-order) factors could be important determinants of scale covariances. Consequently, the nine PCPQ scales were submitted to EFA with MLR estimation and an oblimin rotation, and four factors fit the data very well (RMSEA = 0.00, CFI = 1.00, SRMR = 0.003) and generated a non-significant goodness-of-fit test, $\chi^2(6, N = 393) = 2.18$, $p = .9023$.

Standardized factor loadings from the EFA of the PCPQ scales in sample 1 are shown in Table 4. Based on this analysis, four composite, superordinate scales were constructed. The Pain Diversion scale (M = 2.82, SD = .70, $\alpha = .93$) was comprised of the 17 items from the Suppression, Distraction, and Enhancement scales, and the 12 items from the Dissociation and Reappraisal scales were combined to form the Pain Distancing scale (M = 2.35, SD = .74, $\alpha = .90$). The Pain Focus scale (M = 2.91, SD = .79, $\alpha = .92$) contained the 12 items from Absorption and Rumination, and the Pain Openness scale (M = 2.69, SD = .58, $\alpha = .79$) consisted of the 12 items from the Acceptance and Non-Judgment scales.

[Insert Table 4 about here]

Test-Retest Stability of the PCPQ Scales and Composite Scales

A subsample of the pain sample (n = 146) who repeated the full assessment battery approximately one week following the first administration was used to examine the stability of the scales. The test-retest statistics (correlations and *t*-tests) for the PCPQ specific and composite scales from the pain sample are summarized in Table 5. As shown in these results,

the test-retest stability for eight of the nine specific scales, and three of the four PCPQ composite scales was comparable to the previously validated criterion measures (e.g., the PCS) used in the analyses.

[Insert Table 5 about here]

Criterion-Related Validity of the PCPQ Scales

The validity of the PCPQ specific and composite scales was examined by first computing their correlations with validity criterion measures assessing pain intensity, pain interference, depression, life satisfaction, pain catastrophizing, activity engagement, need for pain control, and pain control beliefs. Zero order correlations are shown in Table 6.

[Insert Table 6 about here]

We hypothesized that adaptive and maladaptive cognitive processes would be associated with respectively better and worse pain-related criterion variables. The adaptive process of Pain Diversion (and associated Distraction and Enhancement scales) was correlated with the criterion variables in this expected direction, and as hypothesized, was significantly correlated with fewer depressive symptoms, lower pain catastrophizing, and higher life satisfaction, activity engagement and pain control beliefs. Although no *a priori* hypotheses were made for Suppression, which also loaded on to the Pain Diversion composite scale, this process emerged as adaptive in these analyses; that is, it was associated with higher life satisfaction, activity engagement, and pain control beliefs, and lower pain catastrophizing. The Pain Distancing domain (and associated Dissociation and Reappraisal scales) was expected to be an adaptive process and was correlated with higher pain control beliefs. The composite Pain Openness scale was hypothesized to be adaptive, however it was not significantly correlated with any of the criterion variables. As expected, the Pain Focus domain was consistently associated with significantly worse scores on all of the pain-related criteria.

The final set of analyses was a series of regression models further examining the relation between the composite scales and the criterion variables, while controlling for pain intensity. The regression findings are shown in Table 7.

[Insert Table 7 about here]

As shown in Table 7, parameter estimates determined that while controlling for pain intensity, the PCPQ Pain Focus scale was associated with significantly worse scores on all of the criterion variables; this is consistent with this domain representing a maladaptive process. The Pain Diversion scale predicted significantly higher activity engagement and stronger pain control beliefs, however it was associated with a higher need for pain control. The Pain Distancing scale significantly predicted variance in activity engagement and pain control beliefs, with higher distancing scores predicting less engagement in activities, but stronger pain control beliefs. The Pain Openness scale was significantly associated with lower pain catastrophizing and need for pain control, and higher activity engagement.

Discussion

The primary purpose of this study was to develop and evaluate scales that could measure cognitive attentional processes theorized by various models to be important in chronic pain. The four PCPQ composite scales – Pain Diversion, Pain Distancing, Pain Focus, and Pain Openness – were found to yield a reliable assessment of *how* individuals think about pain or the cognitive processes individuals typically engage in when they are in pain. The nine scales that assess more specific cognitive processes were also generally reliable and their pattern of correlations with pain-related criterion variables were largely consistent with the putative adaptive vs. maladaptive theoretical conceptualizations. The broad potential clinical and research utility of the scales was demonstrated as items were brief and written at a 3rd grade reading level, thus reducing participant burden and requiring minimal health literacy to comprehend.

The development of a replicable factor structure assessing pain-related cognitive processes suggested by the literature was a key emphasis.(6-10) Hence, a large initial item pool was developed to tap the cognitive processes identified in our literature review.(13) Further, CFAs were conducted across two samples to confirm the replicability of adequate model fit. Results found that not only did the nine-factor solution produce a good fit to data in the derivation sample, but the model also had adequate fit in a replication sample. The findings supported the existence of nine distinct cognitive process responses to pain: suppression, distraction, enhancement, dissociation, reappraisal, absorption, rumination, non-judgment, and acceptance.

Although the scales emerging from the data were distinct, the correlations among subsets of the specific scales were relatively high, and EFA showed that the 9-scales differentially loaded on to four composite scales, all of which demonstrated adequate reliability. The test-retest stabilities for Pain Diversion, Pain Distancing, and Pain Focus were satisfactory; the Pain Openness scale had test-retest stability that was low but not out of keeping with values for several of the comparison scales, such as those from the SOPA and CPAQ-8. We anticipate that the PCPQ composite scales will be most typically used in research and clinical practice, although the individual scales could potentially facilitate more nuanced empirical investigations.

The Distraction, Suppression and Enhancement scales, which can provide a fine-grained analysis of Pain Diversion, involve efforts to shift one's focus to something *other* than the pain, but these processes, while overlapping, are conceptually distinct. Although extant measures combine distraction and suppression,[e.g.,](13, 29, 30) these processes may be differentiated on the basis of the object that becomes the focus of awareness. Specifically, in the process of distraction, the shift of attention is to *anything* other than the pain, whereas suppression entails the intentional *ignoring* of pain, and enhancement is the deliberate

deployment of attention directed towards enhancing the experience of a *positive* thought/experience. Thus, the composite Pain Diversion scale seems to tap the intentional engagement of cognitive processes associated with lessening the attention devoted to pain, or by diverting attention elsewhere. Seminowicz and Davis refer to this as "divided attention" because while one aspect of attention is directed towards non-painful information, pain still demands attention; hence, it is likely rare that pain is completely unattended.(4) These authors state that the success of these cognitive pain diversion processes in coping with pain may be a function of the available, albeit limited, cognitive resources, as well as processing capacity.

Dissociation and Reappraisal comprise the Pain Distancing composite scale. Dissociation involves a change in awareness or conscious experiencing to decrease the intensity of pain by imaginally distancing or separating it from oneself.(13) Similarly, reappraisal is an attempt to change the conscious experience of pain by re-characterizing it as less negative and more bearable. Thus, both scales assess a form of changing one's perception or thoughts about the pain, but differ as to the type of change that is being attempted. In the mechanism of reappraisal, the observed, possibly emotion-eliciting stimulus is reframed into non-emotional terms that are presumably more adaptive – a key strategy of Cognitive Therapy for pain.(31) Essentially, the composite Pain Distancing scale assesses a decentered, rational cognitive process, such that the pain is observed/manipulated as if "from a distance" or separate from self. Thus, this domain may assess a pain-specific form of cognitive defusion (as in the Psychological Flexibility Model),(10) which has also been referred to as reperceiving.(32)

Absorption and Rumination were found to form the Pain Focus domain. Absorption is the immersion of oneself in a single experience, such as pain, and is conceived to be an intentional and perhaps effortful process. On the other hand, rumination has historically been

conceptualized as a maladaptive, automatic process(33) that involves a "tape loop" type of repetitive focus on negative images, thoughts, or experiences, also referred to as worry in the Misdirected Problem Solving Model.(9) The composite Pain Focus scale has items designed to capture cognitive processes that keep attention "locked" onto the pain stimulus. The Pain Focus scale may tap a hypervigilant attentional bias towards pain, which is a key component of both the Misdirected Problem Solving Model,(9) as well as the FAM,(6, 7) and is often assessed using computerized tasks of attentional bias.(34-36) Consistent with this, results indicated that the Pain Focus scale and its Rumination component are strongly related to pain catastrophizing, which has been hypothesized to amplify the pain experience via exaggerated attention biases to sensory and affective pain information.(37) The difference between PCPQ Rumination and the PCS is primarily that the former avoids reference to specific conscious cognitive content and isolates the *process* of rumination, whereas the latter emphasizes the ruminative content and the severity of its emotional aspects.

