Modulation of brain activity in chronic back pain and in osteoarthritis patients by Lidocaine treatment

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INTRODUCTION

- Little is known about the impact of pharmacological intervention on cortical activity in patients suffering from pathological pain. In our previous studies we identified distinct cortical substrates underlying chronic back pain (CBP) and osteoarthritis (OA). We showed that CBP primarily engages the medial prefrontal cortex (MPFC), while OA pain maps to the thalamus, the striatum, bilateral insula, supplementary motor area (SMA) and anterior cingulated cortex (ACC).

- Here we use fMRI to look at brain activity changes in CBP and OA patients before and after two weeks of topical Lidocaine therapy.

METHODS

- Eight CBP patients and four OA patients participated in this study.

- In the scanner, subjects used the finger-span device to track the changes in their pain intensity (pain rating task) and the height of a bar changing in time (visual rating control task) (panels 1 – 2).

- GLM model (FSL software; fmrib, Smith et al. 2001) was used to identify brain areas that were activated for pain and visual rating tasks.

- Higher level analysis was performed to generate group average (pain – visual) activity maps for OA and CBP and to perform a t-test for pre and post treatment (panel 4).

- Covariate analysis was done using FSL to search for brain areas that encode pain intensity in CBP and OA (panel 5) and to investigate the effect of pain intensity on the visual task (panel 6).

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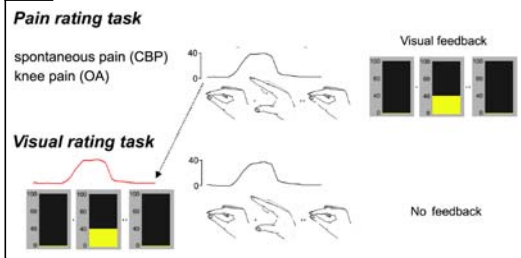
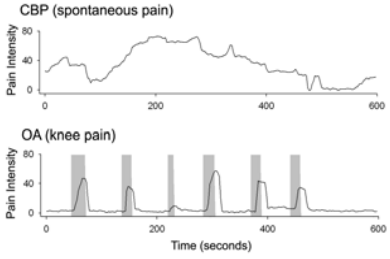
1 Pain and visual rating tasks



In the **pain rating task**, subjects continuously rate the perceived magnitude (black trace) of pain using a finger-span device. They observe the magnitude of their ratings as a bar graph changing in length in proportion to the rating.

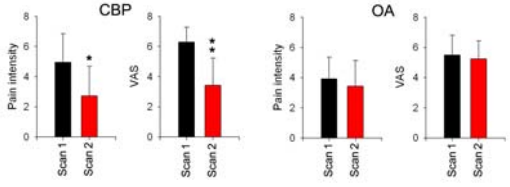
In the **visual rating task**, subjects continuously rate the perceived magnitude of the length of the visual bar (red trace). The length of the bar is derived from the magnitude trace for pain (black in A).

2 Pain rating in CBP and OA



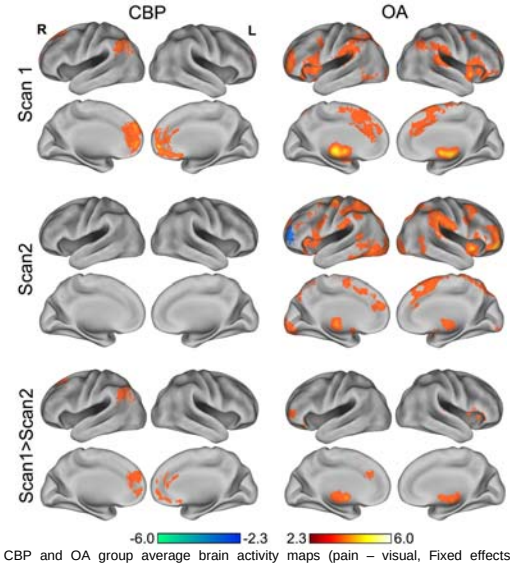
Example of pain rating from one CBP (top) and OA (bottom) patient. CBP patients rated the spontaneous fluctuations of their pain intensity, whereas OA patients rated fluctuations in their pain intensity in response to the application of pressure on their affected knee (gray bars)

3 Pain intensity modulation after Lidocaine treatment in CBP and OA



Group average pain ratings and VAS scores for CBP and OA before (scan1) and after (scan2) treatment with Lidocaine. **Reported pain intensity decreased in CBP (p<0.05), but not in OA after treatment**

4 Brain activity changes after Lidocaine treatment in CBP and OA



CBP and OA group average brain activity maps (pain – visual, Fixed effects analysis) for scan 1 (prior to treatment), scan2 (2 weeks after application of Lidoderm) and contrast between before and after treatment (scan1 – scan2). CBP patients exhibit a significant decrease in MPFC activity after treatment. On the other hand OA patients show significant decreased brain activity in bilateral thalamus , insula, mACC and lateral frontal regions

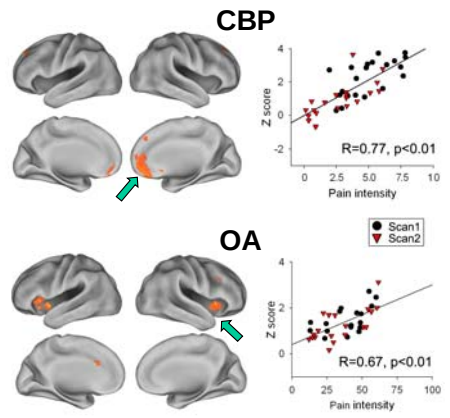
CONCLUSION

- Brain activity in CBP spontaneous pain is very different from that of mechanically evoked pain in OA

- Modulation of afferent input with Lidocaine patches gave rise to different patterns of change in behavior and in brain activity depending on the condition. CBP pain intensity decreased with treatment with a parallel decrease in brain activity. OA patients did not show any treatment response; nevertheless, brain activity decreased in the thalamus, anterior insula, and the lateral frontal cortex.

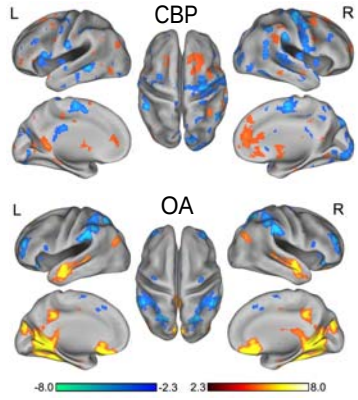
- The results show that Lidocaine therapy is dependent on the clinical condition and its cortical components , and that it might be more efficacious in conditions where spontaneous pain is prominent.

5 Brain regions encoding pain intensity in CBP and OA



Different brain regions encode pain intensity of CBP and OA pain. Pain intensity for CBP (mean rating of pain during scan) exhibits a significant positive correlation with mPFC activity (p<0.01), whereas pain intensity of OA is best correlated with insular activity (p<0.01).

6 Modulation of brain activity in the visual task in OA and CBP



Covariate analysis for visual task with pain intensity(VAS) in CBP and OA. Brain activity for the visual task is modulated differently with pain for CBP and OA.