Modeling the evolution of dynamic brain processes during an associative learning experiment

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Abstract

Our goal is to use local _eld potentials (LFPs) to rigorously study changes in neuronal activity in the hippocampus and the nucleus accumbens over the course of an associative learning experiment. We show that the spectral properties of the LFPs changed during the experiment. While many statistical models take into account nonstationarity within a single trial of the experiment, the evolution of brain dynamics across trials is often ignored. In this paper, we developed a novel time series model that captures both sources of nonstationarity. Under the proposed model we rigorously de_ne the spectral density matrix so that it evolves over time within a trial and also across trials. To estimate the evolving evolutionary spectral density matrix, we used a two-stage procedure. In the _rst stage, we computed the within-trial time-localized periodogram matrix. In the second stage, we developed a data-driven approach for combining information across trials from the local periodogram matrices. We assessed the performance of our proposed method using simulated data. Finally, we used the proposed method to study how the spectral properties of the hippocampus and the nucleus accumbens evolves over the course of an associative learning experiment.

Keywords : Bivariate time series, Cross-coherence, Local stationarity, Spectral analysis, Replicated time series, Signal heterogeneity