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The relationship between negative metacognitive thoughts, pain catastrophizing, and adjustment to chronic pain

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Cognitive appraisals, most notably pain catastrophizing (PC) (Sullivan, Davidson, Garfinkel, Siriapaipant, & Scott, 2009) have been linked to pain intensity, disability, emotional distress, and greater physical dysfunction (Edwards, Cahalan, Mensing, Smith, & Haythornthwaite, 2011; Flor, Behle, & Birbaumer, 1993; Sturgeon & Zautra, 2013b; Westman, Boersma, Leppert, & Linton, 2011). PC can be more disabling (Crombez, Vlaeyen, Heuts, & Lysens, 1999), and emotionally distressing (Edwards et al., 2011) than the pain itself. However, despite the plethora of research on the impact of thought *content* on pain and adjustment, the role of thought *processes*, namely metacognitions, and how pain-related cognitions are regulated remains limited (Yoshida et al., 2012).

Metacognition is considered a form of executive function with regard to cognitive processing (Wells, 2002). It refers to the “regulation and awareness of the current state of cognition, and appraisal of the significance of thought and memories” (Wells, 1995, p. 302). The study of metacognition in the context of mental and physical health is associated with the Self-Regulatory Executive Function (S-REF; Wells & Mathews, 1996), which outlines the role of psychosocial factors in the development and maintenance of emotional disorders. The S-REF suggests that individuals’ positive and negative beliefs about thinking influences their appraisals (e.g. “I must worry in order to be prepared”), and these internal processes form platforms for guiding maladaptive response styles, which impact psychological distress.

Meta-cognitions can be divided into positive and negative meta-cognitive beliefs (Wells, 2002a), with the latter signifying a focus on the uncontrollability of cognitions and a focus on appraisals of danger. Thoughts about controllability of worry and ruminative cognitions, the hallmarks of catastrophizing, may lead to amplification of faulty cognitive processes that are being consistently applied to cope with distress, and result in coping failure. Applying these maladaptive regulatory processes leads to engaging maladaptive coping strategies of worry/rumination, and using coping strategies such as thought suppression that fail to

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modify negative appraisals and beliefs (Wells & Cartwright-Hatton, 2004) and result in escalation of distress, including worsening depression, anxiety and anger. Hence, PC can serve as an antecedent for the activation of negative meta-cognitive processes, leading to worse coping behaviors and exacerbations of pain (Yoshida et al., 2012), all of which perpetuate the cognitive-behavioral pain cycle.

Current heuristic frameworks of understanding psychological and functional status in chronic pain do not include meta-cognition, and recent studies highlight the importance of considering cognitive processes above and beyond pain catastrophizing, including irrational processes and thought intrusion (Lohnberg & Altmaier, 2014; Spada, Gay, Nik evic, Fernie, & Caselli, 2015; Suso-Ribera et al., 2016). Given meta-cognitions in the context of a non-treatment study are likely to remain stable, we assessed them at baseline and conducted a moderation analysis to examine whether negative meta-cognitive beliefs (processes) about worry moderated the relationships of appraisals (i.e. pain catastrophizing) with emotional functioning and physical activity at the daily level in a sample of individuals with chronic pain. We hypothesized that participants endorsing stronger negative meta-cognitive beliefs about worry would have: 1) stronger positive associations between pain catastrophizing and emotional functioning (depression, anxiety, anger); 2) stronger negative associations between pain catastrophizing and physical activity and positive affect.

Methods

Procedures

The current study is a secondary data analysis of the Daily PCS validation study (Darnall et al., 2017). However, our analyses are distinct, as we conducted a multilevel regression model that predicts changes in daily mood and activity based on fluctuations in pain catastrophizing, while controlling for changes in daily pain intensity. The study was approved by the Human Subjects Committee of the Stanford University Institutional Review Board. Participants were recruited through in-house listservs of individuals with chronic pain and/or through a national chronic pain media outlet (National Pain Report). Inclusion criteria were 18 years of age, English literate, current chronic pain, and ability to complete 14 days of daily measures online. A total of 523 participants clicked on the study link, completed an online screening form. A final 305 participants met eligibility criteria, completed an online consent form, and enrolled in the study. At baseline, together with demographic information for age, gender, highest education attained, level of household income, race, and ethnicity, patients also reported their average pain intensity ratings for the previous 30 days (0–10; with “0” being no pain and “10” being worst pain imaginable), in addition to duration of chronic pain. Participants completed a daily battery of questionnaires for 14 consecutive days via a REDCap (Harris et al., 2009) link emailed every 24 hours, beginning 24 hours after completion of their day 1 set of daily measures. Once the survey invitation was sent, participants were allowed 24 hours to complete their daily measures. For compensation, participants were offered a possible total of \$15 compensation in the form of an [Amazon.com](https://www.amazon.com) gift card.