The fourth composite scale, Pain Openness, is comprised of the Non-Judgment and Acceptance scales, key processes in the Psychological Flexibility Model.(10) Non-judgment encapsulates a relationship to pain devoid of attachment and aversion in the form of categories such as "acceptable" or "unacceptable". The process of acceptance however, may function in parallel to this non-judgmental approach in the sense that acceptance also entails a flexible attention to the pain (just as it is) that is devoid of intellectual ideals of how that experience *should* be. Therefore, although non-judgment and acceptance are theoretically distinct processes, they do appear to share an inherent sense of "staying open to experience", which is consistent with the proposed interconnected nature of these processes within the Psychological Flexibility Model.(10) While results support the use of the Non-Judgment scale emerging from this research, the Acceptance scale and the combined composite scale will need further refinement to optimize internal consistency, stability, and validity. A

potential explanation for the less than optimal stability of response to the Pain Openness items in this study may be that it is possible that without formal training in mindfulness or acceptance-oriented coping skills, these items may lack relevance to the lay person. Critically, the Non-Judgment scale provides the first measure of a core aspect of mindfulness specific to the context of pain.

The correlation analyses provided initial insights into the nature of the scales and demonstrated that the PCPQ scales are distinct from other important measures of responses to pain. Although preliminary, the regression analyses showed that the Pain Diversion, Pain Distancing, and Pain Openness composite scales were associated with variables that are thought to assess adaptive functioning, and therefore could potentially be protective factors facilitating effective adjustment to pain. The Pain Focus domain seems to tap maladaptive attentional processes as it was associated with maladaptive functioning across all of the criterion validity measures. Of each of the criterion measures examined, the PCPQ scales most substantially added to the prediction of pain catastrophizing and pain control efforts, while controlling for pain intensity. Further research is needed to validate the PCPQ scales and to more precisely determine the extent to which the processes are related to adaptive and maladaptive responses to pain.

The present scales, like other similar measures are dispositional, in that they ask the individual to retrospectively report methods of thinking that should predict future pain responding. Experimental pain paradigms are well suited for predictive studies to validate the PCPQ scales, provided that situational measures are developed. Experimental tasks also permit a direct, though somewhat artificial, test of the adaptiveness of the processes that are assessed by PCPQ scales and provide an evaluation of the extent to which the processes occur during episodes of acute pain. Experimental research would also permit studies of the effects of coupling particular processes with specific content.

Limitations

The observed preliminary psychometric properties of the PCPQ were strong; however research is needed to address the limitations of this study and further validate the measure. As is common in measure development research, the current study was conducted within an undergraduate population. Although most participants did report recent pain, as expected, the levels of disability and distress due to pain were lower than is typically found in clinical samples; therefore we cannot determine at this point the extent of the generalizability of the current findings to chronic pain populations. The reliability and validity of the scales within clinical samples needs to be established, as does the treatment sensitivity of the PCPQ scales, particularly in response to treatments designed to target specific cognitive processes. It is possible that the adaptive vs maladaptive nature of the scales might vary as a function of context (i.e., such as the context surrounding pain type, site and duration for example). Further, the lack of reverse scored items may engender acquiescence bias. However, we intentionally did *not* include reverse scored items such that assessment was focused on what the process being assessed *is* vs. what it *is not*; the problems associated with reverse scored items have been documented in regards to other cognitive measures used in pain research.(21) Another key limitation is that we do not yet know if cognitive content and process can be *functionally* separated; indeed, one needs some form of content to process (e.g., one cannot ruminate about nothing). In the PCPQ, the cognitive content was always related to the experience of pain. However, the degree of unique and shared variance between cognitive content and process, and whether treatments can actually specifically target only (or even mostly) one or both of these, needs to be investigated. Finally, future research is needed to examine the correlations between the PCPQ explicit self-report scales in relation to other measures (such as the Pain Vigilance and Awareness Questionnaire,(38) and the Experience of Cognitive Intrusion of Pain scale(39)) as well as to experimental implicit

tests of cognitive processes (such as a computerized attention bias paradigm, for example) to further examine the validity of the PCPQ scales.

Conclusions

Although treatments such as mindfulness- and acceptance-based approaches have been developed to target various cognitive processes, to date, there has not been a validated, un-confounded measure of cognitive processes specific to pain available to evaluate their precise influence on pain adjustment and treatment outcomes; the use of the PCPQ scales will allow for such an evaluation.(40) Further, the psychological factors of distress and emotional response have been implicated in the transition of acute to chronic pain.(1, 41) It is possible that *how* individuals think about their pain in the acute phase (such as post-surgically) might also influence recovery and rehabilitation trajectory; therefore, administration of the PCPQ in this context might identify further potential risk factors contributing to the development of chronic pain and disability. Advancing our understanding of the cognitive processes associated with pain and coping thus provides insight into aetiology and maintenance of pain symptoms. Subsequently, this information has the capacity to target pain treatments, and match the most suitable type of treatment approach to each individual patient.

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Running Head: MEASURING PAIN-RELATED COGNITIVE PROCESSES

The Pain-Related Cognitive Processes Questionnaire (PCPQ): Development and Validation

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Abstract

Objective. Cognitive processes may be characterized as *how* individuals think, whereas cognitive content constitutes *what* individuals think. Both cognitive processes and cognitive content are theorized to play important roles in chronic pain adjustment, and treatments have been developed to target both. However, the evaluation of treatments that target cognitive processes is limited because extant measures do not satisfactorily separate cognitive process from cognitive content. The current study aimed to develop a self-report inventory of potentially adaptive and presumed maladaptive attentional processes that may occur when someone is experiencing pain.

Methods. Scales were derived from a large item pool by successively applying confirmatory factor analysis to item data from 2 undergraduate samples (Ns of 393 and 233).

Results. Items, which were generated to avoid confounding of cognitive content with cognitive processes, represented 9 constructs: Suppression, Distraction, Enhancement, Dissociation, Reappraisal, Absorption, Rumination, Non-Judgment, and Acceptance. The resulting 9 scales formed the Pain-Related Cognitive Process Questionnaire (PCPQ), and scale correlations produced 4 conceptually distinct composite scales: Pain Diversion, Pain Distancing, Pain Focus, and Pain Openness. Internal consistency reliabilities of the 9 scales were adequate (αs $\geq$ .70) to good, and the four composite scales had αs $\geq$ .79. Correlations with pain-related criterion variables were generally consistent with putative constructs.

Conclusions. The developed PCPQ scales offer a comprehensive assessment of important cognitive processes specific to pain. Overall, the findings suggest that the PCPQ scales may prove useful for evaluating the role of pain-related cognitive processes in studies of chronic pain.

Key Words: Cognitive Process, Chronic Pain, Assessment

Introduction

There is now compelling evidence demonstrating that the transition from acute to chronic pain entails complex structural, functional and chemical changes within the brain and central nervous system.(1, 2) Further, there is inherent overlap in the neural networks shared by these changes and cognitive factors.(3, 4) Hence, the interaction between pain and cognitions, including executive attentional function, has become an area of intensive investigation.(4, 5) A number of models hypothesizing an important role for central attentional cognitive processes in pain have been proposed, and include the Fear-Avoidance Model (FAM),(6, 7) the Neurocognitive Model of Attention,(8) the Misdirected Problem Solving Model,(9) and the Psychological Flexibility Model.(10) Stemming from these models, various treatments have been proposed, including exposure, mindfulness and acceptance-based approaches. Jensen and colleagues have proposed a key distinction between two types of cognitions: one representing cognitive *processes* (*how* individuals think about pain) and cognitive *content* (*what* individuals think).(11, 12) While there exist reliable and valid measures of pain-related cognitive content, there has been no systematic work to develop a comprehensive set of pain-specific measures that assess pain-related cognitive processes as distinct from cognitive content.

