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Cognitive intrusion of pain and catastrophic thinking independently explain interference of pain in the activities of daily living

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ABSTRACT

Patients with musculoskeletal illness often report that pain interferes with their ability to engage in activities of daily living. Catastrophic thinking is consistently depicted as an important cognitive factor that hinders adjustment to pain. Current research has also shown that pain negatively impacts an individual's ability to maintain attention on the task at hand. While a measure of the experience of cognitive intrusion of pain (ECIP) has been recently developed to quantify the extent of that impact, little research has explored this issue in everyday settings. This study tested the mediating roles of cognitive intrusion of pain and pain catastrophizing scale (PCS) on the association of pain intensity with pain interference in 142 patients with upper-extremity musculoskeletal illness. We found that both cognitive intrusion of pain ($b = 0.136$, bootstrap SE = 0.048, 95% BCa CI [0.052, 0.245]) and pain catastrophizing ($b = 0.114$, bootstrap SE = 0.044, 95% BCa CI [0.047, 0.221]) partly and independently mediated the relationship between pain intensity and pain interference. Although comparable, the mediation effect of cognitive intrusion of pain was slightly larger than that of pain catastrophizing (25.7%, bootstrap SE = 0.094 vs. 21.5%, bootstrap SE = 0.080). Results suggest that pain sensations can interfere with activities of daily living through two distinct mechanisms. A combination of traditional cognitive behavioral therapy and mindfulness skills training targeting both pain catastrophizing and cognitive intrusion has the potential to decrease pain interference and help patients return to normal healthy living in spite of acute or persistent pain.

1. Introduction

Pain distracts attention from activities of daily living (Arnold et al., 2008; Attridge et al., 2015; Bennett et al., 2007). Pain negatively impacts task performance (Buhle and Wager, 2010; Crombez et al., 1996; Van Ryckeghem et al., 2012) particularly for complex tasks that require executive control (Moore et al., 2012). Pain automatically grasps attention from the task at hand, in both healthy individuals (Keogh et al., 2014) as well as those with acute (Gil-Gouveia et al., 2016) and chronic pain conditions (Eccleston, 1995).

The emerging evidence of the impact of pain on attention has led to the development of the Experience of Cognitive Intrusion of Pain (ECIP) scale (Attridge et al., 2015) which captures the processes though which pain impacts attention and cognitions. The intrusion of pain onto cognition is theorized as occurring in three sequential stages (Eccleston and Crombez, 1999): an initial interruption of a mental activity by pain and reorientation of attention toward pain, followed by pain becoming the center of attention and its dominance in mind and subsequent over focus and inability to disengage attention from the pain sensation (Van Damme et al., 2002, 2004). The ECIP is aimed at measuring the *subjective* experience of such intrusion rather than the processes composing the intrusion by focusing on the *extent* to which pain interferes with cognitions.

Prior research has shown that pain catastrophizing is one of the most important cognitive factors associated with decreased function in patients with acute and chronic pain (Das De et al., 2013;

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Golkari et al., 2015; Moradi et al., 2015; Talaei-Khoei et al., 2017). The Pain Catastrophizing Scale (PCS) items capture elements of the second stage of the ECIP in addition to negative thoughts about pain. However, PCS is more theoretically based on the fear of pain and "pain-as-threat" (Sullivan et al., 1995; Vlaeyen and Linton, 2000), while ECIP taps more into the salient nature of the pain (Attridge et al., 2015; Eccleston and Crombez, 1999).

In order to understand the relative contributions of ECIP and PCS in the relationship between pain and function, it is important to test them together within a single model. This would increase our understanding of the mechanism through which pain may lead to inability to engage in activities of daily living due to pain (e.g., pain interference), as well as guide whether psychological interventions should focus on restructuring negative pain thoughts (e.g., traditional cognitive behavioral therapy), redirecting attention from the pain to activities of daily living (e.g., mindfulness), or a combination of these.

The aim of this study was to assess the direct and indirect association of pain intensity to pain interference through engaging in catastrophic thinking about pain and experience of cognitive intrusion of pain. We hypothesized that both ECIP and PCS would partly mediate the association between intensity of pain and interference of pain in activities of daily living. We also hypothesized that ECIP would have a stronger mediation effect than catastrophic thinking about pain.