Measures

The daily version of the Pain Catastrophizing Scale (PCS; Sullivan et al., 1995) was developed and validated by our group (Darnall et al., 2017). The 3-item measure consisted of a single item from the rumination, magnification, and helplessness subscales of the original PCS. Internal consistency of the composite of the 3 daily items was high (Cronbach's $\alpha = 0.892$).

Key daily constructs included measurements of pain intensity, physical activity, depression, anxiety and anger, and positive affect. PROMIS Pain Intensity uses a 0 to 10 Numeric Rating Scale (NRS) that is anchored with "0" = no pain and "10" = the worst pain imaginable (Chapin et al., 2014). The NRS has been validated for specificity and use in chronic pain research (Darnall, Sturgeon, Kao, Hah, & Mackey, 2014; Sturgeon & Zautra, 2013a). Depressed mood, anxious mood, anger, positive affect, and physical activity were similarly measured using a 0–10 NRS. Depressed, anxious, and angry mood were assessed using similar item stems: "In the past 24 hours, to what extent did you feel depressed/anxious/angry?", with 0 corresponding to "Not at all" and 10 corresponding to "All the time". Positive affect was assessed using the question: "To what extent did you feel positive emotions today? (e.g. interested, determined, excited, enthusiastic)", with 0 corresponding to "Not at all" and 10 corresponding to "All the time". Similarly, physical activity was also assessed by asking patients rate their activity level for the past 24 hours on a Numeric Rating Scale (NRS) that is anchored "0" = "Not active" to "10" = "Very active".

Meta-cognitive beliefs were assessed at baseline, before completion of daily diaries. The Meta-Cognitions Questionnaire-30 (MCQ-30; Wells & Cartwright-Hatton, 2004) is a 30-item self-report instrument assessing individual differences in metacognitive beliefs, judgments, and monitoring tendencies. It consists of five factors that measure the following dimensions: (1) positive beliefs about worry (e.g. "worrying helps me cope"); (2) negative beliefs about thoughts concerning uncontrollability and danger (e.g. "when I start worrying I cannot stop"); (3) cognitive confidence (e.g. "my memory can mislead me at times"); (4) beliefs about the need to control thoughts (e.g. "not being able to control my thoughts is a sign of weakness"); and (5) cognitive self-consciousness (e.g. "I pay close attention to the way my mind works"). Higher scores indicate higher levels of maladaptive meta-cognitive beliefs. The MCQ-30 possesses good internal consistency and convergent validity, as well as acceptable test–retest reliability (Spada, Mohiyeddini, & Wells, 2008; Wells & Cartwright-Hatton, 2004). In this sample, internal consistency in this sample for total MCQ (Cronbach's $\alpha = .922$) and the respective subscales (Cronbach's α range: .773 to .922).

Data Analysis

Baseline comparisons were conducted using t-tests, Chi-square and One-Way ANOVAs. Primary analyses were conducted with hierarchical path models using the TYPE = COMPLEX command in Mplus, version 6.12. This analytic approach allows for estimation of relationships between variables at the daily level, while accounting for clustering effects that would lead to biased standard errors using traditional ordinary least-squares (OLS) regression. The analysis in this study consisted of a few steps. First, direct paths of daily pain catastrophizing to each outcome variable (feelings of depression, anxiety, or anger,

positive emotional states, and physical activity), above and beyond the effects of pain intensity, which was included as a covariate in all models. Second, in cases where there was a significant relationship between catastrophizing and an outcome, scores on MCQ subscales were tested as a moderator of this effect, such that both lower-order effects and a cross-level interaction term were modeled, along with pain intensity as a covariate:

$$Outcome = \beta_1 * dPCS + \beta_2 * MCQ + \beta_3 * dPCS * MCQ + \beta_4 * pain\ intensity + \beta_0$$

Though the MCQ contains 5 total subscales, only those subscales reflecting potential vulnerability to negative cognitions (i.e., subscales related to negative beliefs about thoughts, needing to control thoughts, and cognitive self-consciousness) were tested as moderators. This step was taken to reduce the possibility of Type-I error due to an inflated number of analyses. All path coefficients in the final estimated model are presented as standardized beta coefficients. All daily variables were centered on their cluster means (i.e., on the mean score for each participant), while the moderating variables (i.e., MCQ subscale scores) were centered on the grand mean.

