

The Sting of Emotion: A Study on Facial Responses to Emotional and Physical Pain

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Abstract: This paper explores the embodiment of cognitive and emotional processes through the perspective of metaphor theory and embodied cognition. According to embodied cognition, cognitive processes are shaped by bodily interactions with the physical world. A key challenge within this framework is understanding how abstract concepts are represented beyond direct sensory or motor experience. In this work, we investigate whether metaphorical representations of fear involve embodied simulations by analyzing facial expressions under physical and emotional stimuli using the Facial Action Coding System (FACS). Specifically, the study examines the parallels in facial motor responses to physical pain and emotional distress. Our research focuses on identifying shared facial grimacing patterns, such as brow lowering and lip tightening, that signal a “sting” sensation in both contexts. Findings from this research aim to illuminate the embodied nature of emotional experiences, bridging the gap between abstract cognitive representations and their physical manifestations. This research contributes to the broader discussion of how abstract emotional experiences are deeply rooted in physical sensations, with potential implications for therapeutic approaches to emotional pain.

Keywords: Embodied Cognition, Metaphor Theory, Facial Action Coding System (FACS)

1. Introduction

Past studies of whether moral transgression really “leaves a bad taste in the mouth” has demonstrated the embodiment of emotions of disgust [1]. The phrase *“Pain stings like needles in my skin”* is metaphorically similar to Chapman’s moral transgression phrase, suggesting that similar patterns may emerge in emotional pain. Research on facial expressions in response to pain has identified specific movements associated with pain, such as brow lowering, lips tightening, nose wrinkling, and upper lips raising, which is also known as facial grimacing [2,3]. Past researchers have also found a strong correlation between facial grimacing and reported intensity of pain, which further solidifies facial grimacing as a reliable indicator of pain [4]. The Facial Action Coding System (FACS), a system that deconstructs all facial expressions into a set of basic facial movements, can detect and categorize facial grimacing [5]. Additionally, these facial movements activate specific motor regions in the brain to occur [6].

Hypothesis:

Experimental Hypothesis: Emotional pain activates facial motor regions in a manner similar to physical pain.

Alternative/Null Hypothesis (H_0): Emotional pain does not activate facial motor regions similarly to physical pain.

2. Method

2.1. Participants

This study will recruit 50 healthy adult participants aged between 18 and 50 years. Participants will be randomly assigned to either the “emotional pain” group or the “physical pain” group, with 25 participants in each group. The sample size is informed by Chapman et al.’s 2009 study, which used 27 participants for similar research[1]. Considering the complexity of analyzing facial responses in this study, as well as the requirement for two equal-sized comparison groups, a total of 50 participants ensures sufficient statistical power while accounting for individual variability. Participants with a history of PTSD, depression, anxiety, or chronic pain will be excluded from the study to control for potential confounding factors. Additionally, participants with neurological disorders or current psychiatric treatment will be excluded to ensure a homogenous, healthy population.

2.2. Stimuli

The physical pain group will experience mild electrical stimulation delivered via electrodes attached to their skin for ten minutes. The electrical stimulation will be calibrated to produce a noticeable but harmless sensation of physical pain to evoke a direct, realistic pain response. The emotional pain group will be exposed to a ten-minute tragic story video selected and edited from existing films that focus on themes like suffering and loss to invoke emotional pain.

2.3. Procedure

The experiment will first begin with the physical pain group. During the stimuli presentation, their facial expressions will be continuously recorded using high-resolution video monitoring. FACS will be used to analyze specific facial muscle movements--brow lowering, nose wrinkling, upper lip raising, tightening of lips, to identify and categorize the key facial expressions that are characteristic of the “sting” sensation of physical pain. Next, participants in the emotional pain group will go through a stimuli presentation designed to evoke emotional pain. Their facial expressions will be recorded in the same way as in the physical pain group, and FACS will again be used to analyze specific facial movements. The goal of this comparison is to examine whether people show similar facial expressions to the “sting” response when experiencing emotional pain as they do when reacting to physical pain.

2.4. Measures and data analysis

Facial expressions observed in both the physical and emotional pain groups will be analyzed with FACS to identify key facial grimacing movements. We will compare the intensity, frequency, and types of facial responses in the emotional pain group to the specific “sting” expressions observed in the physical pain group. This comparison aims to explore whether emotional pain produces facial expressions that are similar to those triggered by physical pain [1]. An independent samples t-test will be used to compare the average intensity and frequency of specific facial expressions between the physical pain group and the emotional pain group. This will allow us to determine if there are significant differences in the facial expressions associated with each type of pain.

