

Mindfulness for Chronic Back Pain: A Pilot Study of fMRI Resting-State Functional Connectivity

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Introduction

Chronic low back pain (CLBP) is the most prevalent chronic pain condition in the U.S. and is often associated with stress, anxiety, and depression. Mindfulness meditation interventions have been shown to help people with CLBP by alleviating the emotional burden of their pain. However, the neural mechanisms underlying how mindfulness changes a person's relationship to their pain is unclear. Both chronic pain and mindfulness can affect the resting-state functional connectivity of the Default Mode Network (DMN) and the insula, which are involved in self-referential thought and pain perception, respectively. Thus, the connectivity of these networks may underlie changes in how people experience chronic pain following mindfulness training. The authors of this study used functional magnetic resonance imaging (fMRI) to investigate whether mindfulness affects the resting-state functional connectivity of the DMN and insula in people with CLBP.

Methods

Subjects (n=4) were scanned at the MRI Research Facility at Brown University under two conditions: mind-wandering (subjects were told, "Feel free to let your mind wander.") and body-focus ("Pay attention to how your body feels."). While they were in the scanner, subjects had their eyes open and fixated on a cross. Scans occurred before and after subjects followed a one-week program of guided mindfulness meditation at home for 20 minutes each day. The meditation program is available from the University of California Los Angeles (UCLA) Mindful Awareness Research Center (<http://marc.ucla.edu/body.cfm?id=22>). Before each scan session, subjects completed the Roland-Morris Disability

Questionnaire (RMDQ) to assess changes in disability due to CLBP and the Chronic Pain Acceptance Questionnaire (CPAQ) to assess changes in how they felt about their pain. The fMRI data were analyzed in *Matlab* using *SPM* and the *CONN Toolbox*.

Results

Subjects exhibited significant changes in the functional connectivity of the DMN and insula under both conditions (Table 1). The two main nodes of the DMN, the medial prefrontal cortex (mPFC) and posterior cingulate cortex (PCC)/precuneus, showed increased coupling during body-focus (Figure 1). The insula had increased connectivity with frontal regions during body-focus and mind-wandering. In contrast, the mPFC had decreased connectivity with other frontal regions during body-focus, as did the PCC during mind-wandering. The insula's connectivity with somatosensory cortex decreased during both conditions. Before the intervention, the functional connectivity of the PCC to four distinct clusters was greater during body-focus than mind-wandering (Figure 2). After the intervention, one of these clusters in right somatosensory cortex exhibited the opposite pattern, with greater connectivity during mind-wandering than body-focus (Figure 2). Most subjects reported a marginal decrease in pain severity immediately following meditation with the average decreasing from 5.5 to 4.625 ($p = 0.06$). The RMDQ and CPAQ results were mixed with nonsignificant differences overall.

Conclusion

One week of guided mindfulness meditation can change the resting-state functional connectivity of the DMN and insula in people with CLBP. These connectivity changes suggest that meditation influences the neural networks involved in pain perception and self-awareness that are affected by CLBP. Thus, there may be potential for meditation in the treatment of CLBP. Despite the intervention's limited impact on disability and pain acceptance, most subjects reported a decrease in pain severity following meditation, suggesting that

meditation may play a role in pain control. All subjects expressed interest in continuing to practice meditation, which is promising for adherence and future research. More subjects are needed to clarify the effects of meditation on pain perception and to determine if there is a correlation between changes in resting-state connectivity and chronic pain. Given that these results were found after only one week of listening to a guided meditation at home, greater effects may be demonstrated after a more structured and rigorous intervention.