Results

Participants

A total of 305 participants enrolled in the study. Around 70% of participants ($n = 211$) completed 7 days of surveys; those completing fewer than 50% of diaries were excluded from analysis. In the current sample, participants completed 12.12 out of 14 days of diaries on average (86.5% completion rate). Participants were primarily female (87.7%), Caucasian (92.9%), with an average pain intensity of 6.75 out of 10 ($SD = 1.50$) over the previous 30 days. Median pain duration was 1 year; median education level was a completed Associate's Degree or vocational certificate. Pain diagnoses in the study sample were assessed by having participants endorse common pain syndromes (these categories were not mutually exclusive). The pain complaints that were most commonly endorsed were: chronic low back pain (45.5%), fibromyalgia (38.9%), chronic migraines (32.2%), complex regional pain syndrome (32.2%), chronic pelvic pain (16.6%), ongoing pain from a surgical procedure (10.0%), and other types of chronic pain not listed in our questionnaires (49.3%).

Baseline Comparisons

Some differences were noted between those who responded to at least 7 out of 14 days and those who did not. These groups varied significantly on baseline pain intensity, pain interference, energy levels, and physical activity, suggesting more intense pain and pain interference, and physical activity in those participants who completed more diaries ($p > .05$ in all cases).

Preliminary Analyses

Table 1 shows descriptive statistics for all variables included in the study. Table 2 shows correlations between study variables. As expected, pain intensity and negative meta-cognitive beliefs about worry demonstrated significant and positive relationships with pain catastrophizing.

Direct Relationships

As expected, daily pain catastrophizing scores showed significant and positive relationships with depressed mood ($\beta = .342, p < .001$), anxious mood ($\beta = .345, p = .001$), and angry mood ($\beta = .141, p < .001$), above and beyond the effects of daily pain intensity. Similarly, daily pain catastrophizing scores showed a significant and negative relationship with daily positive affect levels ($\beta = -.273, p < .001$) but did not show a significant association with physical activity levels ($\beta = -.096, p = .22$), above and beyond the effects of pain intensity. Meta-cognitive beliefs about the uncontrollability and danger of thoughts were also positively associated with daily depressed mood ($\beta = .444, p < .001$), anxious mood ($\beta = .431, p < .001$), and angry mood ($\beta = .350, p < .001$), and negatively associated with positive affect ($\beta = -.324, p < .001$) but were unrelated to physical activity levels ($\beta = -.077, p = .27$). Meta-cognitive beliefs related to cognitive self-consciousness were also positively associated with daily depressed mood ($\beta = .243, p < .001$), anxious mood ($\beta = .244, p < .001$), and angry mood ($\beta = .202, p < .001$), but were unrelated to daily levels of physical activity ($\beta = .068, p = .32$) or positive affect ($\beta = -.067, p = .31$). Meta-cognitive beliefs regarding a need to control thoughts were significantly and positively associated with daily depressed mood ($\beta = .258, p < .001$), anxious mood ($\beta = .200, p < .001$), and angry mood ($\beta = .266, p < .001$), but unrelated to daily positive affect ($\beta = -.081, p = .19$) and physical activity levels ($\beta = .005, p = .95$). However, none of the examined subscales of the MCQ were found to moderate the relationship between daily pain catastrophizing scores and any of the examined outcomes ($p > .07$ in all cases).

Discussion

Findings revealed that, from a daily coping perspective, negative meta-cognitive beliefs about thoughts, related to uncontrollability or dangerousness of thoughts, a belief that thoughts need to be controlled, and a high degree of attention paid to thoughts, demonstrated independent and parallel relationships with average daily levels of psychological functioning, most notably catastrophizing and negative affective states. This finding suggests that metacognitive beliefs may contribute incrementally to our understanding of pain and its impact on people's functioning, above and beyond the contribution made by measures of cognitive content and coping styles alone. However, they did not appear to modify the strength of daily relationships between pain catastrophizing and emotional states. In this respect, our study findings were somewhat equivocal: participants who reported greater levels of emotional distress also tended to endorse stronger negative meta-cognitive beliefs, but these effects did not extend to the dynamics of daily cognition and affect. Our results may suggest that meta-cognitive beliefs are a parallel indicator of poor psychological adjustment to chronic pain, rather than a risk factor that amplifies the immediate negative consequences of catastrophizing. Despite the decidedly nuanced nature of our findings, they nevertheless highlight that both catastrophizing and cognitive beliefs appear to show relationships with daily psychological states, independent of the effects of one another, and are both correlates of predicting worse pain-related outcomes. Further, those who have more frequent catastrophic thoughts are more likely to have danger-laden cognitions about their thoughts, as well as more distress. These findings are aligned with research showing associations between metacognitions and negative affect (Spada et al., 2015) but *extend on*

