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Cerebral Imaging

Patient-centered interviewing is associated with decreased responses to painful stimuli: An initial fMRI study

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ABSTRACT

Objective: To identify the functional magnetic resonance imaging (fMRI) changes associated with a patient-centered interview (PCI) and a positive provider–patient relationship (PPR).
Methods: Nine female patients participated, five randomly selected to undergo a replicable, evidence-based PCI, the other four receiving standard clinician-centered interviews (CCI). To verify that PCI differed from CCI, we rated the interviews and administered a patient satisfaction with the provider–patient relationship (PPR) questionnaire. Patients were then scanned as they received painful stimulation while viewing pictures of the interviewing doctor and control images (unknown doctor).
Results: Interview ratings and questionnaire results confirmed that PCIs and CCIs were performed as planned and PCIs led to a much more positive PPR. We found significantly reduced pain-related neural activation in the left anterior insula region in the PCI group when the interviewing doctor's picture was shown.
Conclusion: This study identifies an association between a PCI that produced a positive PPR and reduced pain-related neural responses in the anterior insula. This is an initial step in understanding the neural underpinnings of a PCI.
Practice implications: If confirmed, our results indicate one neurobiological underpinning of an effective PCI, providing an additional scientific rationale for its use clinically.

1. Introduction

Research in healthcare communication and clinical medicine indicates that patient-centered interviewing (PCI) enhances the provider–patient relationship (PPR) and, in turn, improves health outcomes [1,2]. This makes the PCI a critical tool for medical care, research, and education. Nevertheless, at least two related factors have impeded the full integration of PCI into mainstream medicine: (a) failure to define PCI in the replicable, behavioral terms needed to conduct interventional research and (b) the absence of an established neurobiological basis for PCI and the PPR. These criticisms have led some to eschew PCI practices, dismissing them as 'soft science' [3]. Our group developed an evidence-based, behaviorally defined PCI method that enabled us to study the PCI experimentally and, in this particular case, to better understand its neurobiological underpinnings [3–8].

Finset and Mjaaland [9] recently proposed a neurobehavioral theory that identifies affect regulation as an immediate outcome of PCI, yet despite the prevalence of fMRI methods, we are aware of no actual research to explore the neurobiological basis of a PCI when it is associated with a positive PPR. However, the Finset and Mjaaland model is consistent with evidence emerging from recent fMRI studies of other dyadic relationships [10,11]. These studies indicate that emotion regulation presents one possible benefit-conferring mechanism associated with a positive relationship. For example, Coan et al. [10] measured brain activity in women subjected to threat of electric shock while holding their husband's hand, the hand of an anonymous male, or no hand at all. The brain response in neural systems including the anterior insula showed a pervasive attenuation of activation when the women held their husband's hand. The anterior insula has been known to substantiate interoceptive awareness [12] but it is increasingly thought to subserve the broader function of integrating afferent physiological signals with higher order contextual information [13,14].

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More recently, Eisenberger et al. [11] examined pain-related brain responses when women in long-term romantic relationships viewed pictures of their partner versus a stranger. These investigators also report reductions in pain-related neural activity in the anterior insula. The findings are consistent with the notion that positive attachment relationships can modulate reactions to perceived pain (threats, more broadly), i.e., positive attachment figures act as emotion regulators in ways that strangers or negative attachments do not [10]. These findings also suggest that out of the network of regions involved in pain or threat processing, the anterior insula region is a key site of modulatory effects.

Deriving an experimental paradigm from those above, we measured brain activation during the anticipation and experience of pain stimulation in patients following a PCI or a standard clinician-centered interview (CCI). Thus, we focus on the period shortly after the interview to assess the neurobiological impact of PCI and the resultant positive PPR. Such an experimental paradigm circumvents practical and interpretive challenges of studying the actual provider–patient interaction while the patient is inside the scanner. To extend the impact of the PCI on the PPR, following the interview, we had the PCI interviewing doctor oversee preparation for scanning and showed his picture during half of the scans. We hypothesized that, compared to a CCI, patients who received a PCI would show significantly reduced pain-related activation in the anterior insula region during the anticipation and experience of painful stimulation while viewing a photograph of the interviewing doctor versus a control image (unknown doctor).