In a recent review of the measures used in pain research that could potentially be used to assess cognitive processes,(13) we identified that only 9% of retrieved measures provided a un-confounded assessment of cognitive process, and most of these were not pain-specific. Of the processes identified in these measures, results indicated an emerging conceptual framework suggesting six theoretically adaptive processes (distraction, enhancement, dissociation, non-judgment, acceptance, reappraisal), two maladaptive (absorption, rumination) and one process that has been viewed by different theories as either adaptive or maladaptive (suppression). Notably, no pain-specific measure was identified that provides a

un-confounded assessment of absorption, rumination, enhancement or non-judgment.(13) Further, many of the pain-specific measures assessing the other cognitive processes consist of only one or two items, which limits their reliability.

Theoretically, the cognitive process of distraction has been described as "divided attention" and entails diverting attention away from pain by attending to something else; the cognitive process of enhancement is distraction that involves diverting attention to positive thoughts.(4) Suppression consists of diverting thoughts by conscious suppression, and captures a form of cognitive avoidance. In contrast, dissociation (also known as "defusion" in the Psychological Flexibility Model) and reappraisal are ways of attending to pain that either distance oneself from the pain or make the pain more tolerable. Non-judgment encapsulates an open monitoring of experience (or "attention to the present" in the Psychological Flexibility Model), without conceptual overlay in the form of labels such as "good" or "bad". Similarly, acceptance is viewed as the active process of allowing experience to *be* experience, without a need for it to be different. Finally, absorption refers to an intense, hypervigilant intentional or unintentional focusing on pain sensations (emphasized in the FAM), and rumination pertains to an unintentional preoccupation with pain, and is a central tenet in the Misdirected Problem Solving Model.

To various degrees, these nine cognitive processes are emphasized (to a greater or lesser extent, depending on the model) in the extant attentional pain models. However, the lack of a valid and reliable measure of these cognitive process domains limits our ability to test these models and the mechanisms of the treatments stemming from these models. Thus, to evaluate the unique role that these processes play in chronic pain coping and treatment, a valid and reliable measure of pain-related cognitive processes is needed. To address this need, the focus of the current study was to develop a measure with a replicable factor structure that assesses each of the nine cognitive process responses to pain: the Pain-Related

Cognitive Process Questionnaire (PCPQ). We hypothesized that items created for the measure would evidence a 9-factor solution, and that these factors might also load on to a smaller set of composite cognitive process scales. To more closely examine the nature of the PCPQ scales, we also investigated their association with theoretically-relevant, pain-related criterion validity variables.

Methods

Study Design. This study employed a repeated measures online survey across two undergraduate samples. The survey included the initial pool of developed PCPQ items and pain-related validity criterion scales thought to reflect adaptive responses (e.g., measures of perceived control over pain). These pain-related validity criterion scales were expected to be positively associated with the adaptive PCPQ scales (Distraction, Enhancement, Dissociation, Non-Judgment, Acceptance and Reappraisal) and negatively associated with the maladaptive PCPQ scales (Absorption, Rumination). The survey also included validity criterion scales thought to reflect maladaptive responses (e.g., pain catastrophizing, pain interference), which were expected to show the opposite pattern of associations with the PCPQ scales as the adaptive validity criterion measures. Because different theoretical perspectives identify suppression as either adaptive or maladaptive, no *a priori* hypotheses were made regarding this cognitive process.

Sample 1 was recruited from the University of Alabama and sample 2 from the University of Queensland. Participants in both samples completed the online survey, which included the initial pool of developed PCPQ items as well as pain-related outcomes and validity criterion variables. The battery of measures was completed twice by sample 1, approximately one week apart. One other measure of the behavioral inhibition and activation systems in the context of pain was concurrently developed with the data obtained from sample 1 (assessing constructs theoretically distinct from those assessed by the PCPQ

measure developed in the current study), and an article describing that measure is currently under review. The study was approved by the Institutional Review Board at the University of Alabama (sample 1) and by the Behavioural & Social Sciences Ethical Review Committee at the University of Queensland (sample 2).

Item Pool Development. Item development was informed via (1) induction from the domains of pain-related cognitive processes emerging from our content review of coping measures used in pain research (i.e., absorption, dissociation, reappraisal, distraction, suppression, acceptance, rumination, enhancement, and a non-judgmental approach (13)), and (2) deduction from theory that is closely aligned with those identified cognitive processes (e.g., theories underlying cognitive therapy theory for reappraisal, acceptance and commitment therapy for acceptance, mindfulness theory for a non-judgmental approach to pain, as well as the other models described in the Introduction). Each author wrote items designed to tap each domain until approximately 13-17 initial non-overlapping items were developed for each domain. Each item was confirmed by each member of the investigative team to capture a specific cognitive process that was not confounded by cognitive content; the only "content" of the item was specific to pain (e.g., not emotional or social response to pain or beliefs about pain).

The content and structure of these initial items was further refined via communication and consensus among the investigators, resulting in a total of 130 items in the initial item pool. The items were reviewed to ensure that each one was related to pain, did not contain double negatives to avoid confusion, and did not include complex sentence structure or passive/ambiguous language. No reverse scored items were included such that assessment was focused on what the process being assessed *is* vs. what it *is not*. We sought to initially construct scales on the basis of *a priori* item assignment to the nine different cognitive process domains. The readability of the instructions and items was considered in this initial

item development stage, with all measure content and items calculated by the Flesch-Kincaid readability statistics to be at the 3rd grade reading level. A response format indicating degree of endorsement for each pain-related cognitive process was selected to quantify how often individuals engage in each process *when in pain*, which is similar to the response format of the widely used Pain Catastrophizing Scale.(14)

Setting and Participants. The online nature of this research allowed the option for undergraduate participants across both samples to complete the assessment batteries from a location of their choosing. The study advertised that only individuals reporting chronic pain (i.e., pain most days of the month in the last 3-months) or recurrent pain (pain at least four times in the last three months or twice in the past month) were allowed to sign-up to participate. Within Sample 1, a total of 457 undergraduate students were recruited from the University of Alabama subject pool, that consisted of first to fourth year undergraduate students enrolled in psychology courses. Of those recruited, 395 participants completed the Time 1 battery and met the study eligibility criteria (see analysis section), and 393 cases were used to derive the scales after eliminating two cases with all PCPQ item data missing. A subset of these participants did not endorse chronic or recurrent pain, hence these participants were omitted from the planned validity analyses which were conducted with what is referred to henceforth as the 'pain sample' (n = 321; comprised of participants who did endorse chronic or recurrent pain). Of the participants comprising the pain sample, 146 completed the Time 2 assessment battery, and these data were used for the planned test-retest stability analyses. Sample 2 was recruited as a replication sample from the University of Queensland subject pool, which also consisted of first to fourth year undergraduate students enrolled in psychology courses. A total of 246 undergraduates were recruited for participation and 233 completed the Time 1 assessment battery and met the eligibility criteria (see analysis section). These participants (n = 233; 10 of whom did not endorse recurrent or chronic pain) were used

to test the replicability of the model derived from sample 1. Demographic information for the total sample 1 and sample 2, and pain information for the pain sample is presented in Table 1.

[Insert Table 1 about here]

Measures

Demographic and Pain Information. Participant demographic characteristics were gathered from a brief questionnaire that was developed for this research. The demographic variables of interest were race/ethnicity, age, and sex. Participants were asked to provide information pertaining to chronic and/or recurrent pain (utilized for determining inclusion/exclusion for the validity analyses), pain type, pain site, pain duration, and other medical diagnoses.

Pain Intensity. Pain intensity data were collected via the Brief Pain Inventory (BPI).(15) Pain severity scores were obtained from the mean of four items, in which respondents rate their most severe pain, least severe pain, average pain over the past week, and current pain on an 11-point Likert scale ranging from 0 = *No pain* to 10 = *Pain as bad as you can imagine*. The BPI has demonstrated excellent internal consistency and concurrent validity via its associations with other pain instruments in other samples of individuals with pain.(15) The BPI Pain Intensity scale was used as one of the criterion measure in this study, and therefore BPI data were analyzed for the pain sample only; its internal consistency in this sample was adequate (α = .78).

