

Stanford



Lisa Giocomo

Professor of Neurobiology

Bio

ACADEMIC APPOINTMENTS

- Professor, Neurobiology
- Member, Bio-X
- Member, Wu Tsai Neurosciences Institute

HONORS AND AWARDS

- Vallee Scholar Award, The Vallee Foundation (2019)
- Young Investigator Award, Society for Neuroscience (2018)
- Office of Naval Research Young Investigator Award, Office of Naval Research (2018)
- James S McDonnell Foundation Scholar, James S McDonnell Foundation Scholar (2016 - 2022)
- Robertson Neuroscience Investigator – New York Stem Cell Foundation, New York Stem Cell Foundation (2015-2019)
- Klingenstein-Simons Fellowship Award in the Neurosciences, Klingenstein-Simons Foundation (2014-2017)
- Sloan Fellow, Alfred P. Sloan Foundation (2013-2015)
- Peter and Patricia Gruber International Research Award, The Gruber Foundation (2012)

PROFESSIONAL EDUCATION

- BA, Baylor University , Psychology (2002)
- PhD, Boston University , Neuroscience (2008)

LINKS

- Giocomo Lab Page: <http://giocomolab.weebly.com/>

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

My laboratory studies the cellular and molecular mechanisms underlying the organization of cortical circuits important for spatial navigation and memory. We are particularly focused on medial entorhinal cortex, where many neurons fire in spatially specific patterns and thus offer a measurable output for molecular manipulations. We combine electrophysiology, genetic approaches and behavioral paradigms to unravel the mechanisms and behavioral relevance of non-sensory cortical organization. Our first line of research is focused on determining the cellular and molecular components crucial to the neural representation of external space by functionally defined cell types in entorhinal cortex (grid, border and head direction cells). We plan to use specific targeting of ion channels, combined with in vivo tetrode recordings, to determine how channel dynamics influence the neural representation of space in the behaving animal. A second, parallel line of research, utilizes a combination of in

vivo and in vitro methods to further parse out ionic expression patterns in entorhinal cortices and determine how gradients in ion channels develop. Ultimately, our work aims to understand the ontogenesis and relevance of medial entorhinal cortical topography in spatial memory and navigation.

Teaching

COURSES

2023-24

- Mathematical Tools for Neuroscience: NBIO 228 (Spr)
- Neuroscience Systems Core: NEPR 203 (Spr)
- The Nervous System: NBIO 206 (Win)

2022-23

- Mathematical Tools for Neuroscience: NBIO 228 (Spr)
- Neuroscience Systems Core: NEPR 203 (Spr)

2021-22

- Mathematical Tools for Neuroscience: NBIO 228 (Spr)
- Neuroscience Systems Core: NEPR 203 (Spr)

2020-21

- Neuroscience Systems Core: NEPR 203 (Aut)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Deniz Bingul, Lucas Encarnacion-Rivera, Sedona Ewbank, Liz Jun, Rennie Kendrick, Gabriel Mel, Josh Melander, Ethan Richman, Daniel Shaykevich, Nate Stockham, Jayashri Viswanathan, Yandan Wang, Ilana Zucker-Scharff

Postdoctoral Faculty Sponsor

Emily Aery Jones, Frances Cho, Can Dong, Samuel Levy, Mari Sosa, Michelle Stackmann, Nakul Yadav

Doctoral Dissertation Advisor (AC)

Tucker Fisher, Charlotte Herber, Lavonna Mark, Francis Masuda, Sky Shi, Carly Stein, Linnie Warton, John Wen

GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Neurosciences (Phd Program)

Publications

PUBLICATIONS

- **Subicular neurons encode concave and convex geometries.** *Nature*
Sun, Y., Nitz, D. A., Xu, X., Giocomo, L. M.
2024
- **Parahippocampal neurons encode task-relevant information for goal-directed navigation.** *eLife*
Gonzalez, A., Giocomo, L. M.
2024; 12
- **Hippocampal sequences span experience relative to rewards.** *bioRxiv : the preprint server for biology*
Sosa, M., Plitt, M. H., Giocomo, L. M.
2023

