

A machine learning approach towards an EEG-based marker of chronic pain

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Introduction

- Chronic pain is a major healthcare issue. Its causes are not fully understood and its treatment is often unsatisfactory.
- Converging lines of evidence indicate that the brain plays a crucial role in the development, maintenance and encoding of chronic pain.
- Can we differentiate between patients with chronic pain and healthy controls by means of EEG?**

Methods

Subjects

- 101 patients with chronic pain (mean age 58.2 ± 13.5 years, 69 f, 32 m)
- 84 matched healthy controls (mean age 57.8 ± 14.6 years, 55 f, 29 m)

Measures

- EEG (64 channels, Brain Products)

Paradigm

- Resting-state, 5 minutes eyes closed

Data analysis

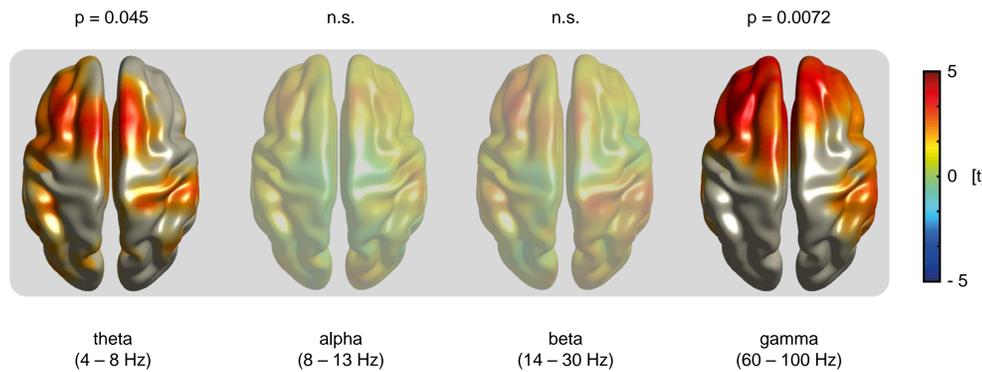
- Software:
 - Matlab
 - Toolboxes: FieldTrip, Brain Connectivity Toolbox
- Univariate
 - Peak frequency
 - Power
 - Connectivity
- Multivariate
 - Support vector machine

Statistical analysis

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

Results – univariate

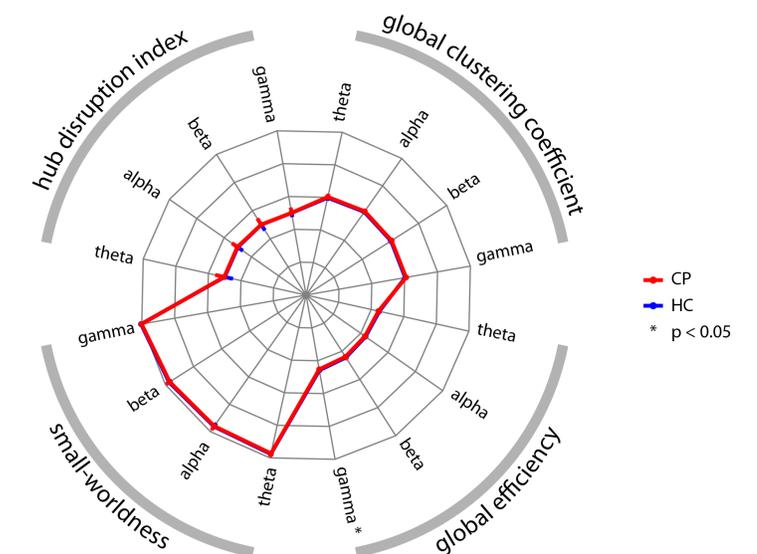
Phase locking value (PLV) based connectivity Chronic pain patients (CP) – healthy controls (HC)



→ Patients with chronic pain show:

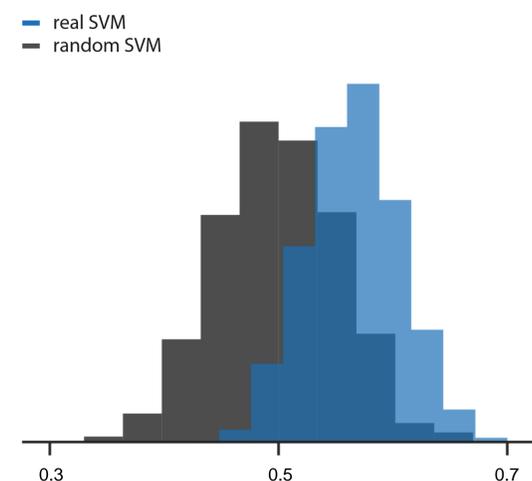
- Increased theta connectivity (Cohen's $d = 0.35$)
- Increased gamma connectivity (Cohen's $d = 0.39$)
- Decreased gamma global efficiency (Cohen's $d = 0.00054$)

Phase locking value (PLV) based graph measures



Results – multivariate

Support vector machine (SVM) Classification accuracy

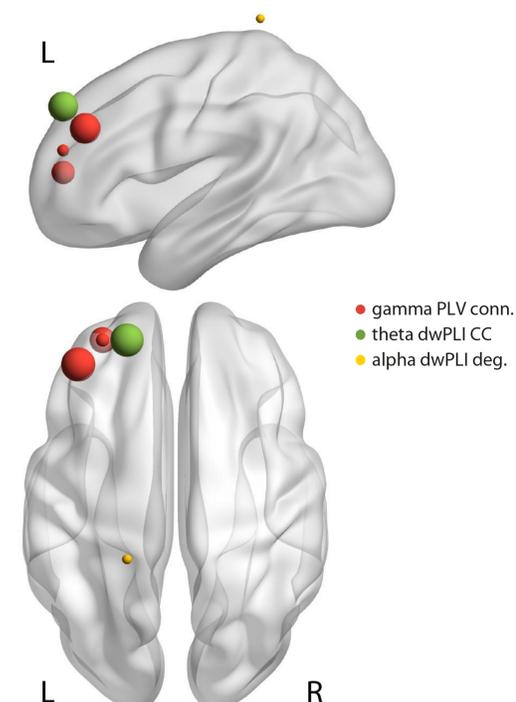


→ Mean classification accuracy ≈ 57 percent

→ Most predictive features are:

- Prefrontal gamma connectivity
- Prefrontal theta clustering coefficient
- Parietal alpha degree

Support vector machine (SVM) Most predictive features



Conclusions

- Univariate statistical tests show significantly increased frontal connectivity in patients with chronic pain
- Multivariate machine learning analysis can significantly differentiate between patients and controls, mostly based on frontal connectivity
- Converging results point towards prefrontal connectivity in the gamma frequency band as a potential marker of chronic pain
- Frequency-specific, non-invasive brain stimulation could reveal causality and clinical usefulness

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