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Dynamic EEG Desynchronization in Response to Vicarious Pain

Authors : Justin Durham, Chanda Rooney, Robert Mather, Mickie Vanhoy

Abstract : The psychological construct of empathy is to understand a person's cognitive perspective and experience the other person's emotional state. Deciphering emotional states is conducive for interpreting vicarious pain. Observing others' physical pain activates neural networks related to the actual experience of pain itself. The study addresses empathy as a nonlinear dynamic process of simulation for individuals to understand the mental states of others and experience vicarious pain, exhibiting self-organized criticality. Such criticality follows from a combination of neural networks with an excitatory feedback loop generating bistability to resonate permutated empathy. Cortical networks exhibit diverse patterns of activity, including oscillations, synchrony and waves, however, the temporal dynamics of neurophysiological activities underlying empathic processes remain poorly understood. Mu rhythms are EEG oscillations with dominant frequencies of 8-13 Hz becoming synchronized when the body is relaxed with eyes open and when the sensorimotor system is in idle, thus, mu rhythm synchrony is expected to be highest in baseline conditions. When the sensorimotor system is activated either by performing or simulating action, mu rhythms become suppressed or desynchronize, thus, should be suppressed while observing video clips of painful injuries if previous research on mirror system activation holds. Twelve undergraduates contributed EEG data and survey responses to empathy and psychopathy scales in addition to watching consecutive video clips of sports injuries. Participants watched a blank, black image on a computer monitor before and after observing a video of consecutive sports injuries incidents. Each video condition lasted five-minutes long. A BIOPAC MP150 recorded EEG signals from sensorimotor and thalamocortical regions related to a complex neural network called the 'pain matrix'. Physical and social pain are activated in this network to resonate vicarious pain responses to processing empathy. Five EEG single electrode locations were applied to regions measuring sensorimotor electrical activity in microvolts (μV) to monitor mu rhythms. EEG signals were sampled at a rate of 200 Hz. Mu rhythm desynchronization was measured via 8-13 Hz at electrode sites (F3 & F4). Data for each participant's mu rhythms were analyzed via Fast Fourier Transformation (FFT) and multifractal time series analysis.

Keywords : desynchronization, dynamical systems theory, electroencephalography (EEG), empathy, multifractal time series analysis, mu waveform, neurophysiology, pain simulation, social cognition
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