Oscillatory Dynamics in Ischaemic Pain

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Background:

The pain experience relies on integration of brain activity across different areas[1], including somatosensory, insular, cingulate, prefrontal cortices, thalamus, subcortical areas and brainstem that belong to different functional systems of the brain but are transiently functionally connected (FC) during pain processing[2]

Pain is associated with complex spatial, temporal and spectral patterns of brain activity[3] measured by Magnetoencephalography. Previous imaging has shown altered connectivity between sensorimotor cortex and resting state networks during tourniquet pain[4]. We aim to demonstrate oscillatory and FC alterations across our tonically painful experimental stimulus.

Methods:

This was a pilot study with 5 participants. Approval was obtained from Cardiff University School of Psychology ethics committee (EC.17.12.12.5171). Post-ischaemia isometric forearm exercises result in a severe, deep aching pain; closely simulating pathological pain. Pain was rated on a scale 0-10 (0=no pain10= worst possible pain) whenever this changed during the experiment. Data analysis assessed alpha (7-14Hz), beta (15-30Hz), gamma (60-90Hz) frequency bands during rest, early pain, late pain and post pain, epoched into 60 trials of 5 second duration. Pre-processing was performed using fieldtrip and beamformed using DICS. We extracted virtual electrodes from left somatosensory cortex (SI), secondary somatosensory cortex, anterior cingulate cortex (ACC), insula and prefrontal cortex using AAL atlas and extracted alpha, beta and gamma amplitude in each ROI across 4 time periods. Connectivity was assessed between pairs of regions.

Results:

No substantial connectivity changes were seen. Increases in alpha and beta amplitudes were seen in the ACC, during transition from early to late pain phase with increases in gamma amplitude occurring in four participants. Oscillatory increases coincided with moderate to severe pain ratings. Increases in oscillatory activity in the ACC may reflect pain-anxiety interaction due to the tonically painful nature of the pain stimulus and therefore comparable to clinical chronic pain[5].

Conclusions

Ischaemic tourniquet pain may be an experimental surrogate for chronic pain evoking oscillatory brain changes in previously reported pain regions in the brain. Although we were unable to demonstrate alterations to FC we intend to perform whole brain network connectivity with future datasets.

References:

1.Apkarian AV *European Journal of Pain* 2005, 9(4), 463-484
2.Ploner M *Trends in Cognitive Sciences*, 2016 Volume 21 , Issue 2 , 100 – 110
3. Ploner M and May ES *Pain* 2017 159: 206-211.
4. Kim J et al *Pain* 2013, Aug; 154(8): 1343-1351
5. Wiech and Tracey *Neuroimage* 2009, Sep;47(3):987-94

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