Pain Interference and Depression. Two Patient-Reported Outcomes Measurement Information System (PROMIS) short-form scales were used to assess pain interference and depressive symptoms.(16) The scales consist of 4 items rated on a 5-point Likert scale ranging from 1 to 5 with anchors unique to each construct. Higher scores indicate higher levels of pain interference and depressive symptoms. The PROMIS scales were developed using item-response theory and have been shown to have good construct validity and

reliability.(16) Good internal consistency for the pain interference and depressive symptom scales was demonstrated in the pain sample of the current study (αs = .86 and .89, respectively).

Life Satisfaction. The Quality of Life Scale (QOLS) assesses life satisfaction in several areas.(17) A life satisfaction score was obtained by summing the respondent's ratings on the 7 items rated on a 7-point self-report scale ranging from 1 = *Totally unsatisfying* to 7 = *Completely satisfying*. Total scores range from 7 to 49 with higher scores indicating greater satisfaction. The QOLS taps a unique construct that differs from pain or disability, as demonstrated by its only moderate correlations with distress, and weak correlations with measures of functioning and pain intensity.(17) The QOLS has been demonstrated to be internally consistent, reliable across time, and representative of a single construct.(17) The internal consistency of the QOLS in the pain sample of the current study was good (α = .84).

Pain Catastrophizing. The Pain Catastrophizing Scale (PCS) was used to assess patient report of catastrophic thinking.(14) The total score of the 13-item measure was used, and asks respondents to rate, using a 5-point Likert scale ranging from 0 = *Not at all* to 4 = *All the time*, the degree to which they have certain thoughts and feelings when experiencing pain. The raw scores are summed and higher scores indicate greater use of catastrophic thinking. The PCS has exhibited strong internal consistency, concurrent and discriminant validity, and high test-retest reliability over a 6-week period.(14, 18, 19) Excellent internal consistency for the PCS total score in the pain sample was shown (α = .93).

Activity Engagement & Need for Pain Control. The Chronic Pain Acceptance Questionnaire-8 item (CPAQ-8) was used to measure acceptance of pain.(20) Participants rate the extent to which the eight statements about pain acceptance are true for them on a Likert scale ranging from 0 = *Never true* to 6 = *Always true*, and higher scores indicate greater levels of acceptance. The CPAQ-8 consists of two subscales originally labelled

Activity Engagement and Pain Willingness. However, given a recent evaluation determined that *all* of the item content assessing "pain willingness" reflects a perceived need or desire for pain control (not a willingness to experience pain) it was recommended that the labels Activity Engagement and Pain Control be used by researchers.(21) In the current study, to distinguish the latter scale from other measures of adaptive beliefs assessing perceived control over pain (e.g., (22)), we use the label "Need for Pain Control", which taps a maladaptive approach to chronic pain. The CPAQ-8 has demonstrated adequate-good internal reliability (α = .77 to .89), strong convergent validity, and good concurrent criterion validity.(20, 23) Good internal consistency was found in the pain sample for the current study for the Activity Engagement subscale (α = .81), and internal consistency was adequate for the Need for Pain Control subscale (α = .67).

Pain Control Beliefs. The Survey Of Pain Attitudes (SOPA) was used to assess pain control beliefs.(24, 25) Each of the five pain control belief items are rated on a 5-point scale ranging from 0 = *This is very untrue for me* to 4 = *This is very true for me*. Higher scores indicate greater endorsement of pain control beliefs. The SOPA pain control beliefs scale has been shown to provide a reliable and valid assessment of this domain.(24, 25) In the pain sample, the SOPA pain control beliefs scale showed adequate internal consistency (α = .65).

Procedures. Participants located at both universities learned about the study through the Psychology Subject Pool website, and if they chose to sign up for study participation they were provided access to the online study link. Upon accessing the link (through Qualtrics), potential participants were asked to read a Participant Information Sheet, which informed them about the study procedures and their rights as a participant. If they agreed to participate, they were then asked to complete each of the Time 1 survey questionnaires. At Time 2, one week later, the sample 1 participants were emailed a link to respond to the same assessment battery as that completed at Time 1, minus the demographic and pain questions.

Participants were given course credit and were provided with a debriefing sheet at completion of each survey. Each of the measures in the assessment batteries was presented in a randomized delivery format to control for potential method bias; individual item administration for the PCPQ items was also random, although the items of all other measures were delivered in the order in which they were validated in their respective measures.

Statistical Analyses

Statistical analyses were accomplished with SPSS version 22 and Mplus version 7.4.(26) SPSS was used primarily for assessment of scale reliabilities, whereas Mplus analyses included exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) with weighted least squares mean and variance adjusted (WLSMV) estimation for ordered categorical item data and robust maximum likelihood (MLR) estimation for continuous data (more than five values or ordered categories). MLR corrects the chi-square test and standard errors of parameter estimates for non-normality.(26) Mplus uses all available information for analysis but does eliminate cases when data are missing for an exogenous variable or for an entire case. A few cases were excluded beforehand because they were missing all or most data for the PCPQ items. Mplus handled missing data with full information maximum likelihood (FIML) estimation, whereas analyses with SPSS used listwise deletion. Cases with a completion time of less than 15 minutes were also excluded, as below 15 minutes was more than 2 SDs below the mean time of completion, suggesting a random, or otherwise biased response pattern.

Model fit in Mplus analyses was judged by the chi-square goodness-of-fit test and by fit indices. The goodness-of-fit test provides the statistical significance of the deviation of the model-generated covariance from the actual covariance matrix, but it is sensitive to sample size, because the power to detect differences increases with sample size. Fit indices, which were chosen based on recommendations of Brown (27) and Hu and Bentler,(28) were the

root-mean-square error of approximation (RMSEA) and the comparative fit Index (CFI) for all analyses, and the standardized root mean square residual (SRMR) was computed for MLR analyses. RMSEA ≤ .06 and CFIs ≥ .95 represent good fit, according to the research of Hu and Bentler,(28) but Brown (27) suggests that values of CFI ≥ .90 and RMSEA ≤ .08 are often considered to indicate acceptable fit. An SRMR ≤ .08 is indicative of adequate fit.(27, 28)

Results

Statistical analyses were used first to derive a set of nine PCPQ scales from the initial pool of 130 items and then to evaluate the nine scales in relation to published scales that were deemed relevant to the concurrent validity of the PCPQ scales. The data from sample 1 who had taken 15-minutes or longer to complete the tests (n = 393) were used to construct the PCPQ scales and determine their internal consistency. The data from participants in sample 2 who completed the survey in ≥ 15 minutes (n = 233) were used to investigate replicability of the factor structure. The concurrent validity analyses were conducted only on a subsample of sample 1 participants – the pain sample – which consisted of 321 students (249 women and 72 men), who were predominantly Caucasian (83%), and 18 to 23 years of age (M = 18.84, SD = 0.96). A smaller subset of the pain sample completed the Time 2 assessment battery, and these data were used to examine the one-week test-retest stability of the scales (n = 146); this subsample was mostly female (n = 111), Caucasian (86%), with a mean age of 18.9 (SD = .91).

Derivation of the Nine PCPQ Scales

Because the large number of initial items made Mplus analysis with WLSMV intractable, the item data for the prospective nine scales were split into two parts (5 scales and 4 scales) for separate analyses, and 393 participants were randomly assigned to a derivation sample (N = 194) and a cross-validation sample (N = 199). CFAs with items assigned

according to *a priori* theoretical specification to oblique factors were conducted on the two sets of prospective scales in the derivation sample, and items with low loadings or large cross-loadings were excluded until adequate model fit was achieved. The two models, one with five factors and the other with four, were applied to the data in the cross-validation sample to assess shrinkage, which was deemed reasonable. The two models with a reduced number of items were then combined to form nine factors, and further modifications were made to improve model fit in the full sample (N = 393) until each of the nine scales had 5-6 items. The final nine-factor model fit the data well. Fit indices were respectable (RMSEA = .038, CFI = .95), but the goodness-of-fit test was significant, $\chi^2(1289, N = 393) = 2037.16$, $p < .001$. However, sample 2, was available to assess fit shrinkage in replication. As expected, model fit in replication was reduced, but indices suggested an adequate fit (RMSEA = .046, CFI =.92). The goodness-of-fit statistic was significant, $\chi^2(1289, N = 233) = 1914.65$, $p < .001$.

