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**TITLE: Neuroimaging and the nature of pain and emotion: New approaches and findings**

**ABSTRACT:**

**Motivation**: Pain and other forms of emotional distress are primary drivers of behavior and core features of many clinical disorders.  In spite of many decades of research, however, fundamental questions remain about how affective processes should be classified (is pain an emotion?) and their relationships with health and disease (are emotional appraisals directly relevant for health?) Brain-based studies can provide an important, new window into these questions. Objective brain markers for pain and emotion could support prediction and diagnosis; provide markers for psychological and drug treatments; bridge animal and human studies at the level of mechanism; integrate psychology with neuroscience and medicine; and provide a basis for re-conceptualizing the nature of pain and emotion. This hope is reflected in major new initiatives from NIH aimed at finding brain mediators of health-related behaviors.

**The challenge**: The success of neurophysiological approaches in understanding pain and emotion hinges on identifying brain markers that are closely linked to behavioral and subjective end-points--and can ultimately yield information beyond the measures used to define them--which has been a major challenge. Human neuroimaging, including functional magnetic resonance imaging (fMRI), is one of the most promising current techniques. However, it has not yet yielded compelling brain markers for pain, emotion, or other mental phenomena.

**Approach and findings**:  I describe recent efforts in my lab to a) identify fMRI-based markers for specific types of affective experiences, and b) use brain markers to  study psychological interventions. Using statistical learning approaches, we have identified a distributed brain pattern that is sensitive and specific for acute physical pain, and generalizes across individuals, studies, and types of pain.  New work also identifies other patterns related to several types of emotional experiences. Analysis of these patterns demonstrates that a) pain and emotion are fundamentally different at the brain level, though they may still interact; b) different brain patterns predict specific emotion categories and emotional experiences; and c) emotions are not processed in dedicated systems, but are constructed from interactions among many systems. We are currently testing a range of psychological interventions, including placebo effects, expectancy effects, cognitive reappraisal, and social interventions.  These interventions influence pain- and emotion-specific brain patterns in some cases. However, in many studies, psychological effects do not reverse the brain patterns indicative of pain and distress, but rather activate additional mechanisms that may change their experience in more complex ways. These findings motivate more nuanced models of the neurophysiology of pain and emotion, in which multiple brain processes mediate distinct components of pain and other emotional responses. Different interventions may work through different brain mechanisms, with distinct functional consequences for health and behavior.