2. Methods

2.1. Overview

Following random allocation with matching for age and SES, each patient took part in a 20–25 min interview, either a PCI or CCI. Next, just prior to the fMRI session, each patient's pain threshold was determined, defined as the point at which electrical stimulation is aversive but tolerable. Perception threshold was also determined, defined as the point at which stimulation is imperceptible. As an extension of the PCI and CCI interventions, this preparation for the fMRI scans was overseen by the interviewing doctor.

Patients were then placed in the fMRI scanner and studied while aversive stimulation (or imperceptible stimulation) was intermittently applied to their left hand. While in the scanner, a screen provided patients with visual cues that indicated the type of stimulation to follow (pain or no-pain). Photographs of a doctor, either the interviewing doctor or an unknown doctor, could also be seen during the task. Prior to the fMRI session, patients were familiarized with the task and were informed that the pictured doctor would be monitoring their scan during the time the doctor appeared on the screen. We measured fMRI signal changes due to changing neural activity at a rate of 2 s, resulting in a series of three dimensional brain images over the course of a scan.

There were three 12-min fMRI scans, with a short break between to minimize any physical discomfort and prevent the scanner from overheating. A combination of cue and subsequent stimulation constituted a trial. A total of 24 trials were presented during each fMRI scan, resulting in a total of 72 trials. Half of the trials were pain trials and the remainder were no-pain trials. The pain trials started with a red arrow cue and ended, after a short interval, with a red dot. The red dot coincided with aversive stimulation. The other half were no-pain trials, starting with a blue arrow cue and ending, after a short interval, with a blue dot. The blue dot was associated with imperceptible stimulation. Patients rated the intensity of stimulations they felt using a 9-point Likert scale ranging for 1 = no pain to 9 = worst pain. During half of the trials of each type (pain, no-pain), patients saw a picture of the interviewing doctor (PCI or CCI), while for the remainder of the trials patients saw a picture of an unknown doctor (matched to the interviewing doctor's age and gender). On the right side of Fig. 1, we show a pain trial and a no-pain trial where a photograph of the interviewing doctor (PCI, CCI) was visible to the patient while in the fMRI scanner; on the left side of Fig. 1 we show a pain trial and a no-pain trial where the photograph was of the unknown doctor. Finally, a single high-resolution anatomical scan was obtained after all fMRI scans were complete.

2.2. Subjects

Nine right-handed female subjects were recruited from the waiting room of a primary care clinic or through newspaper advertisements. They were between 25 and 61 years of age (average age = 49 years). Exclusion criteria were typical for fMRI studies of this type: left-handedness, any prior history of a neurological disorder, the use of psychoactive medications, or prominent pain symptoms. Patients signed informed consent and were paid $100 to participate. The study was approved by the Michigan State University Institutional Review Board. Patients knew only that they were to be interviewed by a doctor and that they were to receive an fMRI pain tolerance study. They did not know their assigned interview type (PCI or CCI). Patients were fully debriefed following completion of their fMRI study.

2.3. Intervention

One of the authors (RS) conducted either a PCI or a CCI for 20–25 min. The PCI was an evidence-based, behaviorally defined method focused on eliciting and responding to emotions [4], while the CCI was a standard interview, focusing on possible disease diagnoses and omitting personal and emotional information. Interviews were videotaped for the evaluation reported here. The PCI method is presented in Table 1. Steps 1 and 2 put the patient at ease and set the agenda but are not patient-centered, while Steps 3 and 4 are the true patient-centered components and focus on personal and emotional issues and establishing a strong relationship. Step 5 is the transition to doctor-centered interviewing.