Table 2 shows items for the nine PCPQ scales with standardized factor loadings from CFAs for the final model with the full derivation sample (sample 1: N = 393) and the replication sample (sample 2: N = 233). Factor correlations ranged from -.39 between Rumination and Enhancement to .89 between Rumination and Absorption in sample 1 and from -.50 between Rumination and Enhancement to .87 between Distraction and Enhancement in sample 2.

[Insert Table 2 about here]

Correlations between the nine scale scores (average item scores) for sample 1 are shown in Table 3, which also gives the means, SDs, and internal consistency reliabilities (α coefficients). The α coefficients in sample 1 had a median of .84 with Rumination having the highest reliability and Acceptance having the lowest. Reliabilities for sample 2 were similar to those in sample 1 and varied from .90 for Rumination to .66 for Acceptance (median =

.84). With the exception of the Acceptance scale, reliabilities were adequate ($\alpha \geq .70$) in both samples, and the Rumination scale had the highest degree of internal consistency ($\alpha = .90$) in both samples.

[Insert Table 3 about here]

Derivation of Composite PCPQ Scales

The nine PCPQ factor scales proved to have adequate psychometric properties for the most part, but correlations between scales were often high, indicating that broader (second-order) factors could be important determinants of scale covariances. Consequently, the nine PCPQ scales were submitted to EFA with MLR estimation and an oblimin rotation, and four factors fit the data very well (RMSEA = 0.00, CFI = 1.00, SRMR = 0.003) and generated a non-significant goodness-of-fit test, $\chi^2(6, N = 393) = 2.18$, $p = .9023$.

Standardized factor loadings from the EFA of the PCPQ scales in sample 1 are shown in Table 4. Based on this analysis, four composite, superordinate scales were constructed. The Pain Diversion scale (M = 2.82, SD = .70, $\alpha = .93$) was comprised of the 17 items from the Suppression, Distraction, and Enhancement scales, and the 12 items from the Dissociation and Reappraisal scales were combined to form the Pain Distancing scale (M = 2.35, SD = .74, $\alpha = .90$). The Pain Focus scale (M = 2.91, SD = .79, $\alpha = .92$) contained the 12 items from Absorption and Rumination, and the Pain Openness scale (M = 2.69, SD = .58, $\alpha = .79$) consisted of the 12 items from the Acceptance and Non-Judgment scales.

[Insert Table 4 about here]

Test-Retest Stability of the PCPQ Scales and Composite Scales

A subsample of the pain sample (n = 146) who repeated the full assessment battery approximately one week following the first administration was used to examine the stability of the scales. The test-retest statistics (correlations and *t*-tests) for the PCPQ specific and composite scales from the pain sample are summarized in Table 5. As shown in these results,

the test-retest stability for eight of the nine specific scales, and three of the four PCPQ composite scales was comparable to the previously validated criterion measures (e.g., the PCS) used in the analyses.

[Insert Table 5 about here]

Criterion-Related Validity of the PCPQ Scales

The validity of the PCPQ specific and composite scales was examined by first computing their correlations with validity criterion measures assessing pain intensity, pain interference, depression, life satisfaction, pain catastrophizing, activity engagement, need for pain control, and pain control beliefs. Zero order correlations are shown in Table 6.

[Insert Table 6 about here]

We hypothesized that adaptive and maladaptive cognitive processes would be associated with respectively better and worse pain-related criterion variables. The adaptive process of Pain Diversion (and associated Distraction and Enhancement scales) was correlated with the criterion variables in this expected direction, and as hypothesized, was significantly correlated with fewer depressive symptoms, lower pain catastrophizing, and higher life satisfaction, activity engagement and pain control beliefs. Although no *a priori* hypotheses were made for Suppression, which also loaded on to the Pain Diversion composite scale, this process emerged as adaptive in these analyses; that is, it was associated with higher life satisfaction, activity engagement, and pain control beliefs, and lower pain catastrophizing. The Pain Distancing domain (and associated Dissociation and Reappraisal scales) was expected to be an adaptive process and was correlated with higher pain control beliefs. The composite Pain Openness scale was hypothesized to be adaptive, however it was not significantly correlated with any of the criterion variables. As expected, the Pain Focus domain was consistently associated with significantly worse scores on all of the pain-related criteria.

The final set of analyses was a series of regression models further examining the relation between the composite scales and the criterion variables, while controlling for pain intensity. The regression findings are shown in Table 7.

[Insert Table 7 about here]

As shown in Table 7, parameter estimates determined that while controlling for pain intensity, the PCPQ Pain Focus scale was associated with significantly worse scores on all of the criterion variables; this is consistent with this domain representing a maladaptive process. The Pain Diversion scale predicted significantly higher activity engagement and stronger pain control beliefs, however it was associated with a higher need for pain control. The Pain Distancing scale significantly predicted variance in activity engagement and pain control beliefs, with higher distancing scores predicting less engagement in activities, but stronger pain control beliefs. The Pain Openness scale was significantly associated with lower pain catastrophizing and need for pain control, and higher activity engagement.

Discussion

The primary purpose of this study was to develop and evaluate scales that could measure cognitive attentional processes theorized by various models to be important in chronic pain. The four PCPQ composite scales – Pain Diversion, Pain Distancing, Pain Focus, and Pain Openness – were found to yield a reliable assessment of *how* individuals think about pain or the cognitive processes individuals typically engage in when they are in pain. The nine scales that assess more specific cognitive processes were also generally reliable and their pattern of correlations with pain-related criterion variables were largely consistent with the putative adaptive vs. maladaptive theoretical conceptualizations. The broad potential clinical and research utility of the scales was demonstrated as items were brief and written at a 3rd grade reading level, thus reducing participant burden and requiring minimal health literacy to comprehend.

The development of a replicable factor structure assessing pain-related cognitive processes suggested by the literature was a key emphasis.(6-10) Hence, a large initial item pool was developed to tap the cognitive processes identified in our literature review.(13) Further, CFAs were conducted across two samples to confirm the replicability of adequate model fit. Results found that not only did the nine-factor solution produce a good fit to data in the derivation sample, but the model also had adequate fit in a replication sample. The findings supported the existence of nine distinct cognitive process responses to pain: suppression, distraction, enhancement, dissociation, reappraisal, absorption, rumination, non-judgment, and acceptance.

Although the scales emerging from the data were distinct, the correlations among subsets of the specific scales were relatively high, and EFA showed that the 9-scales differentially loaded on to four composite scales, all of which demonstrated adequate reliability. The test-retest stabilities for Pain Diversion, Pain Distancing, and Pain Focus were satisfactory; the Pain Openness scale had test-retest stability that was low but not out of keeping with values for several of the comparison scales, such as those from the SOPA and CPAQ-8. We anticipate that the PCPQ composite scales will be most typically used in research and clinical practice, although the individual scales could potentially facilitate more nuanced empirical investigations.

The Distraction, Suppression and Enhancement scales, which can provide a fine-grained analysis of Pain Diversion, involve efforts to shift one's focus to something *other* than the pain, but these processes, while overlapping, are conceptually distinct. Although extant measures combine distraction and suppression,[e.g.,](13, 29, 30) these processes may be differentiated on the basis of the object that becomes the focus of awareness. Specifically, in the process of distraction, the shift of attention is to *anything* other than the pain, whereas suppression entails the intentional *ignoring* of pain, and enhancement is the deliberate

deployment of attention directed towards enhancing the experience of a *positive* thought/experience. Thus, the composite Pain Diversion scale seems to tap the intentional engagement of cognitive processes associated with lessening the attention devoted to pain, or by diverting attention elsewhere. Seminowicz and Davis refer to this as "divided attention" because while one aspect of attention is directed towards non-painful information, pain still demands attention; hence, it is likely rare that pain is completely unattended.(4) These authors state that the success of these cognitive pain diversion processes in coping with pain may be a function of the available, albeit limited, cognitive resources, as well as processing capacity.

