Prefrontal gamma oscillations encode spontaneous fluctuations of chronic back pain intensity

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INTRODUCTION

- Chronic pain is a major healthcare issue characterized by ongoing pain and sensory, cognitive and affective abnormalities. Its neural basis is still not fully understood.
- The intensity of ongoing pain as the key symptom of chronic pain is encoded by brain activity in the medial prefrontal cortex[1]. In addition, ongoing experimental pain in healthy subjects is encoded by neuronal gamma oscillations in prefrontal cortex[2,3]. However, the direct neuronal correlate and frequency profile of the encoding of ongoing pain in chronic pain is still unknown.
- Here, we thus investigated the neurophysiological encoding of ongoing pain in chronic pain using EEG.

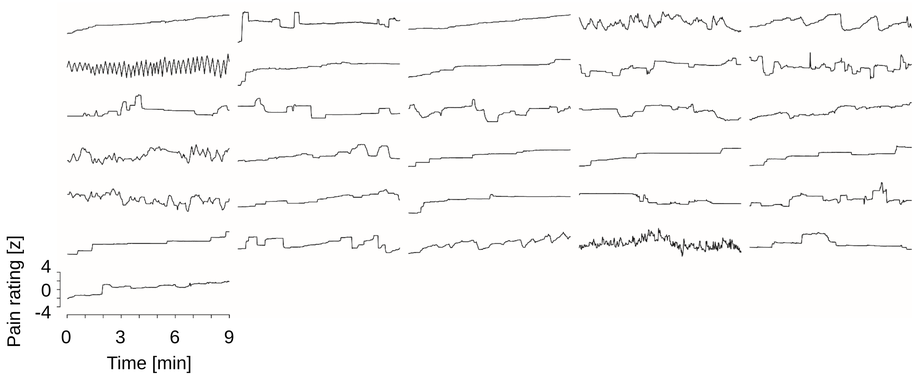
METHODS

- Subjects:
  - 31 chronic back pain patients (56 ± 13 yrs , 17 f)
- Experimental paradigm
  - *Spontaneous pain* condition
    9 min of continous rating of ongoing pain intensity using finger span-device
    (VAS: 0 = no pain, 100 = worst imaginable pain)
  - *Visual control* condition
    Tracking of visually replayed time course of pain rating of the *spontaneous pain* condition
- Measures
  - Continuous (pain) ratings
  - EEG (64 channels)
  - EMG (Neck, Masseter)
- Analyses (Matlab, FieldTrip)
  - Time-frequency analysis
  - Source analysis (beamforming)
  - Linear regressions of (pain) ratings with EEG and EMG data
  - Cluster-based permutation statistics

RESULTS

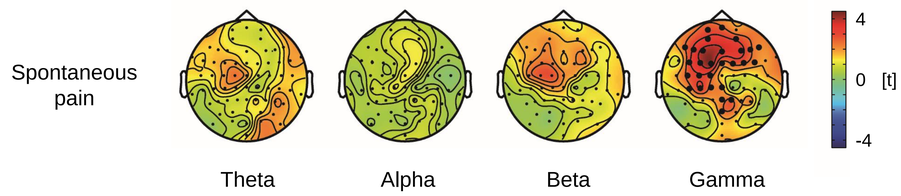
Spontaneous fluctuations of ongoing pain

Behavioral data showed spontaneous fluctuations of ongoing pain over the course of the experiment (mean averaged pain intensity: 41 ± 21 VAS).

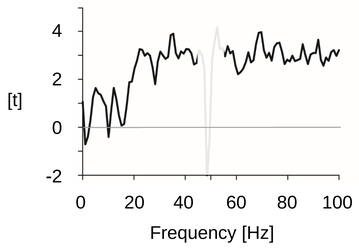


Neurophysiological encoding of ongoing pain

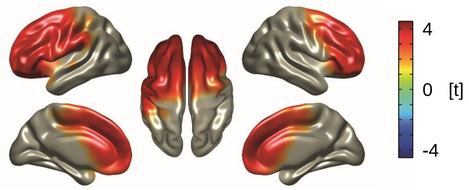
Time courses of ongoing pain ratings in the *spontaneous pain* condition were related to neuronal gamma oscillations at frontal EEG electrodes (t_{max} = 4.3, p = 0.005). Thus, higher pain ratings were associated with stronger frontal gamma oscillations. No relationships in other frequency bands were found (p > 0.05).



A frequency resolved analysis confirmed strongest relations in the gamma range above 30 Hz.



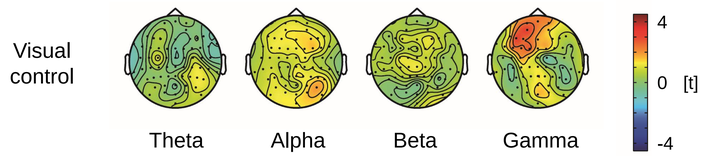
Source analysis of gamma band relationships revealed a bilateral frontal cluster (t_{max} = 4.4, p = 0.008).



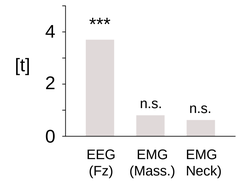
RESULTS

Control analyses

No significant relationships were observed in the *visual control* condition controlling for sensory, motor and attentional components of the pain rating task (p > 0.05).



No significant relationships between ratings in the *spontaneous pain* condition and gamma band activity at EMG electrodes were found (p > 0.05).



CONCLUSIONS

- The present results indicate that prefrontal gamma oscillations encode the intensity of ongoing pain in chronic back pain patients, supporting an important role of emotional-evaluative circuits rather than sensory circuits in ongoing pain[1,4,5].
- Prefrontal gamma oscillations might represent a potential location- and frequency-specific direct neuronal marker of ongoing pain, which can be measured using EEG and could be used for pain diagnosis and treatment.

LITERATURE

[1]Baliki et al., J Neurosci, 2006
[2]Schulz et al., Cereb Cortex, 2015
[3]Nickel et al., Neuroimage, 2017
[4]Hashmi et al., Brain, 2013
[5]Baliki & Apkarian, Neuron, 2015

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