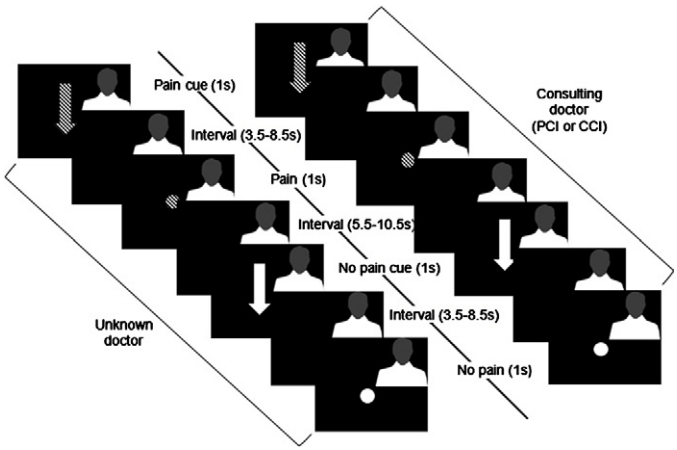

Fig. 1. Trial structure for the pain and no pain conditions. Pain trials started with red (stripped in the figure) arrow, followed after a short delay by a similarly colored dot and simultaneous aversive stimulation. No pain trials started with blue (white in the figure) arrow, followed after a short delay by a similarly colored dot and simultaneous imperceptible stimulation. A doctor's picture appeared on the left corner of the screen during all trials. Half of all trials included a picture of the interviewing doctor (PCI or CCI), while the remainder of the trials included a picture an unknown doctor (matched to the interviewing doctor's age and gender). PCI, patient-centered interview; CCI, clinician-centered interview.

Table 1
The patient-centered interview with 5 steps and 21 substeps.

Step 1—setting the stage for the interview
1. Welcome the patient
2. Use the patient's name
3. Introduce self and identify specific role
4. Ensure patient readiness and privacy
5. Remove barriers to communication
6. Ensure comfort and put the patient at ease
Step 2—chief complaint/agenda setting
1. Indicate time available
2. Indicate own needs
3. Obtain list of all issues patient wants to discuss; e.g., specific symptoms, requests, expectations, understanding
4. Summarize and finalize the agenda; negotiate specifics if too many agenda items
Step 3—opening the HPI
1. Open-ended beginning question
2. 'Nonfocusing' open-ended skills (attentive listening): silence, neutral utterances, nonverbal encouragement
3. Obtain additional data from nonverbal sources: nonverbal cues, physical characteristics, autonomic changes, accouterments, and environment
Step 4—continuing the patient-centered HPI
1. Physical story—obtain description of the physical symptoms [focusing open-ended skills]
2. Personal story—develop the more general personal/psychosocial context of the physical symptoms [focusing open-ended skills]
3. Emotional story—develop an emotional focus [emotion-seeking skills]
4. Empathic responses—address the emotion(s) [emotion-handling skills: NURS]
5. Expand story and responses—expand the story to new chapters (focused open-ended skills, emotion-seeking skills, emotion-handling skills)
Step 5—transition to the doctor-centered process
1. Brief summary
2. Check accuracy
3. Indicate that both content and style of inquiry will change if the patient is ready

2.4. Measures

2.4.1. Intervention fidelity

To confirm the accurate delivery of PCIs and CCIs, we implemented a simplified version of a videotape rating procedure described in an earlier RCT [7]. One blinded independent rater evaluated both the PCI and the CCI interviews for the interviewer's success in achieving the 5 steps and 21 substeps in the patient-centered approach (Table 1).

2.4.2. Intervention impact on the PPR

To confirm that the intervention induced positive PPR changes, we administrated the patient satisfaction with the PPR questionnaire [6–8], a reliable and valid 25-item instrument (available from the authors) that has been shown to have a 4-factor structure: (1) open-endedness of the physician (alpha 0.82), 7 items; (2) the doctor's empathy (alpha 0.89), 11 items; (3) confidence in the doctor (alpha 0.84), 4 items; and (4) general satisfaction with the interaction (alpha 0.71), 3 items [15,16].

