Brain networks of tonic experimental pain assessed by EEG

Moritz M. Nickel, Son Ta Dinh, Elisabeth S. May, Laura Tiemann, Martina Postorino, Markus Ploner

Department of Neurology and TUM-Neuroimaging Center, Technische Universität München, Munich, Germany

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INTRODUCTION

- In the brain, pain emerges from activation of an extended network of brain areas generating oscillations and synchrony at different frequencies.
- Here, we used EEG to comprehensively characterize the spatial and spectral pattern of neuronal oscillations and synchrony during longer-lasting experimental pain.

METHODS

Subjects

- 39 healthy participants (24.3 ± 5.6 yrs, 18 f)

Measures

- EEG (64 channels)

Paradigm

- Tonic painful heat stimuli of 10 min (thermode, Medoc) applied to the left hand or right hand in two tonic pain conditions
- Two visual control conditions

Power analysis

- Global and local power analysis
- Peak frequency analysis

Connectivity analysis

- Phase-based: phase locking value (**PLV**)
- Amplitude-based: orthogonalized amplitude envelope correlation (**AEC**)

Graph analysis

- Nodes = voxels
- Edges = connectivity, thresholded to 10% strongest
- Measures: degree, clustering coefficient, global efficiency, small-worldness, and modularity

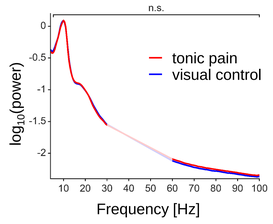
Statistical analysis

- Cluster-based permutation tests
- Non-parametric permutation tests

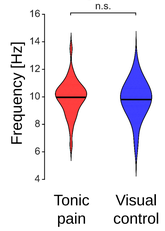
RESULTS

LEFT HAND STIMULATION

Global power

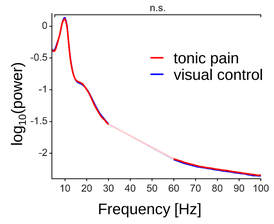


Peak frequencies

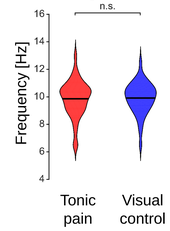


RIGHT HAND STIMULATION

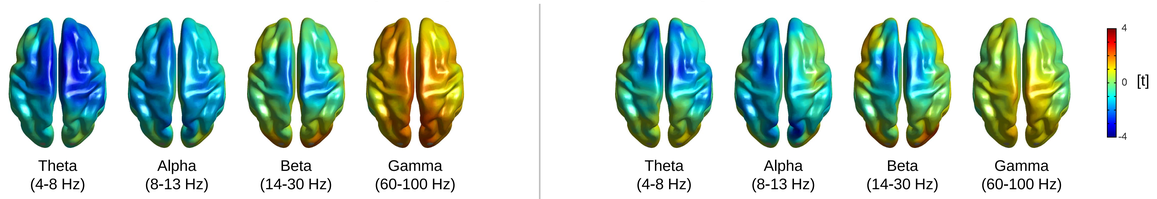
Global power



Peak frequencies

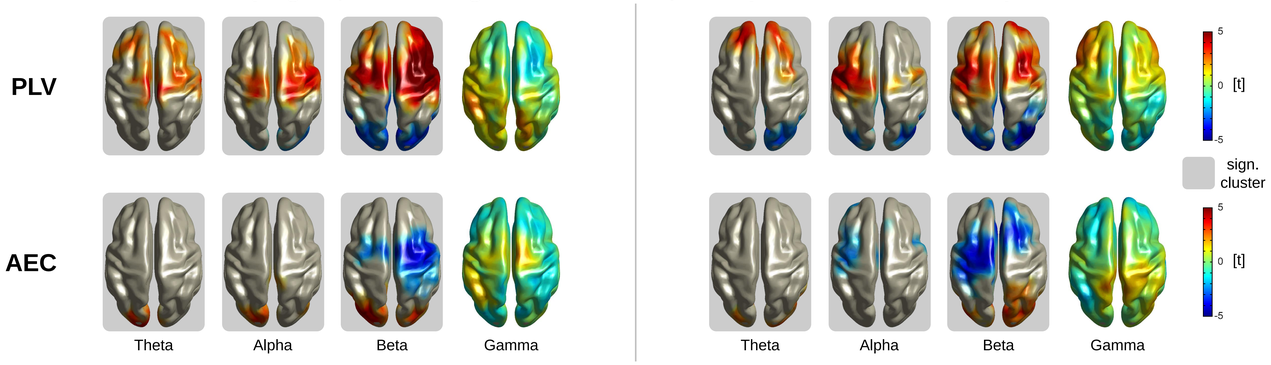


Local power
(tonic pain vs. visual control)



→ No significant change in peak frequency, global or local power between tonic pain and visual control conditions in any frequency band.

Local connectivity
(degree, 10% strongest connections; tonic pain vs. visual control)

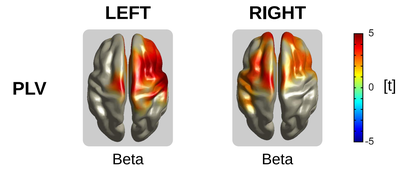


→ Significant increase in phase-based connectivity during tonic pain in alpha and beta frequency bands in the contralateral sensorimotor area.

→ Significant decrease in amplitude-based connectivity during tonic pain in the beta frequency band in the contralateral sensorimotor area.

RESULTS

Long-range connectivity
(excluding nearest neighbors within 3 cm³ cube)



→ Selective increase of long-range connectivity at beta frequencies

Global graph measures

→ No significant changes in PLV- and AEC-based global clustering coefficient, global efficiency, small-worldness, and modularity during tonic pain

CONCLUSIONS

- No difference in peak frequency, global and local power between tonic pain and visual control conditions were found.
- During tonic pain, significant changes of connectivity were observed at alpha and beta frequencies in the contralateral sensorimotor cortex.
- Phase-based and amplitude-based connectivity measures showed opposite effects indicating that they represent different coupling mechanisms.
- Preliminary analyses indicate that changes of phase-based connectivity at beta frequencies particularly include changes in long-range connectivity.

moritz.nickel@tum.de

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