



Oscillatory Changes in Distinct Cortical Areas are Associated with Acute Pain Responses in Chronic Pain Patients

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Highlights

Chronic low back pain (CLBP) patients demonstrated hypersensitivity both at site of chronic pain and at a non-painful site

EEG recordings during evoked pain episodes showed oscillatory changes in specific frequency bands in the medial orbitofrontal (mOFC), anterior cingulate (ACC), and dorsolateral prefrontal cortices (dlPFC)

These cortical circuit elements may underlie the mechanisms behind hypersensitivity and hyperalgesia

Our findings indicate that chronic pain may disrupt multiple cortical circuits to impact nociceptive processing

Background

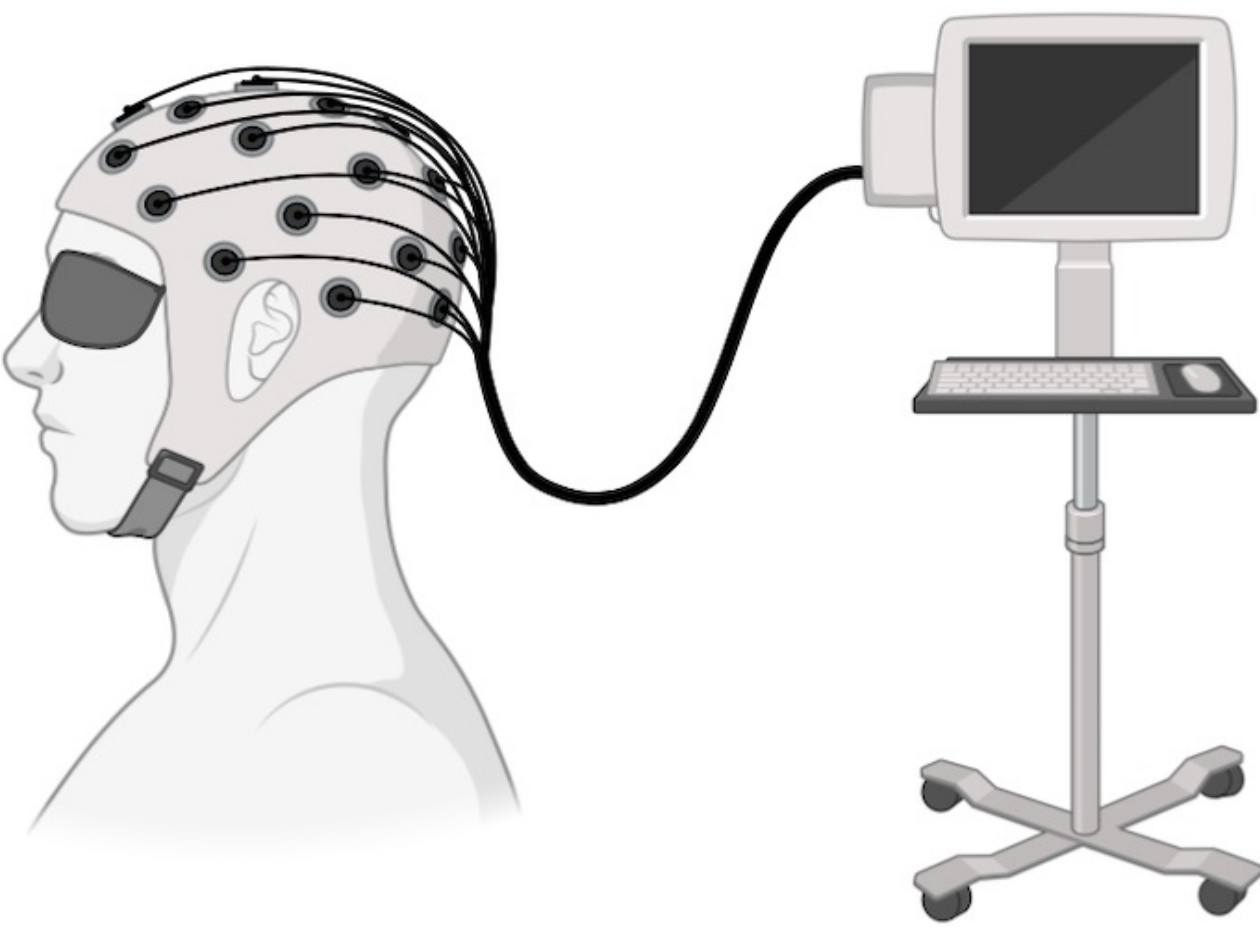
Chronic pain negatively impacts a range of sensory and affective behaviors such as causing hypersensitivity. The mechanisms distinguishing hypersensitivity from generalized site-nonspecific enhancement in the aversive response to nociceptive inputs are not well-known