2.4.3. Brain activation

We conducted all fMRI analyses using Analysis of Functional Neuroimages (AFNI) software [17]. Following a general linear model (GLM) approach, we assessed brain activation (expressed as percent signal change from baseline) during the anticipation and response periods for each trial type (pain or no-pain). We then computed contrasts representing pain versus no-pain conditions during the anticipation and response periods.

To confirm that the anticipation and response to aversive stimulation elicited increased neural activation in our defined region-of-interest (ROI), the anterior insula bilaterally, we first averaged contrast (pain versus no-pain) values across anticipation and response periods. We then subjected these to a one-sample *t* test. To test our hypothesis, we then extracted contrast (pain versus no-pain) percent signal change values from the activated anterior insula regions for each subject. We analyzed these data using a repeated-measures ANOVA, with intervention type (PCI, CCI) as a between-subjects factor, and doctor photograph (interviewing, unknown), hemisphere (right, left) and period (anticipation, response) as within-subjects factors using SPSS version 18 (SPSS, Chicago, IL). Based on convention, all analyses were one tailed ($p < 0.05$).

2.4.4. Behavioral ratings

We first computed contrasts representing the subjective experience of stimulation intensity for pain versus no pain trials. We then submitted the contrast (pain versus no pain) ratings to a repeated-measures ANOVA with intervention type (PCI, CCI) as between-subjects factor and doctor photograph (interviewing, unknown) as within-subjects factor.

3. Results

3.1. Intervention delivery and impact on the PPR

As expected, shown in Table 2, PCI subjects had significantly higher scores for patient-centeredness compared to CCI subjects for Steps 3 ($p < 0.01$) and 4 ($p < 0.03$), but not for Steps 1, 2, and 5, thus confirming accurate implementation of the PCI intervention. Furthermore, shown in Table 3, PCI patients reported significantly higher satisfaction with the PPR, demonstrating that the PCI produced positive PPR changes. Significantly higher scores for the PCI group were observed for all four factors of the scale (all $p < 0.01$).

3.2. Brain activation and behavioral ratings

The first step in the fMRI analysis confirmed that the anticipation and response to aversive stimulation elicited increased activation in pain-related ROIs in the anterior insula bilaterally ($p < 0.05$, corrected for multiple comparisons). Consistent with previous findings, results showed a main effect of period, such that pain-related activation was greater during the experience of pain than during the anticipation period ($p < 0.01$).

Hypothesis-testing results revealed that pain-related activation was modulated by intervention type (PCI versus CCI), as indicated by a significant intervention type × doctor photograph interaction. Tests of simple effects revealed that this interaction was primarily driven by the PCI group, who demonstrated significantly reduced pain responding in the left anterior insula while viewing a photograph of the PCI versus the unknown doctor ($p < 0.05$) (Fig. 2). This effect failed to reach significance in the right anterior insula, but was in the same direction ($p = 0.16$). When we aggregated data from each hemisphere, reduced activation remained significant ($p < 0.05$). No significant differences were observed in the CCI group. Thus, the PCI intervention resulted in attenuated activity in pain-related neural regions during pain when patients viewed images of the interviewing versus an unknown doctor.

Table 2
Tests of patient centered interview (PCI) versus clinician centered interview (CCI) group differences for intervention steps.

Intervention steps	*t*	*p*
Step 1: setting stage for the interview	0.723	0.493
Step 2: chief complaint/agenda setting	1.972	0.089
Step 3: opening the HPI	5.693	0.001
Step 4: continuing the patient-centered HPI	2.947	0.021
Step 5: transition to the doctor-centered process	1.219	0.262

Table 3
Tests of patient centered interview (PCI) versus clinician centered interview (CCI) group differences for factors derived from the patient provider relationship (PPR) questionnaire.