- **Hippocampal place code plasticity in CA1 requires postsynaptic membrane fusion.** *bioRxiv : the preprint server for biology*
Plitt, M. H., Kaganovsky, K., Südhof, T. C., Giocomo, L. M.
2023
- **Ketamine evoked disruption of entorhinal and hippocampal spatial maps.** *Nature communications*
Masuda, F. K., Aery Jones, E. A., Sun, Y., Giocomo, L. M.
2023; 14 (1): 6285
- **Neural circuit dynamics of drug-context associative learning in the mouse hippocampus.** *Nature communications*
Sun, Y., Giocomo, L. M.
2022; 13 (1): 6721
- **Experience-dependent contextual codes in the hippocampus.** *Nature neuroscience*
Plitt, M. H., Giocomo, L. M.
2021
- **Mouse entorhinal cortex encodes a diverse repertoire of self-motion signals.** *Nature communications*
Mallory, C. S., Hardcastle, K., Campbell, M. G., Attinger, A., Low, I. I., Raymond, J. L., Giocomo, L. M.
2021; 12 (1): 671
- **Dynamic and reversible remapping of network representations in an unchanging environment.** *Neuron*
Low, I. I., Williams, A. H., Campbell, M. G., Linderman, S. W., Giocomo, L. M.
2021
- **Distance-tuned neurons drive specialized path integration calculations in medial entorhinal cortex.** *Cell reports*
Campbell, M. G., Attinger, A., Ocko, S. A., Ganguli, S., Giocomo, L. M.
2021; 36 (10): 109669
- **Entorhinal velocity signals reflect environmental geometry.** *Nature neuroscience*
Munn, R. G., Mallory, C. S., Hardcastle, K., Chetkovich, D. M., Giocomo, L. M.
2020
- **Remembered reward locations restructure entorhinal spatial maps.** *Science (New York, N.Y.)*
Butler, W. N., Hardcastle, K. n., Giocomo, L. M.
2019; 363 (6434): 1447–52
- **Principles governing the integration of landmark and self-motion cues in entorhinal cortical codes for navigation.** *Nature neuroscience*
Campbell, M. G., Ocko, S. A., Mallory, C. S., Low, I. I., Ganguli, S., Giocomo, L. M.
2018
- **Grid scale drives the scale and long-term stability of place maps** *NATURE NEUROSCIENCE*
Mallory, C. S., Hardcastle, K., Bant, J. S., Giocomo, L. M.
2018; 21 (2): 270–+
- **A Multiplexed, Heterogeneous, and Adaptive Code for Navigation in Medial Entorhinal Cortex** *NEURON*
Hardcastle, K., Maheswaranathan, N., Ganguli, S., Giocomo, L. M.
2017; 94 (2): 375–?
- **Environmental Boundaries as an Error Correction Mechanism for Grid Cells** *NEURON*
Hardcastle, K., Ganguli, S., Giocomo, L. M.
2015; 86 (3): 827-839
- **Spatial Coding Dysfunction and Network Instability in the Aging Medial Entorhinal Cortex.** *bioRxiv : the preprint server for biology*
Herber, C. S., Pratt, K. J., Shea, J. M., Villeda, S. A., Giocomo, L. M.
2024
- **Remapping in a recurrent neural network model of navigation and context inference.** *eLife*
Low, I. I., Giocomo, L. M., Williams, A. H.
2023; 12