2.5. Ethical considerations

Prior to the experiment, participants will receive a detailed explanation of the procedure, including the nature of the stimuli and any potential discomfort they might experience. Participants will be informed of their right to withdraw from the study at any time. Participants in the emotional pain group will be offered post-experiment emotional support. They will have the option to speak with a counselor if they experience lingering distress following the presentation of the tragic story videos.

2.6. Predictions

According to the Craig & Patrick’s 1985 science report and Ekman. & Friesen's 1978 report, we learned that “the intensity of pain is highly correlated to grimacing including facial movements of brow lowering, nose wrinkling, upper lip raising, and tightening of lips” [3, 4]. With the FACS technique, we can capture these movements of the participant's face. Thus, when participants are subjected to mild electrical stimulation, their faces should show facial distortions such as nose wrinkling, upper lip raising, etc. (Figure 1), and the degree of facial distortion increases with the intensity and duration of the pain (Figure 2). If our experimental hypothesis, “emotional pain activates facial motor regions in a manner similar to physical pain.” is valid, participants who feel emotional pain by watching tragic video stories should show similar facial grimacing as those who received mild electric stimulus (Figure 1).

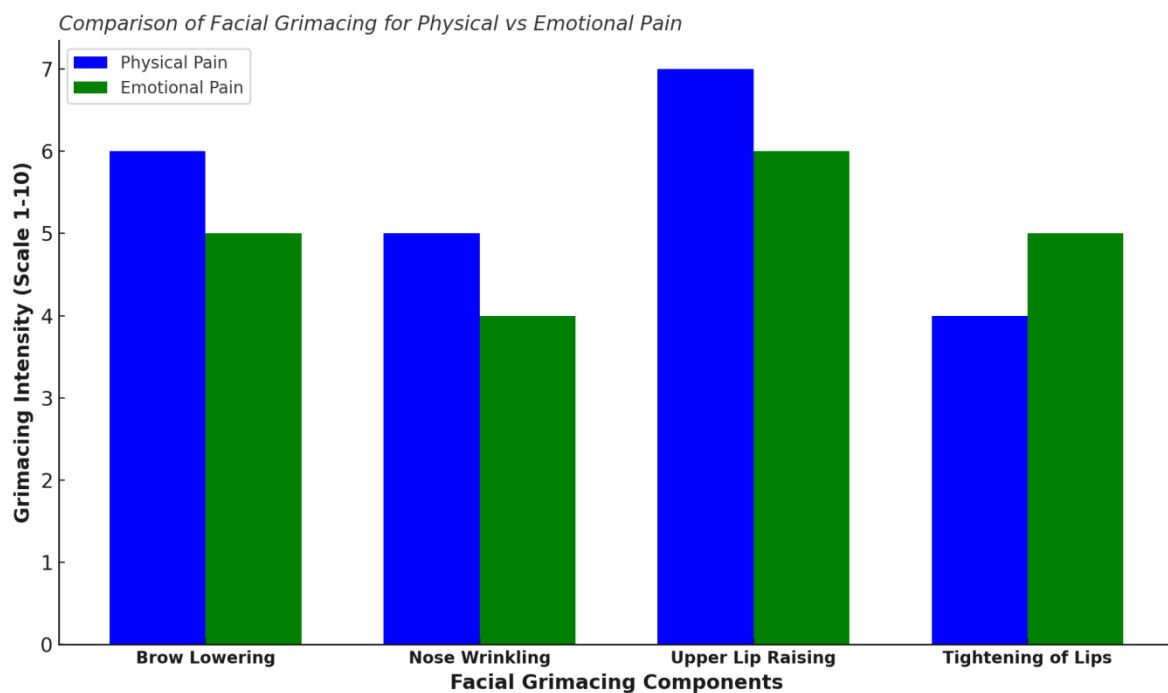


Figure 1: Predictions of differences between physical pain and emotional pain in facial expression distortions, specifically by comparing the intensity of brow lowering, nose wrinkling, upper lip raising and tightening of lips