Factors	*t*	*p*
Open-endedness	5.078	0.001
Doctor's empathy and sensitivity	6.274	0.000
Confidence in the doctor	4.028	0.005
General satisfaction with the interaction	8.582	0.000

Repeated-measures ANOVA performed on self-reported pain ratings revealed no significant main effects or interactions. However, a contrast between pain ratings for the interviewing versus the unknown doctor in the PCI group was in the predicted direction ($p = 0.11$) with reduced self-reported pain intensity when viewing the picture of the interviewing doctor.

4. Discussion and conclusion

These findings represent the initial step in identifying the neural underpinnings of a PCI when associated with a positive PPR.

4.1. Discussion

We provide preliminary evidence that a PCI (with continued monitoring by the interviewer during preparation and scanning) associated with a positive PPR modulates patients' neurobiological responses to painful events. Specifically, we found that a positive PPR resulting from an experimentally applied 20–25 min PCI was associated with attenuated pain-related responses in the anterior insula when patients saw a photograph of the interviewing doctor. This result is consistent with the neuroimaging literature showing the anterior portion of the insular cortex to be active during emotional challenges, emotional recall, and self-generated emotions, suggesting its key role in the conscious, evaluative, experiential, and expressive aspects of internally generated emotional and visceral responses [12–14,18–24].

In pain-processing studies, the anterior insula involvement is reported as part of network of brain regions subserving the anticipation and experience of pain, with conscious emotional responding as the constituent process most consistently linked with activation in this region [10,11,25]. This is particularly important because the hallmark of the PCI is emotional modulation during Steps 3 and 4, achieved by eliciting the patient's emotion, addressing it, and thereby establishing a positive relationship [4,26].

The observed attenuation of pain-related activation in the anterior insula also supports and extends previously reported similar effects in the context of positive attachment relationships [10,11]. We hypothesize that, just as in a strong marriage, the strong PPR resulting from the PCI is mediating the neurobiological changes. The fact that attenuated pain responding was only observed when viewing the image of the interviewing relative to an unknown doctor is also consistent with the idea that the physical presence [10] or at least a visual reminder [11] of a positive relationship partner may be necessary for enhanced emotion regulation during threat.

If proven in additional research, the fact that similar findings have emerged in different relationship contexts suggests a common welfare-enhancing mechanism [11,27,28]. Taken as a whole, these findings support the hypothesis that the presence or