Aim

To examine electrophysiological and phenotypic changes in recorded EEG data to better understand the mechanisms behind chronic pain

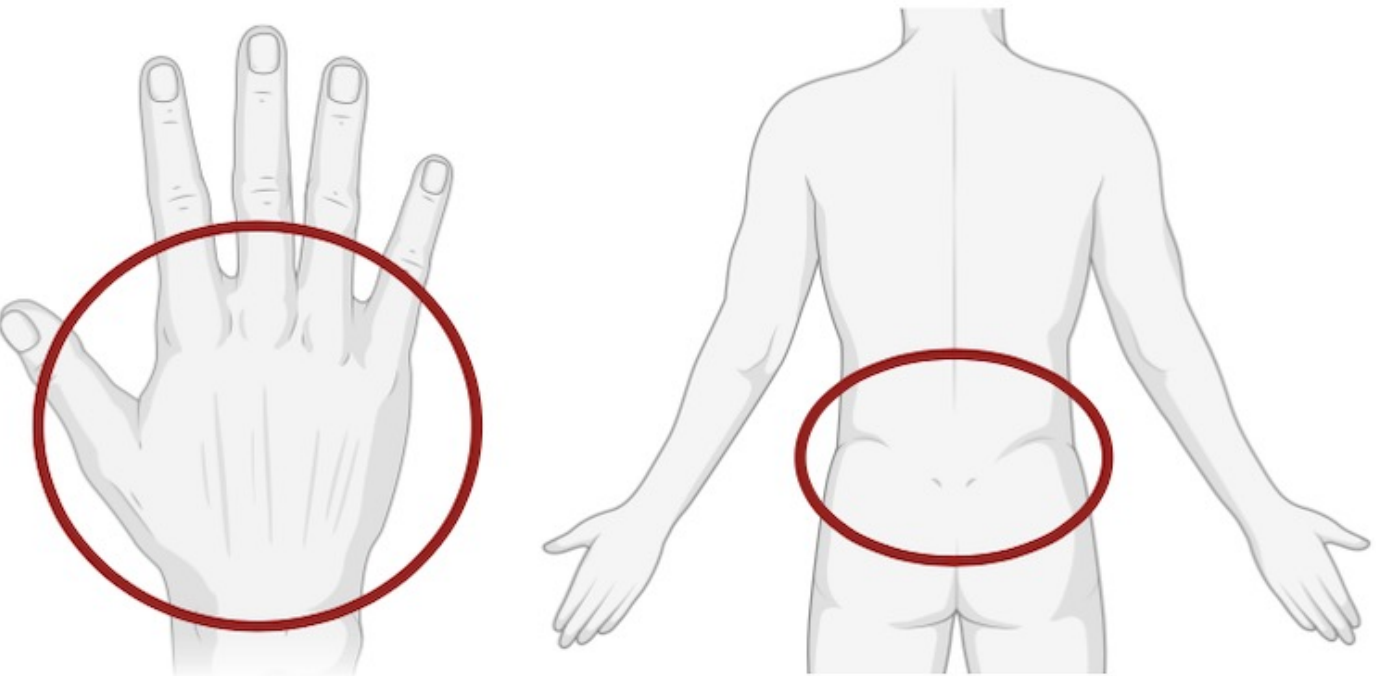
Methods

IRB-approved study. Written informed consent was obtained from all participants.
Illustrations created with BioRender.com

