MODULATIONS OF ONGOING OSCILLATIONS EXERTED BY SUSTAINED PAINFUL HEAT AND NON-PAINFUL COLD STIMULI RECORDED FROM THE HUMAN INSULA USING INTRACEREBRAL EEG

G. Liberati[1], D. Mulders[1], L. Lebrun[1], A. Courtin[1], S. Ferrao Santos[2], J.-G. Ribeiro Vaz[3], C. Raftopoulos[3], A. Mouraux[1]

[1]Institute of Neuroscience, Université catholique de Louvain, [2]Dept. of Neurology, Saint-Luc University Hospital, [3]Dept. of Neurosurgery, Saint-Luc University Hospital

INTRODUCTION

The human insula is a target for spinothalamic input, but there is still no consensus on its role in pain perception. Using intracerebral electroencephalography (iEEG) recorded from patients undergoing a presurgical evaluation of focal epilepsy, we recently observed that sustained periodic heat nociceptive stimuli selectively modulated theta- and alpha-band ongoing oscillations recorded from the insula[1]. These modulations, however, are not necessarily pain-specific, as they could be simply related to the activation of the spinothalamic system, and/or to the conveyance of thermal information. The aim of the present study was to disentangle these aspects by comparing the effects of sustained periodic painful heat stimulation and sustained periodic non-painful cold stimulation on insular ongoing oscillatory activity.

METHODS

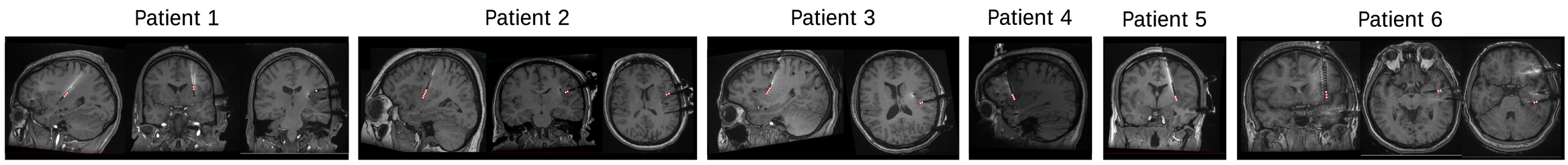

Fig. 1. Participants. 6 patients undergoing intracerebral EEG (14 electrodes, 34 left insular contacts) participated in the experiment.

Fig. 2. Sensory stimulation. A cutaneous thermal stimulator was applied on the forearm to deliver two types of sustained periodic stimuli (0.2 Hz, 75 s):
- painful heat stimuli
- non-painful cold stimuli

