Brain-Heart Interactions Modulate EEG Activity During Elicited Emotional States

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Aims: The research aims to examine brain-heart interactions (BHI) by studying the coupling of four EEG rhythms from six cortical locations with cardiac activity measured as PPG. It seeks to identify the links in the networks facilitating these interactions, understand the involvement of specific brain areas and explore mediating frequency bands during emotional contexts.

Methods: Using the DEAP dataset, EEG and PPG recordings from 10 participants were analyzed. Data from 6 selected electrodes were used to extract the brain rhythms theta, alpha, beta, and gamma. The controlled time-delay stability (cTDS) technique assessed interactions between these brain rhythms and the heart, accounting for delays and indirect connections. Linkage strength was evaluated using observed cTDS percentage. High (H) and low (L) valence (V) and arousal (A) were assessed for emotional granularity.

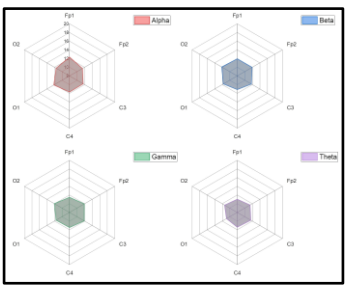

Figure 1: Networks of brain-to-heart interactions during HAHV.

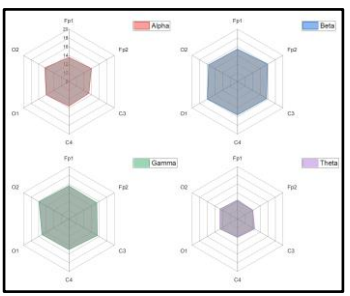

Figure 2: Networks of heart-to-brain interactions during HAHV.

Results: The results show a consistent pattern across all emotional states. The distribution of average link strength across different brain areas in the HAHV, LAHV, HALV, and LALV networks exhibited relative symmetry. When examining the directionality of the BHI, it was found that the strength of links in the heart-to-brain networks was significantly higher compared to the brain-to-heart networks. These findings suggest that the heart plays a driving role in influencing brain activity. Notably, beta and gamma frequency bands exhibited stronger connection strength in the heart-to-brain networks. This study highlights the utility of the cTDS algorithm in quantifying coupling and BHI.