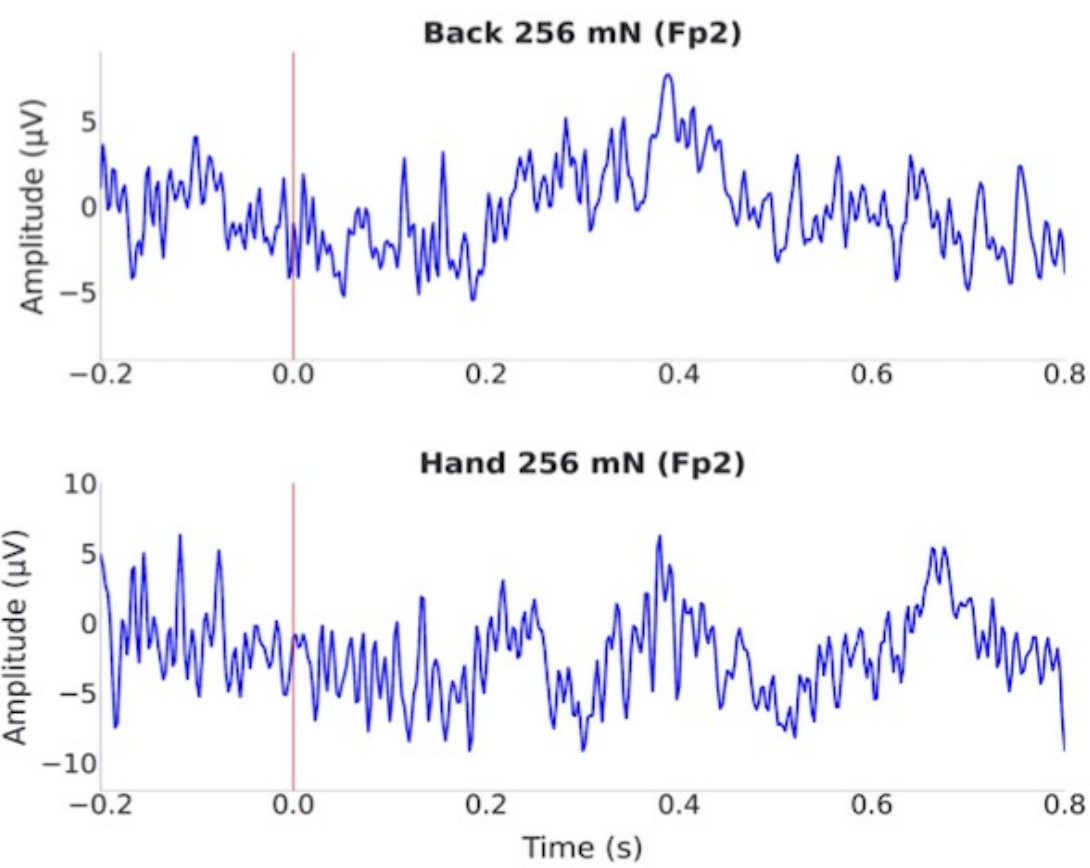


High-density EEG (64-channels)
Patient blindfolded
10 minutes baseline recording (eyes closed/eyes open)

Continued EEG recording
Evoked Potentials (Mechanical Stimuli)
Subjective pain scores (0-10) reported