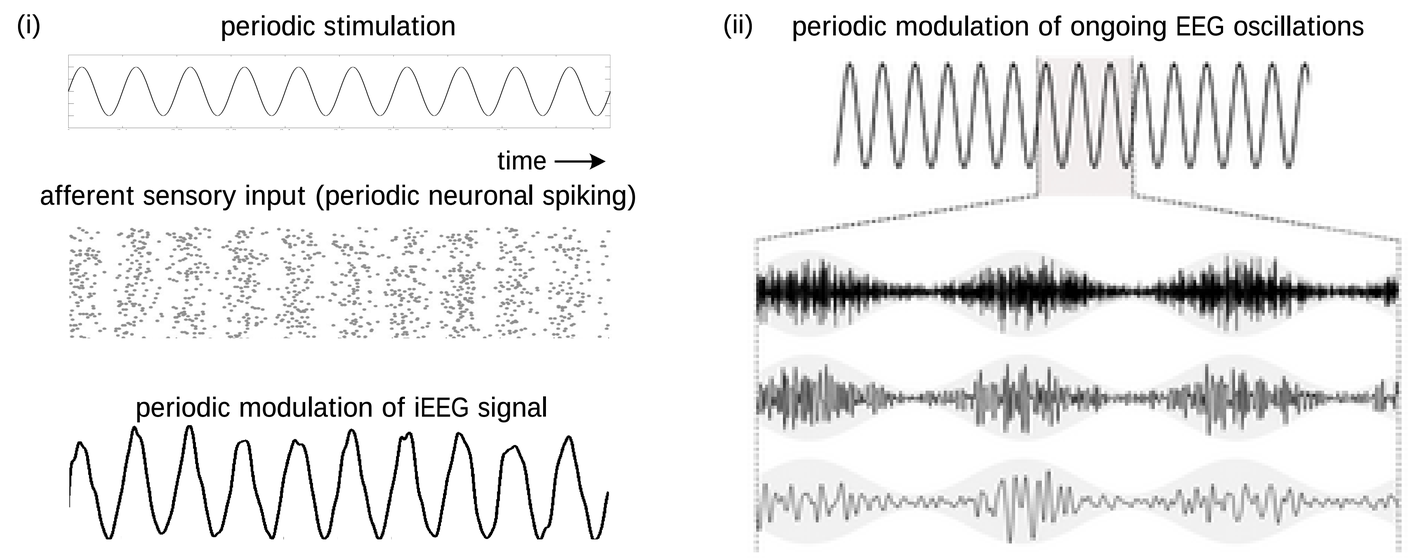

Fig. 3 Insular activities. Using a frequency tagging approach[2] we investigated (i) the periodic modulation of the iEEG insular signal, and (ii) the periodic modulation of ongoing insular oscillations within different frequency bands

RESULTS

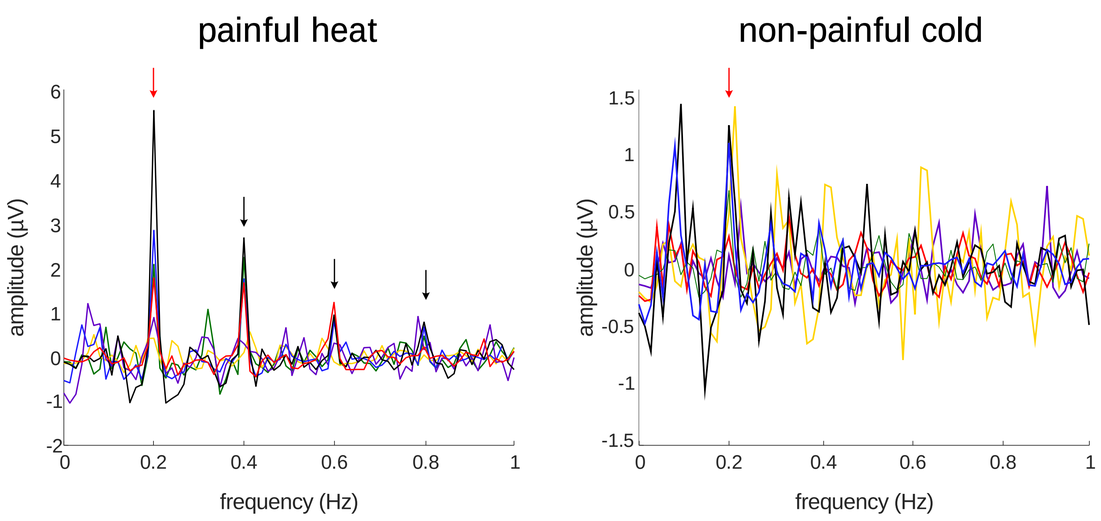

Fig. 4 Periodic modulation of the iEEG insular signal. Painful heat periodic stimuli elicited a clear enhancement of iEEG amplitude at the frequency of stimulation (0.2 Hz, red arrow) and at its harmonics (black arrow). Although less markedly, and with lower signal-to-noise ratio, non-painful cold periodic stimuli also elicited an enhancement of iEEG amplitude at 0.2 Hz (red arrow).