Dissociation and Reappraisal comprise the Pain Distancing composite scale. Dissociation involves a change in awareness or conscious experiencing to decrease the intensity of pain by imaginally distancing or separating it from oneself.(13) Similarly, reappraisal is an attempt to change the conscious experience of pain by re-characterizing it as less negative and more bearable. Thus, both scales assess a form of changing one's perception or thoughts about the pain, but differ as to the type of change that is being attempted. In the mechanism of reappraisal, the observed, possibly emotion-eliciting stimulus is reframed into non-emotional terms that are presumably more adaptive – a key strategy of Cognitive Therapy for pain.(31) Essentially, the composite Pain Distancing scale assesses a decentered, rational cognitive process, such that the pain is observed/manipulated as if "from a distance" or separate from self. Thus, this domain may assess a pain-specific form of cognitive defusion (as in the Psychological Flexibility Model),(10) which has also been referred to as reperceiving.(32)

Absorption and Rumination were found to form the Pain Focus domain. Absorption is the immersion of oneself in a single experience, such as pain, and is conceived to be an intentional and perhaps effortful process. On the other hand, rumination has historically been

conceptualized as a maladaptive, automatic process(33) that involves a "tape loop" type of repetitive focus on negative images, thoughts, or experiences, also referred to as worry in the Misdirected Problem Solving Model.(9) The composite Pain Focus scale has items designed to capture cognitive processes that keep attention "locked" onto the pain stimulus. The Pain Focus scale may tap a hypervigilant attentional bias towards pain, which is a key component of both the Misdirected Problem Solving Model,(9) as well as the FAM,(6, 7) and is often assessed using computerized tasks of attentional bias.(34-36) Consistent with this, results indicated that the Pain Focus scale and its Rumination component are strongly related to pain catastrophizing, which has been hypothesized to amplify the pain experience via exaggerated attention biases to sensory and affective pain information.(37) The difference between PCPQ Rumination and the PCS is primarily that the former avoids reference to specific conscious cognitive content and isolates the *process* of rumination, whereas the latter emphasizes the ruminative content and the severity of its emotional aspects.

The fourth composite scale, Pain Openness, is comprised of the Non-Judgment and Acceptance scales, key processes in the Psychological Flexibility Model.(10) Non-judgment encapsulates a relationship to pain devoid of attachment and aversion in the form of categories such as "acceptable" or "unacceptable". The process of acceptance however, may function in parallel to this non-judgmental approach in the sense that acceptance also entails a flexible attention to the pain (just as it is) that is devoid of intellectual ideals of how that experience *should* be. Therefore, although non-judgment and acceptance are theoretically distinct processes, they do appear to share an inherent sense of "staying open to experience", which is consistent with the proposed interconnected nature of these processes within the Psychological Flexibility Model.(10) While results support the use of the Non-Judgment scale emerging from this research, the Acceptance scale and the combined composite scale will need further refinement to optimize internal consistency, stability, and validity. A

potential explanation for the less than optimal stability of response to the Pain Openness items in this study may be that it is possible that without formal training in mindfulness or acceptance-oriented coping skills, these items may lack relevance to the lay person. Critically, the Non-Judgment scale provides the first measure of a core aspect of mindfulness specific to the context of pain.

The correlation analyses provided initial insights into the nature of the scales and demonstrated that the PCPQ scales are distinct from other important measures of responses to pain. Although preliminary, the regression analyses showed that the Pain Diversion, Pain Distancing, and Pain Openness composite scales were associated with variables that are thought to assess adaptive functioning, and therefore could potentially be protective factors facilitating effective adjustment to pain. The Pain Focus domain seems to tap maladaptive attentional processes as it was associated with maladaptive functioning across all of the criterion validity measures. Of each of the criterion measures examined, the PCPQ scales most substantially added to the prediction of pain catastrophizing and pain control efforts, while controlling for pain intensity. Further research is needed to validate the PCPQ scales and to more precisely determine the extent to which the processes are related to adaptive and maladaptive responses to pain.

The present scales, like other similar measures are dispositional, in that they ask the individual to retrospectively report methods of thinking that should predict future pain responding. Experimental pain paradigms are well suited for predictive studies to validate the PCPQ scales, provided that situational measures are developed. Experimental tasks also permit a direct, though somewhat artificial, test of the adaptiveness of the processes that are assessed by PCPQ scales and provide an evaluation of the extent to which the processes occur during episodes of acute pain. Experimental research would also permit studies of the effects of coupling particular processes with specific content.

Limitations

The observed preliminary psychometric properties of the PCPQ were strong; however research is needed to address the limitations of this study and further validate the measure. As is common in measure development research, the current study was conducted within an undergraduate population. Although most participants did report recent pain, as expected, the levels of disability and distress due to pain were lower than is typically found in clinical samples; therefore we cannot determine at this point the extent of the generalizability of the current findings to chronic pain populations. The reliability and validity of the scales within clinical samples needs to be established, as does the treatment sensitivity of the PCPQ scales, particularly in response to treatments designed to target specific cognitive processes. It is possible that the adaptive vs maladaptive nature of the scales might vary as a function of context (i.e., such as the context surrounding pain type, site and duration for example). Further, the lack of reverse scored items may engender acquiescence bias. However, we intentionally did *not* include reverse scored items such that assessment was focused on what the process being assessed *is* vs. what it *is not*; the problems associated with reverse scored items have been documented in regards to other cognitive measures used in pain research.(21) Another key limitation is that we do not yet know if cognitive content and process can be *functionally* separated; indeed, one needs some form of content to process (e.g., one cannot ruminate about nothing). In the PCPQ, the cognitive content was always related to the experience of pain. However, the degree of unique and shared variance between cognitive content and process, and whether treatments can actually specifically target only (or even mostly) one or both of these, needs to be investigated. Finally, future research is needed to examine the correlations between the PCPQ explicit self-report scales in relation to other measures (such as the Pain Vigilance and Awareness Questionnaire,(38) and the Experience of Cognitive Intrusion of Pain scale(39)) as well as to experimental implicit

tests of cognitive processes (such as a computerized attention bias paradigm, for example) to further examine the validity of the PCPQ scales.

Conclusions

Although treatments such as mindfulness- and acceptance-based approaches have been developed to target various cognitive processes, to date, there has not been a validated, un-confounded measure of cognitive processes specific to pain available to evaluate their precise influence on pain adjustment and treatment outcomes; the use of the PCPQ scales will allow for such an evaluation.(40) Further, the psychological factors of distress and emotional response have been implicated in the transition of acute to chronic pain.(1, 41) It is possible that *how* individuals think about their pain in the acute phase (such as post-surgically) might also influence recovery and rehabilitation trajectory; therefore, administration of the PCPQ in this context might identify further potential risk factors contributing to the development of chronic pain and disability. Advancing our understanding of the cognitive processes associated with pain and coping thus provides insight into aetiology and maintenance of pain symptoms. Subsequently, this information has the capacity to target pain treatments, and match the most suitable type of treatment approach to each individual patient.