these findings to show associations on the *daily* level and associations with psychological outcomes in individuals with chronic pain. These findings are also consistent with neuroimaging research showing that catastrophic thinking and specifically rumination on pain activate the brain similarly as an anxiety disorder (such as GAD) in the absence of GAD or any anxiety disorder diagnosis (Jiang et al., 2016), thereby highlighting substantial overlap in the manifestation of pain rumination and anxiety disorders that appears to be distinct from diagnostic pathology.

Additionally, the findings identify the need for further study of metacognition and its potential impacts in chronic pain, which may necessitate examination in other empirical contexts (e.g., longitudinal or clinical studies to determine construct stability or its suitability as a mediator of psychological intervention). They also highlight the importance of considering interventions that target cognitive appraisal processes beyond catastrophizing, including uncontrollability and danger-laden thought patterns. Apart from our group's work on the daily PCS, this is the first study to date that examines *daily* reports of catastrophizing and pain-related outcomes over the course of two weeks. These findings demonstrate the importance of meta-cognition in a more dynamic way than single-observation retrospective report, and may suggest that there is value in studying the effects of metacognition at the daily level.

The findings identify, for the first time in the literature, a link between meta-cognitive thoughts about worry and both catastrophizing and indicators of general emotional distress among chronic pain patients. Metacognitions, as a self-regulatory executive function, are responsible for the persistence of thought patterns, and in our model, negative thoughts about uncontrollability and danger of worry, which refer to dangers of worry and a lack of control over one's worry, may explain the maintenance of pain catastrophizing as a form of coping in response to physical triggers (e.g. pain sensations, or negative thoughts). Similarly, a belief that thoughts need to be controlled and a high degree of attention paid to thoughts showed similar effects. Our findings are partially consistent with research linking metacognitions to catastrophizing (Spada et al., 2010), in that they suggest that negative metacognitive beliefs may reflect a greater tendency towards frequent catastrophic appraisal of pain, though the consequences of these catastrophic appraisal for mood and activity appear to manifest similarly regardless of meta-cognitive beliefs. Notably, this study provides evidence that these metacognitive processes do show some implications at the daily level, though their effects are likely better defined as a more stable marker of poor psychological adjustment to pain.

The study has important research and clinical implications. From an interventional perspective, clinicians should consider metacognitions as potential therapeutic targets, which is aligned with third-wave therapeutic approaches that underscore recognizing and accepting cognitive and meta-cognitive processes. If metacognitions can be identified, techniques can be tailored to target catastrophic thinking more effectively among chronic pain patients. Our findings demonstrate that metacognitions and catastrophizing both independently contribute to distress at the daily level. Hence, existing treatment is likely effective in treating catastrophizing in the absence of danger-laden and uncontrollability metacognitions; however, when negative meta-cognitive beliefs are present, they may act as an additional risk

factor that warrants specific intervention. Metacognitive Therapy approaches target rumination and restructuring positive and negative metacognitive beliefs (Wells & King, 2006; Wells, Fisher, Myers, Wheatley, Patel, & Brewin, 2009), both of which are unhelpful. However, even though Metacognitive Therapy has not been validated in chronic pain, it might prove useful for these patients. This is supported by a recent meta-analysis showing that Metacognitive Therapy resulted in superior outcomes to those resulting from Cognitive-Behavioral Therapy among patients with anxiety and depression (Normann, van Emmerik, & Morina, 2014). Similarly, there are existing interventions validated for use in chronic pain that may be useful in addressing maladaptive meta-cognitive beliefs. Both Mindfulness-Based Stress Reduction and Acceptance and Commitment Therapy emphasize changing reactions to thoughts, rather than focusing on preventing or changing thought content. Hence, these approaches may serve as a way to alleviate meta-cognitive vulnerability. Future research can explore whether targeting metacognitive processes may alleviate the effect of catastrophizing and improve outcomes.