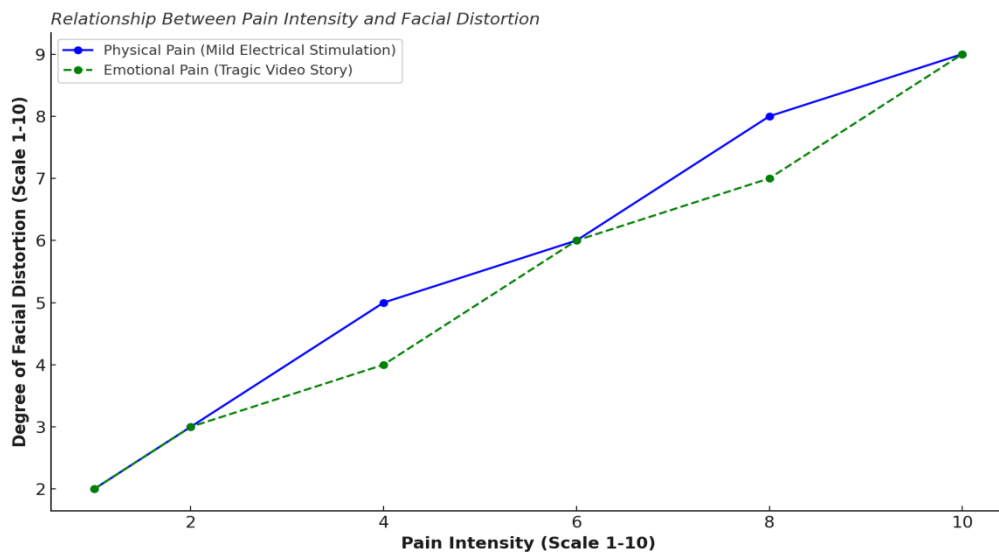


Figure 2: Predictions of the relationship between pain intensity and the degree of facial distortion in physical and emotional pain situations

3. Implications and future study

The findings of this study hold substantial implications for understanding the relationship between the processing of emotional and physical pain. If the results confirm the hypothesis that emotional pain activates facial motor regions similarly to physical pain, this outcome would reinforce the embodiment theory and highlight the integral role of perceptual-motor systems in our comprehension of abstract emotional concepts. Such results would lend credence to the notion that our emotional experiences are not merely abstract but are deeply rooted in physical sensations, expanding the framework within which we interpret both emotional and physical pain. Conversely, if the results do not support the hypothesis, this would raise critical questions about the generalizability of embodied cognition principles. This distinction would prompt a reevaluation of therapeutic approaches grounded in embodied cognition, particularly those applied to emotional disorders.

Future research might employ fMRI studies to examine specific brain regions activated during experiences of emotional and physical pain. Through this method, researchers could gain a more nuanced understanding of the neural overlap between these two types of pain, enabling a detailed mapping of the neural circuits involved in the embodied representation of abstract emotional concepts. Additionally, future studies could investigate the influence of individual differences in empathy on the processing of emotional pain. For instance, individuals with high empathy might experience emotional pain more intensely, possibly exhibiting increased motor region activation in response to emotionally charged stimuli. Such findings would reveal how variability in empathy levels impacts the embodiment of emotional and physical pain.

4. Conclusion

This study investigates the embodiment of emotional pain through the theoretical perspectives of embodied cognition and metaphor theory. By analyzing facial expressions elicited by both physical and emotional pain using the Facial Action Coding System (FACS), this research seeks to determine whether emotional pain triggers facial motor responses similar to those observed in physical pain. The hypothesis asserts that emotional pain, like physical pain, can activate specific facial

expressions—such as lowered brows and tightened lips—thus demonstrating an embodied component to emotional experience.

Our findings aim to expand the framework of embodied cognition by suggesting that abstract emotions are not solely cognitive but are also rooted in physical expression and perception. Additionally, this study underscores the relevance of metaphor theory in shaping our understanding of complex emotions through associations with bodily responses, proposing that emotions such as fear are “embodied” through metaphorical constructs that invoke motor responses.

If the predictions of this research are supported, they would reinforce the theory that emotional experiences have a physical dimension, influencing not only our interpretation of emotions but also how emotional pain might be managed in therapeutic contexts. This embodied approach could pave the way for innovative therapeutic interventions that utilize the link between physical expression and emotional states to address conditions characterized by emotional pain.

Future research could benefit from exploring the neural mechanisms connecting emotional and physical pain through techniques such as functional magnetic resonance imaging (fMRI) to identify motor regions engaged during emotional experiences. Additionally, examining individual differences, such as empathy levels, may reveal how personal traits impact the intensity and outward manifestation of emotional pain.

Acknowledgement

Shuangyi Wu, Yijing Lin, Wenjing Zhou and Xing Yan contributed equally to this work and should be considered co-first authors.

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