

Cortico-Hippocampal Circuit Interactions in Shaping Place Cell and Memory Functions

January 13

Tuesday, 12:30 pm

Billings Building—Rosedale Room

SPEAKER:



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Abstract

Stability and flexibility of neuronal ensembles are crucial brain functions, notably supporting learning and memory. However, little is known about how these features of local circuits are influenced by long-range inputs allowing communication across brain regions. Here, we show that lateral entorhinal cortex glutamatergic (LECGLU) and GABAergic (LECGABA) projections to CA3 recruit specific microcircuits that conjunctively provide stability to neuronal ensembles supporting learning. LECGLU drives excitation in CA3 but also substantial feedforward inhibition that prevents somatic and dendritic spikes. Conversely, LECGABA suppresses this local inhibition to disinhibit CA3 activity with compartment- and pathway-specificity by selectively boosting somatic output to integrated LECGLU and CA3 recurrent network inputs. This synergy allows the stabilization of spatial representations relevant to learning, as both LECGLU and LECGABA control the remapping of CA3 place cells across contexts and over time. Overall, our findings provide circuit mechanisms whereby long-range glutamatergic and GABAergic corticohippocampal inputs cooperatively shape experience-dependent spatial coding in CA3.



Publications

Robert V, O'Neil K, Moore JJ, Rashid SK, Johnson CD, De La Torre RG, Zemelman BV, Clopath C, Basu J. Cortical glutamatergic and GABAergic inputs support learning-driven hippocampal stability. *Science*. 2025 Dec 11;390(6778):eadn0623. doi: 10.1126/science.adn0623. Epub 2025 Dec 11. PMID: 41166439. Press and Media Coverage.

Butola, T., Hernández Frausto, M., Blankvoort, S., Flatset, M. S., Peng, L., Elmaleh, M., Hairston, A., Hussain, F., Clopath, C., Kentros, C., Basu, J. Hippocampus shapes cortical sensory output through a direct feedback circuit. *Nat Neurosci*. 2025 Feb 18. doi: 10.1038/s41593-025-01883-9. PMID: 39966537. Press and Media Coverage.

Moore JJ, Rashid SK, Bicker E, Johnson CD, Codrington N, Chklovskii DB, Basu J. Sub-cellular population imaging tools reveal stable apical dendrites in hippocampal area CA3. *Nat Commun*. 2025 Jan 28;16(1):1119. PMCID: PMC11775317.