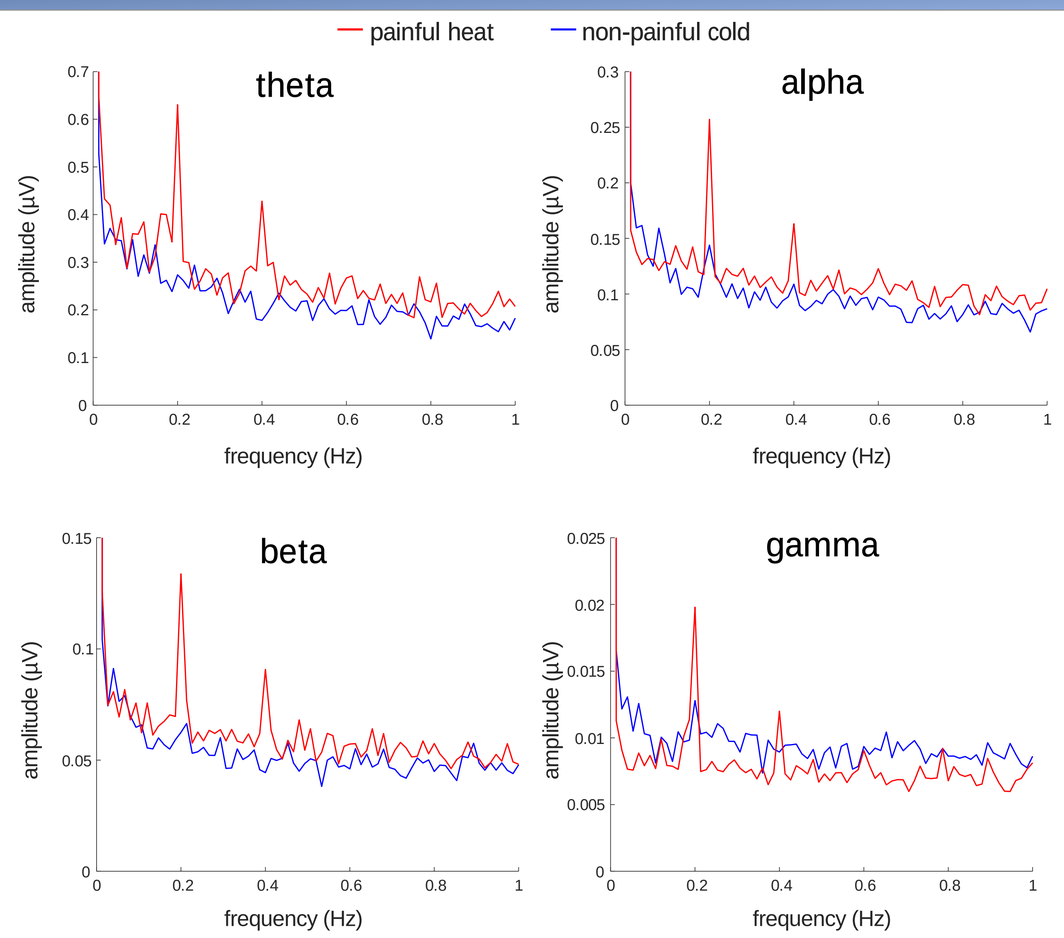

Fig. 5 Periodic modulation of ongoing insular oscillations. Painful heat periodic stimuli exerted 0.2 Hz modulations of ongoing oscillations in all frequency bands - particularly in the theta frequency band. In contrast, non-painful cold stimuli did not exert a 0.2 Hz modulation of ongoing theta oscillations, and only very small modulations of ongoing alpha, beta, and gamma oscillations.

CONCLUSIONS

These findings suggest that the strong modulation of theta oscillations exerted in the human insula by painful heat stimuli might be unrelated to the activation of the spinothalamic system and/or to the processing of thermal information, and could be more strongly related to pain perception. Nevertheless, because non-painful cold stimulation led to a markedly smaller periodic response compared to painful heat stimulation, we should not completely rule out the possibility that a non-painful cold stimulation leading to a stronger periodic response might also lead to a modulation of theta oscillations. This aspect will be further investigated in an additional experiment.

[1]Liberati et al. 2019, *Neuroimage.* [2]Regan (1989), Human Brain electrophysiology