The study has a number of limitations. First, self-report biases may have contributed to errors in self-report measurements. However, given the daily nature of the assessments, we reduced the effects of recall-bias that is typically associated with self-report. A longitudinal design would allow for establishing causal relationships, however, the current study spanned a time period of 14 days, which may increase reliability of estimates but nevertheless functions in essence as a cross-sectional analysis at the daily level. Additionally, chronic pain was loosely defined as an inclusion criterion, and our use of broad self-reported pain categories, which was necessary due to the open-ended nature of our pain diagnosis question, may include some degree of error in terms of participants' beliefs regarding the etiology of their pain. As a result, our pain diagnosis categories should be interpreted only as a broad-level description of the pain locations and characteristics of our mixed chronic pain sample. Despite strengths in generalizability, this heterogeneity precludes clear comparisons of these effects across different pain conditions. For instance, research shows that headaches have a neurological basis, and they are likely initiated by one of numerous pathways including nerve stimulation, irritation or disinhibition (Bogduk & Mercer, 2000). This factor may influence patients' attributions regarding the etiology of their conditions, which may impact their cognitive content and coping style. Further, the sample for the study was primarily female, which limits generalizability to the broader chronic pain population. Finally, the MCQ-30 was developed and validated in patients with generalized anxiety disorder. The MCQ-30 measures general meta-cognitive constructs that do not directly and specifically address pain. Use of targeted measures of metacognition, such as the meta-cognitions about Symptom Control Scale (Fernie, Maher-Edwards, Murphy, Nik evi , & Spada, 2015), may reveal findings disparate from those reported here. Additionally, while the cross-sectional nature of our results do not allow us to determine whether meta-cognitive beliefs and pain catastrophizing can be considered distinct therapeutic targets, this study provides evidence that metacognitive processes have implications at the daily level, and their effects in our analyses may be best interpreted as a more stable marker of poor psychological adjustment to pain. It would be worthwhile to examine whether meta-cognitive beliefs are malleable in chronic pain as they appear to be in other populations, and whether treatment-related changes in these beliefs presage psychological improvements in

individuals with chronic pain. Future research can explore the mechanistic role of metacognitive beliefs.

Despite these limitations, our findings demonstrate the both factors appear to impact pain-related adaption, however their effects do not presently appear to be interactive. The findings also highlight how measures of metacognition may contribute to our understanding of pain and its impact on people's functioning above and beyond the contribution made by measures of cognitive content and coping styles alone.

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Significance

Findings highlight the need to better characterize the value of metacognitive beliefs as an important predictor and therapeutic target. Despite limited evidence of a dynamic relationship between metacognition and daily adjustment to chronic pain, results emphasize the potential importance of interventions that target cognitive appraisal process beyond catastrophizing, including uncontrollability and danger-laden thought patterns.

Table 1

Descriptive Statistics.

Study variable	Mean (SD)
Daily Pain Intensity	5.64 (1.59)
Daily Pain Catastrophizing	3.28 (.906)
Daily Depressed Mood	3.34 (2.32)
Daily Anxious Mood	3.28 (2.37)
Daily Angry Mood	2.38 (2.18)
Daily Positive Mood	4.41 (1.74)
Daily Physical Activity	3.87 (1.61)
MCQ-CSC	2.61 (.877)
MCQ-UD	1.88 (.840)
MCQ-NCT	1.72 (.612)

Note: MCQ: Meta-Cognitions Questionnaire; CSC: Cognitive Self-Confidence; UD: Uncontrollability and Danger of Thoughts; NCT: Need to Control Thoughts

Table 2

Correlations between study variables.

	1	2	3	4	5	6	7	8	9	10
Daily Pain Intensity	1	.528**	.359**	.303**	-.276**	.314**	-.256**	.035	.101**	.108**
Daily Pain Catastrophizing		1	.573**	.518**	-.411**	.488**	-.311**	.204**	.317**	.296**
Daily Depressed Mood			1	.714**	-.467**	.629**	-.303**	.201**	.376**	.282**
Daily Anxious Mood				1	-.356**	.637**	-.195**	.225**	.455**	.294**
Daily Angry Mood					1	-.354**	-.168**	.296**	.473**	.418**
Daily Positive Mood						1	.512**	-.080**	-.204**	-.105**
Daily Physical Activity							1	-.040*	-.091**	-.017
MCQ-CSC								1	.495**	.494**
MCQ-UD									1	.496**
MCQ-NCT										1

Note:

** p < .01;

* p < .05.

Note: MCQ: Meta-Cognitions Questionnaire; CSC: Cognitive Self-Confidence; UD: Uncontrollability and Danger of Thoughts; NCT: Need to Control Thoughts*Note:* Correlations estimated using non-aggregated daily variables (N = 2557).