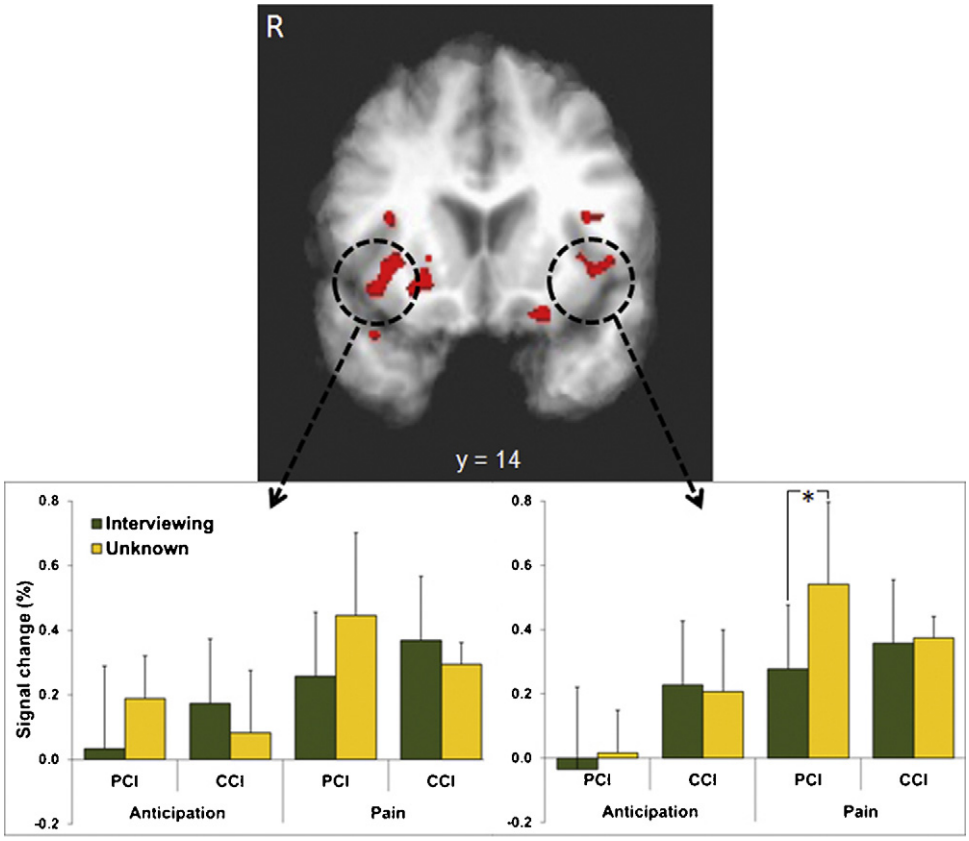

Fig. 2. The brain images illustrate the results of fMRI activation analysis. Circled clusters indicate greater activation for pain than no pain trials across anticipation and pain response epochs for our ROIs in the bilateral anterior insula. Bar graphs for the circled clusters illustrate average percentage signal change contrast (pain versus no pain) scores extracted from the anterior insula ROIs. Error bars represent the 95% confidence intervals; PCI, patient-centered interview; CCI, clinician-centered interview; $^{*}p < 0.05$.

even a visual image of socially supportive figures, such as a doctor or spouse, provides important biological safety signals, resulting in the attenuation of emotional responses during anxiety-producing challenges [11].

That there was no other treatment administered in this study suggests that the neurobiological mechanism here may be distinct from expectancy-based mechanisms [29], but it is possible they could be related to an affective component of placebo analgesia. If the pain- or stress-reducing mechanism suggested here is confirmed, the PCI may be particularly beneficial for patients with pain- or anxiety-related ailments and may underlie findings of decreased need for pain medications associated with positive PPR [30]. Because the present study involves experimentally manipulated PPR over a single session, results may provide only a tenuous link to other previously reported health benefits associated with PCI [7,8,31–33].

Nevertheless, the observed diminution of neural responding is consistent with the neurobiological theory proposed by Finset and Mjaaland [9] that identifies affect regulation as an immediate outcome of person-centered consultation. Of note is that the PCI method used in this study comprises all 4 key areas identified in the proposed theory: (1) establishing rapport, (2) patient disclosure of emotional cues and concerns, (3) the doctor's expression of empathy, and (4) positive reappraisal of concerns.

Reduced responding to stressful events merits further study as an initial outcome of a positive PPR that may contribute to the maintenance of a healthy immune system resulting in positive effects on a number of health outcomes [32,34,35]. In addition, stress-reducing effects of a positive PPR may indirectly influence health outcomes by promoting behavioral changes, such as self-confidence and motivation to practice healthy behaviors and follow medical advice [9,36]. Further brain imaging research is necessary to determine if a stress-reducing mechanism is separable or integrally related to other associations of a positive PPR.

4.1.1. Limitations

As a first study conducted with a small patient sample, we consider these results as preliminary and in need of replication with a larger sample size. It is possible that the observed effects may disappear with a larger sample. Further, the present findings do not inform how powerful or long-lasting the effects of a single PCI may be. Additional research is needed on the PCI to determine how long and over what period of time it must be applied to affect the neurobiological profile. We also studied the neurobiological impact of a specific PCI method, suggesting the need to study other methods of developing a positive PPR.

4.2. Conclusion

A PCI intervention was associated with attenuation of pain-related neural responses in the anterior insula.

4.3. Practice implications

Present findings show promise in identifying a neurobiological basis for a PCI-induced positive PPR and, if confirmed, can provide further scientific support for PCI as a fundamental clinical skill.

Disclosure statement

We confirm all patient/personal identifiers have been removed or disguised so the patient/person(s) described are not identifiable and cannot be identified through the details of the story.

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