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Presentation Abstract

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Title:	Interactions between core and matrix thalamocortical systems in human sleep spindle synchronization
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Abstract:

Sleep spindles in mammals are thought to contribute to memory consolidation and have restorative functions. In humans, sleep spindles consist of waxing and waning field potentials at 11-15 Hz, which last 0.5-3 seconds and recur every 5-15 seconds. Humans sleep spindles are highly synchronous across the scalp when measured with EEG channels, but not when measured simultaneously with MEG sensors which exhibit low correlation and low coherence with each other and with EEG signals. Spindles generated in the thalamus recruit cortical circuits. A core subsystem projects focally to layer 4 of the cortex and a matrix subsystem projects more diffusely to layer 1. We used a computational model to explore the hypothesis that interactions between the core and matrix thalamocortical subsystems were responsible for the complex spatio-temporal patterns of spindles observed experimentally.
The thalamocortical network model included two populations of thalamic relay (TC) cells and reticular (RE) neurons (core and matrix) and two related populations of cortical excitatory (CX) and inhibitory neurons. The core network formed specific (focused) projections between the thalamus and the cortex while the matrix network made diffuse projections between the thalamus and the cortex. The diffuse thalamocortical and corticothalamic connections of the matrix system

helped synchronize neural firing leading to more synchronous activity in the superficial cortical layers, as observed experimentally. In a previous study we used a coherence measure for traveling waves. In this study the synchrony measure was an all-to-all, zero-time-lag cross correlation of the estimated LFP related to the Schreiber reliability measure. Furthermore, two distinct populations of RE neurons allowed spindles to be independently initiated in the core and propagated to the matrix with a systematic delay of hundreds of milliseconds after the core. In both core and matrix subsystems the TC cells fire at 5-6 Hz with the RE and CX cells active at double this frequency, 10-12 Hz. Relative synchrony of spindle oscillations between core and matrix networks depended on the pattern of intracortical connections between the networks. Our results suggest that the differential activity patterns in the core and matrix thalamocortical network may explain discrepancies between the temporal patterns of spindles simultaneously observed in EEG and MEG recordings. This is consistent with the hypothesis that EEG recordings are sensitive to the cortical spindle activity in the superficial layers generated by the matrix subsystem while MEG recordings reflect spindle components in the deep layers generated by the core subsystem.

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