2. Methods

2.1. Participants and procedures

Our Institutional Review Board approved this cross-sectional study. We enrolled 142 patients with upper extremity musculoskeletal illness from the Hand and Upper Extremity Service of a large urban teaching hospital. Inclusion criteria were as follows: 1) 18 years or older, 2) English literacy and 3) the ability to give informed consent. Exclusion criteria include: 1) pregnancy, as required by the IRB, and 2) severe untreated mental health issues such as bipolar disorder or substance abuse. In practice, no participants were excluded due to either exclusion criteria. Potential participants were approached as they were waiting for their medical appointments. All enrolled patients completed the informed consent.

Patients completed a battery of questionnaires including demographic factors, history of their upper extremity illness, pain intensity, pain interference, pain catastrophizing and the experience of cognitive intrusion of pain. Patients had a mean age of 51 (range: 22 to 62) and an average of 15 years of education. Participants were mostly White (85%, with 9% Black, 8% Latino, 3% Asian and 2% other races), employed (58%, with 25% student, retiree or homemaker, 14% unable to work and 3% out of work), married or living with a partner (58%, with 34% never married, 6% divorced or separated and 2% widowed), known to the clinic (56%), with a non-traumatic problem (58%), without any prior surgery for the current musculoskeletal problem (61%), and balanced between women (51%) and men (49%).

2.2. Measurements

2.2.1. Pain intensity

Pain intensity was assessed with the Patient Reported Outcome Measurement Information System (PROMIS) Scale (v1.0) Pain Intensity 3a. The PROMIS scores are weighted T-score calibrated so that the mean of 50 and standard deviation (SD) of 10 being the mean and SD of the samples derived from U.S. populations (Cella et al., 2007; Liu et al., 2010). This provides cross-comparability of the scores among different samples derived within U.S. population. The PROMIS pain Intensity scale consists of three items with two questions asking about the intensity of pain in the past 7 days at its worse and on average and one question regarding the intensity of the pain at the present moment. The tripartite item bank gives the respondent the opportunity to communicate the broader range of pain intensity (average and worst pain) in a broader recall period (current pain and past 7 days) comparing to one-item numerical rating scale (NRS) of pain. Responses were captured on a 5-point Likert type answers from "no pain" to "very severe", with higher scores depicting more intense pain.

2.2.2. Pain interference

We used PROMIS Bank v1.1 Pain Interference Computerized Adaptive Test (CAT) to measure consequences of pain on different aspects of one's life as manifested in an individual's perception of difficulties engaging in activities of daily living. The questionnaire consists the extent to which pain hinders commitment to enjoyment of life (e.g., "participate in leisure activities") and impedes engagement with cognitive (e.g. "taking new information"), physical (e.g., "getting groceries") and social (e.g., "socializing with others") activities. Responses were captured on a 5-point scale from "never" to "always" or "not at all" to "very much" depending on the item. Higher scores indicate more pain interference. PROMIS pain interference item bank showed good psychometrical reliability (Cronbach's $\alpha = 0.99$) and concurrent validity corresponding to previously established measures such as Brief Pain Inventory (BPI) (Cleeland and Ryan, 1994) interference subscale ($rho = 0.90$) and medical outcomes Short Form-36 (SF-36) (Ware, 2000; Ware and Sherbourne, 1992) bodily pain subscale ($rho = -0.84$) (Amtmann et al., 2010).

2.2.3. Catastrophic thinking about pain

The Pain Catastrophizing Scale (PCS) was used to measure catastrophic thinking about pain. PCS consists of 13 items pertaining to orientation of thoughts and feelings toward pain (e.g., I worry all the time about whether the pain will end). Participants rate their thoughts and feelings when experiencing pain on a 5-point Likert type scale, from 0 "not at all" to 4 "all the time". Scores of all items are summed to produce the PCS total score ranging from 0 to 52. Higher scores depict greater catastrophic thinking about pain. The PCS has shown good reliability and construct validity (Sullivan et al., 1995).

2.2.4. Cognitive intrusion of pain

The cognitive intrusion of pain was assessed by a newly developed measure of the Experience of Cognitive Intrusion of Pain (ECIP) (Attridge et al., 2015). The 10-item measure subjectively probes three stages of the effect of pain on cognition: a) initial interruption by pain and reorientation of the attention toward pain (3 items, e.g., "Pain easily captures my thinking"), b) the dominance of pain on the mind (4 items, e.g., "I keep thinking about pain ") and c) control by pain and difficulty disengaging attention from pain (3 items, e.g., "I can't push pain out of my thoughts") (Attridge et al., 2015). Participants choose the extent to which each of these 10 items describes how pain intrudes into their cognition when encountering painful situations on a 7-point Likert type scale from 0 being "not at all applicable" to 6 being "highly applicable". A total score is created by the sum of the individual scores of all 10 items (range: 0 to 60). In a series of