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Table 1. *Sample characteristics*

	Sample 1 (n = 391[1])		Sample 2 (n = 233)	
Variable	*M* (*SD*)	%	*M* (*SD*)	%
Age	19(.96)		20(5.18)	
Sex				
Male		24		24
Female		76		76
Race				
Caucasian		82		63
African-American		11		0
Asian		.5		27
Other		6.5		10
Relationship status				
Single		66		58
In a relationship/Married		34		42
Employment status				
Not working		71		50
Employed full-time		1		2
Employed part-time		28		48
Pain Sample (sample 1 subsample; n = 321)				
Average Pain Duration (months)	28(29)			
Primary pain region				
Head, face, mouth		24		
Lower back, sacrum, coccyx		22		
Lower limbs		16		
Abdominal (stomach)		14		
Upper shoulder and upper limbs		10		
Other		14		
Primary pain type				
Pain from injury		34		
Headache		22		
Soft tissue or muscle pain		21		
Menstrual		10		
Other (e.g., arthritis, neuropathic)		13		

[1] Note, sample size is 391 as two cases had missing demographic data

Table 2. *Standardized Loadings from CFAs of PCPQ Scales for Sample 1 and Sample 2 (in parentheses)*

	PCPQ Factor					
Items (in response to "When in Pain...")	Suppression		Distraction		Enhancement	
I stop myself from thinking about the pain	.68	(.72)				
I clear my mind of thoughts about the pain	.74	(.78)				
I pretend the pain doesn't exist	.66	(.49)				
I prevent myself from thinking about the pain	.70	(.74)				
I push down thoughts about the pain	.68	(.69)				
I avoid thinking about pain	.70	(.70)				
I focus on something other than the pain			.81	(.82)		
I divert my attention away from the pain, on to something else			.76	(.72)		
I think of something other than the pain			.77	(.80)		
I let my mind wander from the pain			.71	(.71)		
I take my mind off the pain by thinking about other things			.78	(.71)		
I concentrate on pleasurable thoughts when I feel the pain					.78	(.73)
I give pleasant sensations my full attention					.61	(.69)
I focus on positive thoughts when I feel the pain					.78	(.77)
I focus on being aware of the positive things in my life					.80	(.76)
I pay attention to sensations that are more comfortable than the pain					.68	(.78)
I savor pleasant experiences other than the pain					.64	(.63)

Table 1 Continues

	PCPQ Factor					
Items (in response to "When in Pain...")	Dissociation		Reappraisal		Absorption	
I observe the pain sensations as if from a distance	.73	(.73)				
I imagine the pain sensation as an image or object that is separate from me	.78	(.76)				
I tell myself that the pain is not real	.69	(.81)				
I think of the pain as something separate from me	.72	(.79)				
I imagine that the pain is not a part of me	.80	(.75)				
I let myself have the feeling of being a detached observer of the pain	.74	(.73)				
I think about the pain in a new, more positive way			.74	(.75)		
I think about the pain in a different way, so that it is more bearable			.69	(.78)		
I change my thinking about pain			.72	(.66)		
I change my view of the pain to make it more helpful			.78	(.78)		
I alter my outlook of the pain so that it seems better			.75	(.72)		
I shift my perspective of the pain so it isn't so negative			.77	(.79)		
I concentrate intensely on my experience of pain					.75	(.75)
I pay close attention to the pain I am experiencing					.81	(.69)
I pay close attention to feelings of physical tension and discomfort					.73	(.71)
I deliberately notice the sensations of pain					.63	(.51)
I closely attend to the sensation of the pain					.64	(.60)
I closely examine the painful sensations					.70	(.66)

Table 1 Continues

Items (in response to "When in Pain...")	PCPQ Factor					
	Rumination		Non-Judgment		Acceptance	
I am unable to think of anything other than the pain	.77	(.82)				
I become preoccupied with the pain	.85	(.73)				
I keep thinking about the pain	.85	(.84)				
Pain is the only thing on my mind	.80	(.85)				
I cannot stop thinking about the pain	.81	(.82)				
I have a hard time focusing on things other than the pain	.75	(.79)				
I do not make judgments about the pain as a "good" or "bad" experience			.63	(.73)		
I do not make judgments about the pain as "acceptable" or "unacceptable"			.50	(.46)		
I acknowledge the pain without judgment			.67	(.65)		
I am aware of my pain but do not see it as good or bad			.68	(.73)		
I do not give the pain any meaning			.61	(.62)		
I do not put any labels on the pain			.54	(.52)		
I allow the pain to be part of my experience					.62	(.35)
I do not fight against the pain					.40	(.32)
I allow any pain I have to be present without needing it to be different					.43	(.65)
I consent to the experience of pain					.68	(.37)
I am aware of the pain without needing it to be different than how it is					.48	(.77)
I am able to stay in touch with all sensations, including the pain, and allow them to be present					.56	(.52)

Note. All factor loadings are statistically significant ($p < .001$). N = 393 for sample 1, and N = 233 for sample 2.

Table 3. *Means, SDs, Correlations, and Reliabilities for Nine PCPQ Scales Constructed by CFA with Sample 1 (N = 391)*

Scale	Mean	SD	α	1	2	3	4	5	6	7	8	9
1. Suppression	2.71	0.73	.82	1.00								
2. Distraction	3.03	0.82	.85	.70**	1.00							
3. Enhancement	2.76	0.80	.84	.71**	.72**	1.00						
4. Dissociation	2.15	0.79	.85	.50**	.29**	.46**	1.00					
5. Reappraisal	2.53	0.80	.86	.64**	.54**	.64**	.68**	1.00				
6. Absorption	2.89	0.79	.84	-.20**	-.26**	-.14**	.13**	.00	1.00			
7. Rumination	2.93	0.90	.90	-.28**	-.33**	-.21**	.01	-.12*	.76**	1.00		
8. Non-Judgment	2.63	0.72	.74	.41**	.34**	.34**	.34**	.38**	-.06	-.12*	1.00	
9. Acceptance	2.74	0.63	.68	.18**	.09	.11*	.28**	.24**	.35**	.24**	.46**	1.00

* $p < .05$; ** $p < .01$

Table 4. *Standardized Loadings for EFA of Nine PCPQ Scales with Sample 1 Data (N = 393)*

	Composite Scales			
	Pain Diversion	Pain Distancing	Pain Focus	Pain Openness
Suppression	**.66**	.21	-.10	.08
Distraction	**.92**	-.14	-.04	.03
Enhancement	**.82**	.12	.07	-.06
Dissociation	-.04	**.91**	.01	.03
Reappraisal	.39	**.55**	.02	.03
Absorption	.03	.04	**.92**	.04
Rumination	-.03	-.04	**.82**	-.01
Non-Judgment	.17	.12	-.20	**.51**
Acceptance	-.04	-.02	.07	**.91**

Note. Salient loadings are in boldface.

Table 5. *Test-retest stability for the PCPQ specific and composite scales in sample 1 (N=146)*

Scales	Time 1 Mean(*SD*)	Time 2 Mean(*SD*)	Test-retest *t*	*p*	*r*
Composite Cognitive Processing Scales					
Pain Diversion	2.93(.72)	2.85(.73)	1.66	.10	.69
Pain Distancing	2.35(.73)	2.35(.76)	-.002	.99	.71
Pain Focus	2.90(.81)	2.76(.82)	2.80	.01	.72
Pain Openness	2.73(.59)	2.68(.62)	.95	.34	.54
Specific Cognitive Processing Scales					
Suppression	2.76(.73)	2.75(.74)	.24	.81	.58
Distraction	3.20(.84)	3.02(.84)	2.87	.01	.59
Enhancement	2.88(.82)	2.82(.83)	1.09	.28	.68
Dissociation	2.15(.80)	2.18(.77)	-.50	.62	.63
Reappraisal	2.54(.82)	2.51(.89)	.49	.62	.68
Absorption	2.88(.81)	2.74(.79)	2.32	.02	.62
Rumination	2.91(.92)	2.76(.93)	2.56	.01	.72
Non-Judgment	2.67(.74)	2.64(.74)	.63	.53	.57
Acceptance	2.79(.64)	2.73(.69)	.92	.36	.41
Criterion Measures					
BPI Pain Interference	2.54(.89)	2.29(.88)	4.17	<.001	.67
PROMIS Depression	2.00(.87)	1.88(.89)	2.01	.05	.69
QoLS Life Satisfaction	5.17(.99)	5.18(1.03)	-.16	.87	.63
PCS Pain Catastrophizing	2.64(.86)	2.54(.85)	1.94	.05	.72
CPAQ Activity Engagement	5.61(1.00)	5.36(1.33)	2.28	.02	.38
CPAQ Need for Pain Control	3.97(1.05)	3.81(1.06)	1.87	.06	.56
SOPA Pain Control Beliefs	2.91(.86)	3.03(.81)	-2.01	.05	.58