Pin-prick stimulators (32 mN and 256 mN)
20-40 trials/stimulus/location



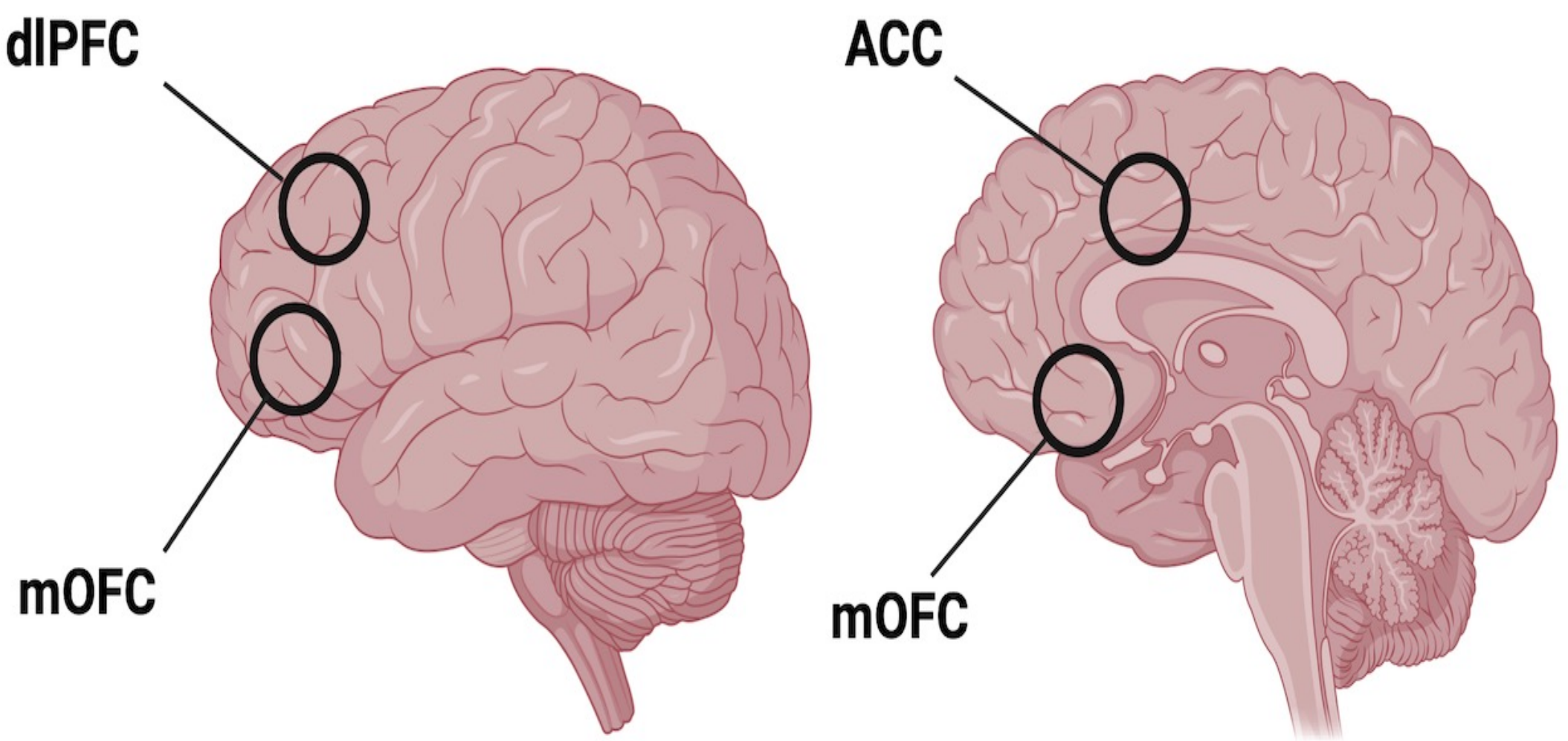
EEG data analysis
(showing example EEG recording)
Measuring and quantifying EEG powers and bands, using computational algorithms for source localization

Results

Gender and age-matched participants (n = 30): 73% male, mean age (years) $\pm$ SD : 49.9 ± 18.3 for CLBP participants, 50.5 ± 14.6 for pain-free control participants

Illustrations created with BioRender.com

	Pain-free Controls (n = 15)	CLBP Participants (n = 15)	P-value
Dorsum of Hand			
Pain Scores (0-10); median [IQR]			
Low stimulus (32 mN)	0.7 [0.3–1.1]	1.3 [0.7–2.4]	<0.001
High Stimulus (256 mN)	1.9 [1.0–3.3]	3.1 [2.3–4.6]	<0.001
P-value	<0.001	<0.001	
Lower Back			
Pain Scores (0-10); median [IQR]			
Low stimulus (32 mN)	1.2 [0.4–2.1]	2.1 [1.2–2.8]	0.001
High Stimulus (256 mN)	2.0 [1.1–3.8]	3.3 [2.3–4.5]	0.003
P-value	0.047	<0.001	



Source Localization:
Lateral (left) and medial (right) views of brain and the regions of interest used for source localization.

Changes in peak and mean power at given frequency

Frequency bands:	mOFC*	ACC*	dlPFC*
Theta (4-8Hz)	↑	-	↑
Beta (8-15 Hz)	-	-	-
Alpha (15-30 Hz)	↑	-	-
Low-gamma (30-60 Hz)	-	-	-
High-gamma (60-100 Hz)	-	↑	

Localized hypersensitivity: significance ($p < 0.05$) when comparing 256 mN stimuli only to the back ($p < 0.05$) in CLBP participants vs. pain-free controls.

Generalized hyperalgesia: significance ($p < 0.05$) when comparing 256 mN to hand in CLBP participants vs. pain-free controls.

Future Directions

- Larger sample size
- Functional connectivity analysis
- Other pain conditions

References

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