The mechanism of sleep spindles generation: New insights from a computational model and EEG data of the transgenic mice

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Sleep spindles are distinctive EEG waves during NREM sleep, with the frequency in the range 9-15 Hz. Altought the thalamocortical (TC) system is considered as a main source of sleep spindles, several studies indicate that also cortical interneurons may play pivotal roles in generating sleep spindles.
Here, we hypothesized that a certain firing pattern in cortical interneurons is essential for sleep spindles generation, and developed a minimum computational model of an inhibitory cortical neuron with five channels and a pump, which recapitulates the firing pattern of cortical neurons during sleep spindles. Comprehensive bifurcation and detailed mathematical analyses predicted that one channel family play a role in generating the electrophysiological characteristics of sleep spindles. Then, we generated transgenic mice and analyzed sleep spindles from EEG data. As a result, a part of transgenic mice showed decreased sleep spindles episode and events. Combining these two approaches, we suggest a novel mechanism of sleep spindles generation, which may become a potential target for a treatment or a biomarker of certain diseases related to sleep spindles, like schizophrenia or absence seizure.