Investigation of Spatio-Temporal Dependencies in Epileptic ECOG

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Abstract

There is evidence that the mechanisms leading to epileptic seizures can be understood by continuously tracking the ongoing spatio-temporal mappings in the brain. However, the exact spatio-temporal changes leading to epileptic seizures, although widely studied, are not well understood yet. Previous studies have mostly focused on individually tracking the dynamical changes along time. However, approaches to simultaneously explain a system’s temporal changes in its overall spatial configuration can be much more effective in efforts to characterize epileptic events.

In this study, we propose a simple statistical approach to quantify the temporal changes in spatial patterns of an ECOG. Previously, we developed a non-linear synchronization measure, called the SOM-Similarity Index, to quantify mutual associations between various brain regions. We propose to apply the mantel test statistics on the SOM-similarity indices to track the temporal changes of the spatial patterns. Statistical comparisons between inter-ictal and pre-ictal states suggest significant changes in the spatial connectivity prior to a seizure. Another aspect of this study investigates the regional groupings in the ECOG spatial networks at different ictal-states. We develop a model that will allow us to study the various cluster patterns in an epileptic brain. Studies on 10 seizures, from 2 patients reveal strong connections between the Left-sub-temporal and the Left-temporal depth areas. In addition, strong homologous connectivity is found in the orbito-frontal regions.

In the third aspect of this study, we investigate on the differences in the synchronization levels between the focal and the non-focal hemispheres at pre-ictal and post-ictal states. Statistical tests confirm the existence of significant differences at pre-ictal states followed by a strong entrainment, 20 minutes post-ictal period.