Table 6. *Correlations between the PCPQ scales and criterion variables (n=321)*

PCPQ Scales	Criterion Variables							
	Pain Intensity	Pain Interference	Depression	Life Satisfaction	Pain Catas-trophizing	Activity Engagement	Need For Pain Control	Pain Control Beliefs
Composite PCPQ Scales								
Pain Diversion	-.05	-.04	-.13*	.18**	-.26**	.15**	.01	.40**
Pain Distancing	.06	.05	.01	.07	-.09	-.08	.05	.33***
Pain Focus	.17**	.26**	.33**	-.21**	.67**	-.24**	.36**	-.26**
Pain Openness	.07	-.02	.07	.00	-.08	.07	-.04	.08
Specific PCPQ Scales								
Suppression	-.02	-.03	-.09	.12*	-.22**	.12*	-.03	.36**
Distraction	-.05	-.05	-.11*	.16**	-.29**	.22**	.00	.34**
Enhancement	-.06	-.03	-.14*	.20**	-.19**	.07	.06	.37**
Dissociation	.09	.09	.10	.00	-.01	-.17**	.02	.29**
Reappraisal	.01	.00	-.08	.13*	-.15**	.02	.07	.31**
Absorption	.15**	.22**	.28**	-.17**	.57**	-.19**	.32**	-.18**
Rumination	.17**	.27**	.33**	-.21**	.68**	-.25**	.36**	-.31**
Non-Judgment	.01	-.07	-.09	.08	-.22**	.06	-.10	.21**
Acceptance	.12*	.04	.22**	-.09	.11	.05	.04	-.10

*$p < .05$; **$p < .01$

Table 7. *Regression analysis results of the PCPQ composite scales predicting the criterion variables (n=321)*

Step, Predictor Variable	R^2	ΔR^2	$F(R^2\Delta)$	β	t	p
Criterion Variable: BPI Pain Interference						
Step 1:	.22	.22	88.99			<.001
Pain Intensity				.47	.94	<.001
Step 2:	.26	.04	4.68			.001
Pain Intensity				.44	8.85	<.001
Pain Diversion				.07	1.01	.31
Pain Distancing				.03	.39	.70
Pain Focus				.22	3.99	<.001
Pain Openness				-.08	-1.52	.13
Criterion Variable: PROMIS Depression						
Step 1	.05	.05	15.41			<.001
Pain Intensity				.22	3.93	<.001
Step 2	.14	.09	8.09			<.001
Pain Intensity				.16	2.95	.003
Pain Diversion				-.04	-.47	.64
Pain Distancing				.03	.42	.67
Pain Focus				.29	4.93	<.001
Pain Openness				.05	.97	.34
Criterion Variable: QOLS Life Satisfaction						
Step 1	.001	.001	.34			.56
Pain Intensity				-.03	-.58	.56
Step 2	.05	.05	4.45			.002
Pain Intensity				.00	.06	.95
Pain Diversion				.13	1.70	.09
Pain Distancing				-.01	-.17	.86
Pain Focus				-.15	-2.46	.015
Pain Openness				-.03	-.59	.56
Criterion Variable: PCS Pain Catastrophizing						
Step 1	.08	.08	27.17			<.001
Pain Intensity				.28	5.21	<.001
Step 2	.49	.41	62.46			<.001
Pain Intensity				.18	4.34	<.001
Pain Diversion				.08	1.38	.17
Pain Distancing				-.06	-1.11	.27
Pain Focus				.66	14.47	<.001
Pain Openness				-.09	-2.02	.045
Criterion Variable: CPAQ Activity Engagement						
Step 1	.04	.04	14.77			<.001
Pain Intensity				-.21	-3.84	<.001
Step 2	.13	.09	7.93			<.001
Pain Intensity				-.17	-3.15	.002
Pain Diversion				.22	2.84	.005
Pain Distancing				-.26	-3.60	<.001
Pain Focus				-.15	-2.47	.014
Pain Openness				.12	2.07	.04

Table Continues

	Criterion Variable: CPAQ Need for Pain Control					
Step 1:	.10	.10	33.38			<.001
Pain Intensity				.31	5.78	<.001
Step 2:	.23	.14	14.04			<.001
Pain Intensity				.26	5.15	<.001
Pain Diversion				.24	3.43	.001
Pain Distancing				-.05	-.72	.47
Pain Focus				.41	7.28	<.001
Pain Openness				-.11	-1.99	.048
	Criterion Variable: SOPA Pain Control Beliefs					
Step 1	.05	.05	16.29			<.001
Pain Intensity				-.22	-4.04	<.001
Step 2	.23	.18	18.41			<.001
Pain Intensity				-.20	-3.91	<.001
Pain Diversion				.21	2.98	.003
Pain Distancing				.21	3.15	.002
Pain Focus				-.13	-2.26	.02
Pain Openness				-.04	-.74	.46

Note. The *p* value reported for Step 1 and 2 is the significance of the *F* change value.

The Pain-Related Cognitive Process Questionnaire (PCPQ)

Instructions: Listed below are a number of statements describing different ways of responding to pain. Use the following scale to indicate the degree to which you respond to pain in each of these ways. Please answer these questions based on your chronic and/or any intermittent pain that you experience.

0 = Not at all
1 = Rarely
2 = Sometimes
3 = Often
4 = All or most of the time

When in pain…

1. I let myself have the feeling of being a detached observer of the pain
2. I pay close attention to the pain I am experiencing
3. I think about the pain in a new, more positive way
4. I cannot stop thinking about the pain
5. I do not make judgments about the pain as a "good" or "bad" experience
6. I pay attention to sensations that are more comfortable than the pain
7. I closely examine the painful sensations
8. I become preoccupied with the pain
9. I divert my attention away from the pain, on to something else
10. I am able to stay in touch with all sensations, including the pain, and allow them to be present
11. I observe the pain sensations as if from a distance
12. I think about the pain in a different way, so that it is more bearable
13. I concentrate on pleasurable thoughts when I feel the pain
14. I alter my outlook of the pain so that it seems better
15. I am unable to think of anything other than the pain
16. I focus on something other than the pain
17. I closely attend to the sensation of the pain
18. I am aware of my pain but do not see it as good or bad
19. I prevent myself from thinking about the pain
20. I allow any pain I have to be present without needing it to be different
21. I imagine that the pain is not a part of me
22. I change my view of the pain to make it more helpful
23. I avoid thinking about pain
24. I let my mind wander from the pain
25. I do not make judgments about the pain as "acceptable" or "unacceptable"
26. I tell myself that the pain is not real
27. I focus on being aware of the positive things in my life

28. I take my mind off the pain by thinking about other things
29. I pretend the pain doesn't exist
30. I do not give the pain any meaning
31. I have a hard time focusing on things other than the pain
32. I think of something other than the pain
33. I focus on positive thoughts when I feel the pain
34. I keep thinking about the pain
35. I consent to the experience of pain
36. I give pleasant sensations my full attention
37. I concentrate intensely on my experience of pain
38. I change my thinking about pain
39. I am aware of the pain without needing it to be different than how it is
40. I stop myself from thinking about the pain
41. I imagine the pain sensation as an image or object that is separate from me
42. I savor pleasant experiences other than the pain
43. I do not put any labels on the pain
44. I pay close attention to feelings of physical tension and discomfort
45. I push down thoughts about the pain
46. I deliberately notice the sensations of pain
47. I do not fight against the pain
48. Pain is the only thing on my mind
49. I acknowledge the pain without judgment
50. I allow the pain to be part of my experience
51. I shift my perspective of the pain so it isn't so negative
52. I clear my mind of thoughts about the pain
53. I think of the pain as something separate from me

Scoring Instructions

Scale Scoring: Add all items and divide by the number of items in the scale.

Suppression: 19, 23, 29, 40, 45, 52
Distraction: 9, 16, 24, 28, 32
Enhancement: 6, 13, 27, 33, 36, 42
Absorption: 2, 7, 17, 37, 44, 46
Rumination: 4, 8, 15, 31, 34, 48
Dissociation: 1, 11, 21, 26, 41, 53
Reappraisal: 3, 12, 14, 22, 38, 51
Non-Judgmental: 5, 18, 25, 30, 43, 49
Acceptance: 10, 20, 35, 39, 47, 50

Global Scales: Add items from all first-order scales and divide by the number of scales in the global domain.

Pain Diversion: Suppression, Distraction, Enhancement
Pain Distancing: Dissociation, Reappraisal
Pain Focus: Absorption, Rumination
Pain Openness: Non-Judgmental, Acceptance