- **A positively tuned voltage indicator for extended electrical recordings in the brain.** *Nature methods*
Evans, S. W., Shi, D., Chavarha, M., Plitt, M. H., Taxidis, J., Madruga, B., Fan, J. L., Hwang, F., van Keulen, S. C., Suomivuori, C., Pang, M. M., Su, S., Lee, et al
2023; 20 (7): 1104-1113
- **All-optical physiology resolves a synaptic basis for behavioral timescale plasticity.** *Cell*
Fan, L. Z., Kim, D. K., Jennings, J. H., Tian, H., Wang, P. Y., Ramakrishnan, C., Randles, S., Sun, Y., Thadhani, E., Kim, Y. S., Quirin, S., Giocomo, L., Cohen, et al
2023
- **Neural ensembles in navigation: From single cells to population codes.** *Current opinion in neurobiology*
Aery Jones, E. A., Giocomo, L. M.
2022; 78: 102665
- **A unified theory for the computational and mechanistic origins of grid cells.** *Neuron*
Sorscher, B., Mel, G. C., Ocko, S. A., Giocomo, L. M., Ganguli, S.
2022
- **From Rats to Humans: how novel behavioral paradigms and reinforcement learning can bridge the gap in translation.** *Lab animal*
Gonzalez, A., Giocomo, L. M.
2022
- **Task engagement turns on spatial maps.** *Nature neuroscience*
Low, I. I., Giocomo, L. M.
2022
- **Fifty years of the brain's sense of space** *NATURE*
Low, I. C., Giocomo, L. M.
2021
- **The grid code for ordered experience.** *Nature reviews. Neuroscience*
Rueckemann, J. W., Sosa, M., Giocomo, L. M., Buffalo, E. A.
2021
- **Navigating for reward.** *Nature reviews. Neuroscience*
Sosa, M., Giocomo, L. M.
2021
- **Spatial memory: Place cell activity is causally related to behavior.** *Current biology : CB*
Plitt, M. H., Giocomo, L. M.
2021; 31 (7): R335–R337
- **Multiple head direction signals within entorhinal cortex: origin and function.** *Current opinion in neurobiology*
Munn, R. G., Giocomo, L. M.
2020; 64: 32–40
- **Topography in the Bursting Dynamics of Entorhinal Neurons.** *Cell reports*
Bant, J. S., Hardcastle, K. n., Ocko, S. A., Giocomo, L. M.
2020; 30 (7): 2349–59.e7
- **The fruit fly gets oriented** *NATURE*
Campbell, M. G., Giocomo, L. M.
2019; 576 (7785): 42–43
- **The Shifting Sands of Cortical Divisions** *NEURON*
Hardcastle, K., Giocomo, L. M.
2019; 102 (1): 8–11
- **The Shifting Sands of Cortical Divisions.** *Neuron*
Hardcastle, K. n., Giocomo, L. M.
2019; 102 (1): 8–11

- **Emergent elasticity in the neural code for space.** *Proceedings of the National Academy of Sciences of the United States of America*
Ocko, S. A., Hardcastle, K., Giocomo, L. M., Ganguli, S.
2018
- **Self-motion processing in visual and entorhinal cortices: Inputs, integration, and implications for position coding.** *Journal of neurophysiology*
Campbell, M. G., Giocomo, L. M.
2018
- **Heterogeneity in hippocampal place coding.** *Current opinion in neurobiology*
Mallory, C. S., Giocomo, L. M.
2018; 49: 158–67
- **From entorhinal neural codes to navigation** *NATURE NEUROSCIENCE*
Mallory, C. S., Giocomo, L. M.
2018; 21 (1): 7–8
- **Cell types for our sense of location: where we are and where we are going** *NATURE NEUROSCIENCE*
Hardcastle, K., Ganguli, S., Giocomo, L. M.
2017; 20 (11): 1474–82
- **Environmental boundaries as a mechanism for correcting and anchoring spatial maps** *JOURNAL OF PHYSIOLOGY-LONDON*
Giocomo, L. M.
2016; 594 (22): 6501-6511
- **Large scale in vivo recordings to study neuronal biophysics.** *Current opinion in neurobiology*
Giocomo, L. M.
2015; 32: 1-7
- **Large scale in vivo recordings to study neuronal biophysics** *CURRENT OPINION IN NEUROBIOLOGY*
Giocomo, L. M.
2015; 32: 1-7
- **Neuroscience: Internal compass puts flies in their place.** *Nature*
Clandinin, T. R., Giocomo, L. M.
2015; 521 (7551): 165-166
- **Spatial representation: maps of fragmented space.** *Current biology*
Giocomo, L. M.
2015; 25 (9): R362-3
- **Computational diversity in the hippocampus: a matter of components.** *journal of physiology*
Giocomo, L.
2015; 593 (7): 1525-1526
- **Imagine a journey through time and space.** *Nature neuroscience*
Giocomo, L. M.
2015; 18 (2): 163-164
- **Hyperpolarization-Activated Cyclic Nucleotide-Gated 1 Independent Grid Cell-Phase Precession in Mice** *HIPPOCAMPUS*
Eggink, H., Mertens, P., Storm, E., Giocomo, L. M.
2014; 24 (3): 249-256
- **Topography of head direction cells in medial entorhinal cortex.** *Current biology*
Giocomo, L. M., Stensola, T., Bonnevie, T., Van Cauter, T., Moser, M., Moser, E. I.
2014; 24 (3): 252-262
- **The neural encoding of space in parahippocampal cortices** *FRONTIERS IN NEURAL CIRCUITS*
Giocomo, L. M., Roudi, Y.
2012; 6

