

Interpersonal Relationships and Intimacy Affect Top-down Processing of Empathy

I-Y. Chen¹, K-H. Chou², C-W. Lan³, Y-W. Cheng¹, and C-P. Lin^{1,3}

¹Institute of Neuroscience, National Yang-Ming University, Taipei, Taiwan, ²Institute of Biomedical Engineering, National Yang-Ming University, Taipei, Taiwan,

³Institute of Biomedical imaging and Radiological Sciences, National Yang-Ming University, Taipei, Taiwan

Introduction

Being in a close relationship is essential to well being and health. The cognitive significance of closeness can be described as including the other in the self [1]. Overlapping between other and self can be represented as a change in resource allocation strategy, actor/observer perspective, and vicariously sharing other's characteristics. Further, empathy is associated with the ability to experience and understand what others feel without confusion between oneself and others [2]. Intuitively, people in close relationships are more likely to share and respond to each other's feelings. Previous studies revealed great mutual understanding, or sense of knowing each other's experiences, in couples when both partners experience pain [3]. However, the way intimate relationships modulate empathy remains unclear. Perspective taking is the stepping-stone to human empathy [4]. Considering that "love is blind", which changes the actor/observer perspective by allowing more overlap between other and self, we hypothesized that imagining oneself, a loved one, and a stranger in pain will result in different degrees of activation in the pain matrix.

Materials and Methods

Thirty-six (18 males) right-handed healthy participants were enrolled in the study (mean age 23; SD 3 years) after providing written informed consent. None of the participants had any history of neurological or psychiatric disorders and all were free of medication at the time of the testing. Prescreening interviews were conducted to verify whether they are in love or not. They reported to be in a close relationship for an average of 31 months. The participants were required to fill in the inclusion of other in the self (IOS) scale [5] to assess closeness in their relationships. The presentation of the visual stimuli followed a block design. The stimuli included animated images displaying hands and feet in blocks depicting painful (Pain) and non-painful (Neutral) situations. Each run was preceded by an instruction explicitly indicating the perspective from which participants had to imagine the scenario (Self, Loved one, or Stranger). The priming instructions for perspective taking were indicated by a photo of the participants (self perspective), a photo of their partner (loved one's perspective), and a photo of another (unknown) participant (stranger's perspective). The order of the stimulus condition (Pain vs. Neutral) was randomized within each run. The order of the runs was counterbalanced across participants. All fMRI analysis was performed in SPM2 (Wellcome Department of Cognitive Neurology, Institute of Neurology, London, UK). After fMRI scanning, participants had to evaluate the pain intensity supposedly felt by the target (self, loved one, stranger) and the unpleasantness felt by themselves when observing painful stimuli with different perspectives. This evaluation was measured with a 6-point visual analog scale, using "from no pain to extreme pain" and "from no effect to extreme unpleasantness" as target words [6].

Results

Behavioral measurement

Mean values of the IOS were 4.8 ± 1.2 . Analysis of ratings of pain intensity revealed a main effect of perspective taking (Self vs. Loved one vs. Stranger) [$F(2, 31) = 14.831, P < 0.001$] as well as for unpleasantness felt by themselves [$F(2, 31) = 13.46, P < 0.001$]. *Post-hoc* comparison showed that the effect of perspective taking was mainly driven by significantly higher ratings of pain intensity and unpleasantness elicited by imagination of the Self and the Loved one, than the Stranger ($P < 0.05$). This indicates that participants rated scenarios to be more painful and unpleasant when imagining from their loved one's perspective as opposed to that of a stranger.

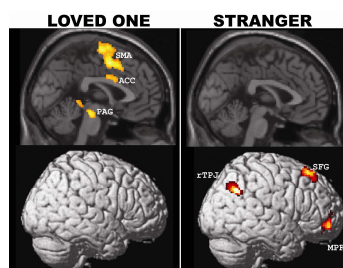
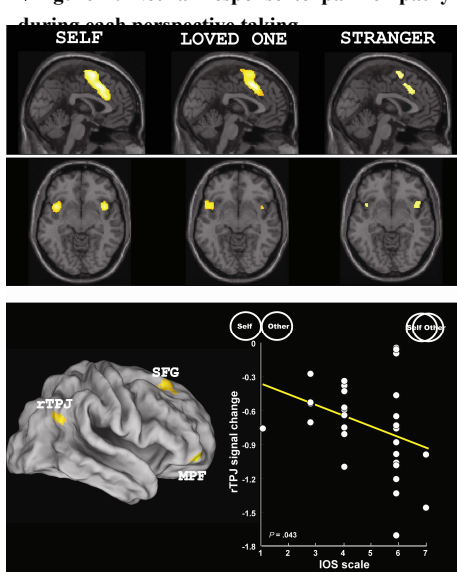
fMRI activation pattern

The hemodynamic response elicited by the painful nature of the stimuli, irrespective of the perspective adopted by the participants, was found in the pain matrix including the anterior cingulate cortex (ACC), supplementary motor area (SMA), periaqueductal gyrus (PAG), postcentral gyrus, and bilaterally in the anterior insula. When further examining whether activity in pain matrix was modulated by perspective taking, activation in the anterior insula showed a gradient decline from the Self, the Loved one, to the Stranger perspectives (Figure 1). Direct and reverse comparisons between the Self and Stranger perspectives revealed the involvement of a neural network similar to that observed in previous fMRI studies [7]. Activation associated with the Self-condition was detected in the ACC, anterior insula, and bilaterally in the thalamus. The reverse comparison showed increased activity in the superior frontal gyrus (SFG), medial prefrontal gyrus (MPF), and right temporo-parietal junction (TPJ). Interestingly, comparisons between the Loved one vs. Stranger perspectives in painful situations revealed such double dissociation. The ACC was more activated in the Loved one's perspective, whereas the right TPJ was activated in the Stranger's perspective (Figure 2).

Correlation analysis between BOLD signals and IOS

To investigate whether the neural activation detected when participants imagined a loved one in painful situations was affected by the reported quality of their relationship, multiple regression analysis was computed between the contrast image and the IOS. A significant cluster of activation detected in the right TPJ showed a significant negative correlation with the IOS ratings ($\beta = -0.432, t = -2.124, P = 0.043$) (Figure 3). That is, the closer the relationship, the greater the right TPJ deactivation.

↓ Figure 1. Neural response to pain empathy during each perspective taking.



↑ Figure 2. Pain empathy responses associated with imagining a loved one and a stranger in pain. Double dissociation of pain empathy-related hemodynamic activity in the ACC and right TPJ.

← Figure 3. Correlation of the right TPJ activity and the Inclusion of Other in the Self (IOS) scale while participants imagine their loved one in painful situations. Lower activity in the right TPJ is associated with higher IOS scores.

Conclusions

Overall our study indicates that intimacy modulates the top-down process of pain empathy. The Loved one than the Stranger's perspective yielded more overlapping with the Self's as indicated by stronger hemodynamic response in the ACC and insula. The closer participants reported to be their relationship the more self-other overlap resulted in the more deactivation in the right TPJ, MPF, and SFG. These fMRI findings are consistent with the cognitive and affective implications of intimacy posited by Aron (1991) [1].

Reference

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