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Presentation Abstract

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Title:	Role of thalamocortical matrix projections in sleep spindles synchronization
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Abstract: Sleep spindles consist of waxing-and-waning field potentials at 11-15 Hz, which last 0.5-3 seconds and recur every 5-15s in normal stage 2 sleep. They are thought to contribute to memory and have restorative functions. In vivo, in vitro, and computational studies suggest that the minimal circuit accounting for spindle oscillations consists of the reciprocal interaction between the GABAergic thalamic reticular neurons and the excitatory thalamocortical relay cells. Humans sleep spindles are highly synchronous across the scalp when measured by EEG, but not when measured simultaneously with MEG. MEG signals show low correlation and low coherence with each other or with EEG signals. Principal Components Analysis shows that the MEG field pattern is more complex than the EEG pattern. To study synchronization properties of spindles which may underlie these differences, we implemented a thalamocortical network model including populations of thalamic relay (TC) cells (including both “core” TC neurons forming specific (focused) projections to the cortical layers 4 and 6 and “matrix” neurons forming diffuse projections to the layer 1) and reticular (RE) neurons as well as several layers of cortical excitatory neurons and inhibitory interneurons. One- and two-dimensional network models included up to ~20,000 conductance based neurons and ~10,000,000 synapses. In the model of the isolated thalamus, spindle oscillations were maintained by interaction between RE and TC neurons. In the full thalamocortical model, spindle sequences propagated to the cortex leading to complex interactions between populations of thalamic and cortical neurons. Diffuse thalamocortical projections of the matrix TC neurons and

feedback corticothalamic input helped to synchronize neuronal firing leading to more synchronous activity in the superficial (vs. deep) cortical layers, as observed experimentally. This difference in synchronization properties was minimal at the onset of a spindle oscillation but increased progressively toward the end of spindle. This suggests that the differential activity patterns in the core and matrix thalamocortical subsystems may explain discrepancies between the temporal patterns of spindles simultaneously observed in EEG and MEG recordings.

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