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- **Phase precession and variable spatial scaling in a periodic attractor map model of medial entorhinal grid cells with realistic after-spike dynamics** *HIPPOCAMPUS*
Navratilova, Z., Giocomo, L. M., Fellous, J., Hasselmo, M. E., McNaughton, B. L.
2012; 22 (4): 772-789
 - **Spatial Representation: Maps in a Temporal Void** *CURRENT BIOLOGY*
Giocomo, L. M., Moser, E. I.
2011; 21 (23): R962-R964
 - **Grid Cells Use HCN1 Channels for Spatial Scaling** *CELL*
Giocomo, L. M., Hussaini, S. A., Zheng, F., Kandel, E. R., Moser, M., Moser, E. I.
2011; 147 (5): 1159-1170
 - **Frequency of Subthreshold Oscillations at Different Membrane Potential Voltages in Neurons at Different Anatomical Positions on the Dorsoventral Axis in the Rat Medial Entorhinal Cortex** *JOURNAL OF NEUROSCIENCE*
Yoshida, M., Giocomo, L. M., Boardman, I., Hasselmo, M. E.
2011; 31 (35): 12683-12694
 - **Computational Models of Grid Cells** *NEURON*
Giocomo, L. M., Moser, M., Moser, E. I.
2011; 71 (4): 589-603
 - **Cellular dynamical mechanisms for encoding the time and place of events along spatiotemporal trajectories in episodic memory** *BEHAVIOURAL BRAIN RESEARCH*
Hasselmo, M. E., Giocomo, L. M., Brandon, M. P., Yoshida, M.
2010; 215 (2): 261-274
 - **Cholinergic Modulation of the Resonance Properties of Stellate Cells in Layer II of Medial Entorhinal Cortex** *JOURNAL OF NEUROPHYSIOLOGY*
Heys, J. G., Giocomo, L. M., Hasselmo, M. E.
2010; 104 (1): 258-270
 - **Evaluation of the Oscillatory Interference Model of Grid Cell Firing through Analysis and Measured Period Variance of Some Biological Oscillators** *PLOS COMPUTATIONAL BIOLOGY*
Zilli, E. A., Yoshida, M., Tahvildari, B., Giocomo, L. M., Hasselmo, M. E.
2009; 5 (11)
 - **A phase code for memory could arise from circuit mechanisms in entorhinal cortex** *NEURAL NETWORKS*
Hasselmo, M. E., Brandon, M. P., Yoshida, M., Giocomo, L. M., Heys, J. G., Fransen, E., Newman, E. L., Zilli, E. A.
2009; 22 (8): 1129-1138
 - **Knock-Out of HCN1 Subunit Flattens Dorsal-Ventral Frequency Gradient of Medial Entorhinal Neurons in Adult Mice** *JOURNAL OF NEUROSCIENCE*
Giocomo, L. M., Hasselmo, M. E.
2009; 29 (23): 7625-7630
 - **Time constants of h current in layer II stellate cells differ along the dorsal to ventral axis of medial Entorhinal cortex** *JOURNAL OF NEUROSCIENCE*
Giocomo, L. M., Hasselmo, M. E.
2008; 28 (38): 9414-9425
 - **Computation by Oscillations: Implications of Experimental Data for Theoretical Models of Grid Cells** *HIPPOCAMPUS*
Giocomo, L. M., Hasselmo, M. E.
2008; 18 (12): 1186-1199
 - **Neuromodulation by glutamate and acetylcholine can change circuit dynamics by regulating the relative influence of afferent input and excitatory feedback** *MOLECULAR NEUROBIOLOGY*
Giocomo, L. M., Hasselmo, M. E.
2007; 36 (2): 184-200
 - **Temporal frequency of subthreshold oscillations scales with entorhinal grid cell field spacing** *SCIENCE*
Giocomo, L. M., Zilli, E. A., Fransen, E., Hasselmo, M. E.
2007; 315 (5819): 1719-1722

- **Grid cell firing may arise from interference of theta frequency membrane potential oscillations in single neurons** *HIPPOCAMPUS*
Hasselmo, M. E., Giocomo, L. M., Zilli, E. A.
2007; 17 (12): 1252-1271
- **Difference in time course of modulation of synaptic transmission by group II versus group III metabotropic glutamate receptors in region CA1 of the hippocampus** *HIPPOCAMPUS*
Giocomo, L. M., Hasselmo, M. E.
2006; 16 (11): 1004-1016
- **Nicotinic modulation of glutamatergic synaptic transmission in region CA3 of the hippocampus** *EUROPEAN JOURNAL OF NEUROSCIENCE*
Giocomo, L. M., Hasselmo, M. E.
2005; 22 (6): 1349-1356