Neuroscience 2015

Presentation Abstract

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Program#/Poster#:	815.18/Z20
Presentation Title:	Structural connectivity between cortex and thalamus determines temporal features of sleep spindles
Location:	Hall A
Presentation time:	Wednesday, Oct 21, 2015, 1:00 PM - 5:00 PM
Presenter at Poster:	Wed, Oct. 21, 2015, 2:00 PM - 3:00 PM
Topic:	++E.08.e Sleep: Systems
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Abstract:	Sleep spindles are waxing and waning oscillatory activity (at 11-15 Hz) observed during stage II sleep. Individual spindles last about 0.3-2 seconds and recur at intervals

from 2 to 15 seconds. MEG and EEG show significant differences in spindle occurrences, with about 50% of MEG spindles occurring without EEG spindles whereas only 15% of EEG spindles occur alone [1]. 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 apical dendrites of layer 5 neurons in layer 1. We previously hypothesized that difference between MEG and EEG signals may reflect difference between those projections [2]. In this study, we used computational modeling and laminar recordings from epilepsy patients to identify the mechanism that results in differences in spindle occurrence across different cortical layers. Laminar recordings showed higher probability of spindle occurrence (based on automated spindle detection) in middle layers (putative layers 3/4) compared to deeper layers (putative layers 5/6). Using a reduced thalamocortical model with only one cortical layer (with pyramidal and inhibitory neurons) and a corresponding thalamic network (thalamocortical and reticular neurons) we found that the interspindle interval and the probability of spindle occurrence in a given interval decreased with increases in the level of spontaneous miniature excitatory synaptic activity and increases in the fanout (number of efferent neurons connected) of thalamocortical and corticothalamic connectivity. We then simulated a multilayer cortex model, which included three layers for cortex (layer 3/4, 5 and 6) and separate thalamic neurons for core and matrix subsystems. The fanout of the thalmocortical and corticothalamic projections between matrix thalamic neurons to layer 5 neurons was made to be wider than the core thalamic neuron projections to layer 3/4. In the full model, spindles occurred more often in layer 3/4 than in layer 5, with a shorter median inter-spindle interval. In addition, the spindles in layer 5 were more synchronous across neurons compared to layer 3/4. Overall, this study demonstrates that differences in the projections between thalamus and cortex may determine the spatiotemporal features of spindle activity across cortical layers.
References 1. Dehghani N, Cash SS, Halgren E (2011) Emergence of synchronous EEG spindles from

	asynchronous MEG spindles. Hum Brain Mapp 2. Bonjean M, Baker T, Bazhenov M, Cash S, Halgren E, et al. (2012) Interactions between Core and Matrix Thalamocortical Projections in Human Sleep Spindle Synchronization. J of Neuroscience
Disclosures:	**G.P. Krishnan:** None. **M.J. Choinski:** None. **L.E. Muller:** None. **D.J. Hagler:** None. **S.S. Cash:** None. **T.J. Sejnowski:** None. **E. Halgren:** None. **M. Bazhenov:** None.
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