

Network Analysis of Spread of Low Frequency Activity Induced in *Ex vivo* Horizontal Cortical Slice Preparations

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Abstract

During slow wave sleep (<1Hz) membrane potential of cortical neurons spontaneously fluctuates between two states: UP-state is the active phase, when the plasma membrane is depolarized and action potentials can be elicited; DOWN-state is the inactive phase, when neurons are hyperpolarized. Earlier, we identified that the entorhinal (ERh) cortex exhibits this low frequency oscillation in rat brain slices. Our further goal was to define through what connections the activity spreads in the connected cortical regions, and also to identify network connections between cells firing during activation.

We studied slow oscillation using microelectrophysiological methods in rat brain slice preparations of limbic cortical regions. Multi- and single unit activity was extracted from our field recordings to find correlation between field events and single cell firing. We studied vertical spread between cortical layers using current-source density analysis and horizontal spread between adjacent cortical regions by cutting different connections between ERh and perirhinal (PRh) cortices.

UP-states that we registered *ex vivo* have similar appearance as those registered *in vivo*; field potential events were in strict correlation with multi-unit activity and single cell firing.

In most cases, the activity initiated in the infragranular layers and then spread upwards. We found network connections between identified cells that also showed similar pattern.

The frequency of the slow oscillation registered in both areas was identical. In most cases UP-states registered from the PRh cortex followed those generated in the ERh cortex with specific latency, whilst cutting the supragranular layers and the corpus callosum altered the area of initiation and the spread of the activity.

Our results indicate that this activity could be the *ex vivo* model of cortical UP and DOWN activity. In vertical plane, layer V activates the supragranular layers and single cells constitute complex networks thanks to their extensive dendritic arborization. Under normal circumstances, in horizontal slices ERh cortex may trigger the activity, which then spreads from the ERh cortex toward the PRh cortex mostly through supragranular and extracortical connections. However, in the absence of connections between ERh and PRh cortices, the activity of PRh cortex disengages from that of ERh cortex, thus the initiation area may be changed.