INSTITUTO CAJAL

SEMINARIO PRESENCIAL

Martes, 14 de Mayo de 2024
12:30 h. Instituto Cajal - CSIC

Dra. CARMEN VARELA

Psychology Department, Florida State University

INVESTIGATING THE ROLE OF THALAMOCORTICAL CIRCUITS AND SLEEP OSCILLATIONS IN LEARNING

Abstract

Memories of the events in our lives (episodic memories) would have limited value if they were simply a record of daily experiences. Instead, new episodic memories must be stabilized and integrated with prior knowledge to support adaptive behaviors. These processes remain poorly understood but are known to be facilitated by sleep oscillations. As a result of memory consolidation, animals gain a generalized understanding of the world, a mental model to make sense of their surroundings and guide behavior in a flexible and effective manner. In this talk, I will describe my laboratory's research program to uncover how thalamocortical dynamics promote the consolidation of episodic memories and support adaptive behavior.

I will present results from electrophysiology recordings in behaving rats describing how sleep oscillations provide a temporal scaffold to organize neuronal interactions between thalamocortical and hippocampal regions during sleep. I will discuss preliminary evidence from electrophysiology and optogenetics experiments suggesting that the sparse activation of thalamic cells during sleep promotes memory consolidation and cognitive flexibility.

Affiliation and short bio

AREAS OF INTEREST:

Sleep Oscillations and their Role in Memory Consolidation: Dynamics and coupling of NREM sleep oscillations (spindles, slow oscillations, sharp-wave ripples); learning; cognitive flexibility; closed-loop auditory stimulation (CLAS) for memory improvement.

Neural Basis of Predictive Coding: Mental schemas; generalization; deviance detection; corticothalamic feedback.

Link between Thalamic Activity and Neurodegeneration: Thalamic firing modes; sleep architecture; sleep fragmentation; Alzheimer's Disease.

Interactions between Thalamic Neurons and Glia: Synaptic pruning; synaptic stabilization; calcium regulation; neural activity and inflammation.

RESEARCH BACKGROUND

POST-DOCTORAL

Thalamo-Neocortico-Hippocampal interactions in behaving rodents. I developed a preparation to record, for the first time, single cells and local field potentials simultaneously from three areas that are key for cognitive function (midline thalamus, prefrontal cortex and CA1). I demonstrated functional and anatomical contributions of cells in the midline thalamus to the coordination between hippocampus and neocortex thought to underlie sleep-dependent memory consolidation.

Ph.D. THESIS

Title: 'Functional Differences between First and Higher Order Thalamic Nuclei: Effects of Modulatory Systems and Response Properties'. I demonstrated that cells in primary sensory and associative nuclei of the thalamus are differentially affected by neuromodulators that control attention and sleep (acetylcholine, serotonin), suggesting heterogeneous state-dependent functional channels in thalamocortical associative networks.

Related publications with the topic

Varela, C, Moreira J, Kocaoglu B, Dura-Bernal S, Ahmad SA. A Mechanism for Deviance Detection and Contextual Routing in the Thalamus: A Review and Theoretical Proposal. In press.

Varela C, Wilson MA. Reversal Learning: It's Just a Phase. Current Biology (2022). Dispatch. Vol. 32, Issue 15, pr849-r851, August 08, 2022. https://doi.org/10.1016/j.cub.2022.06.045.

Desai NV, Varela C. Distinct burst properties contribute to the functional diversity of thalamic nuclei. J Comp Neurol (2021) doi:10.1002/cne.25141.

Varela C, Wilson MA. mPFC spindle cycles organize sparse thalamic activation and recently active CA1 cells during non-REM sleep. eLife 9, e48881 (2020). DOI: 10.7554/eLife.48881

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Avda. Doctor Arce, 37. 28002. Madrid. Tel. 91 585 4750

www.cajal.csic.es