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Customization of coherence analysis by relaxing its iso-frequency constraint

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Coherence analysis is a tool to probe the functional connectivity of two neural oscillators through studying the two signals recorded from them. A sliding window cuts the two signals into a number of corresponding epochs. The power of any given frequency in the two signals can be expressed as a pair of multidimensional vectors. The number of dimensions is equal to the number of the epochs. Coherence of the two signals at that given frequency is calculated as the squared cosine of the angle between these two multidimensional vectors. This style of calculation of coherence is based on the presumption that the functional connectivity of the two oscillators would be demonstrated as simultaneous, linearly correlated wax and wane in the power of oscillation in identical frequencies; but many connected neural oscillators do not exhibit this behavior. An example is the circuitry of Globus Pallidus internus (GPi), thalamocortical relay nucleus (TC), and thalamic reticular nucleus (RE). In this circuit, a four Hz burst activity in GPi triggers an eight Hz burst in TC under the effect of RE. Therefore, GPi and TC are functionally connected but not in identical frequencies and this aspect of their connectivity can not be demonstrated by the conventional coherence analysis. The present study suggests a customized version of coherence in which the calculation of coherence can be extrapolated to the vectors representing powers of non identical frequencies in the two signals. This extrapolation has been tested on a model of GPi-TC-RE and a peak in the customized coherence between the vector of 4 Hz activity of GPi and the vector of 8 Hz activity of TC has been demonstrated.