Zhenrui Liao, MD, PhD

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Citizenship: USA

Education & Training

2017–2024 MD, Columbia University College of Physicians and Surgeons

2019–2022 PhD in Neurobiology and Behavior, Columbia University
Advisor: Attila Losonczy, MD, PhD
Thesis: Towards a Neuroscience of "Stories": Metric Space Learning in the Hippocampus
Recognition: Emeritus Professors in Columbia Douglas Chalmers Graduate Scholar

2017 MS in Electrical Engineering, Columbia University
(concentration in Systems Biology and Neuroengineering)

2017 BS in Electrical Engineering, Columbia University

Publications

* denotes equal contribution

Key publications

2024 **Z. Liao** *, K. Gonzalez*, D. Li, C. Yang, D. Holder, N. McClain, G. Zhang, S. Evans, M. Chavarha, M. Z. Lin, A. Losonczy, and A. Negrean. Functional architecture of intracellular oscillations in hippocampal dendrites. *Nature Communications (accepted)*, 2024a

2024 **Z. Liao** *, S. Terada*, I. Raikov*, D. Hadjiabadi*, M. Szoboszlay, I. Soltesz, and A. Losonczy. Inhibitory plasticity supports generalization in the hippocampus. *Nature Neuroscience (accepted)*, 2024b. URL https://www.biorxiv.org/content/early/2022/11/03/2022.11.02.514897

2022 L. B. Liu, A. Losonczy, and **Z. Liao**. Tension: A Python package for FORCE learning. *PLOS Computational Biology*, 2022b

2021 S. Terada, T. Geiller*, **Z. Liao** *, J. O'Hare*, B. Vancura*, and A. Losonczy. Adaptive stimulus selection for consolidation in the hippocampus. *Nature*, 2021a

2021 B. Dudok*, M. Szoboszlay*, A. Paul*, P. M. Klein*, **Z. Liao** *, E. Hwaun, G. G. Szabo, T. Geiller, B. Vancura, B.-S. Wang, S. McKenzie, J. Homidan, L. M. Klaver, D. F. English, Z. J. Huang, G. Buzsáki, A. Losonczy, and I. Soltesz. Recruitment and inhibitory action of hippocampal axo-axonic cells during behavior. *Neuron*, 2021

2020 F. Sparks*, **Z. Liao** *, W. Li, A. Grosmark, I. Soltesz, and A. Losonczy. Hippocampal adult-born granule cells drive network activity in a mouse model of chronic temporal lobe epilepsy. *Nature communications*, 11(1):1–13, 2020

Other publications

2021 D. Hadjiabadi, M. Lovett-Barron, I. G. Raikov, F. T. Sparks, **Z. Liao**, S. C. Baraban, J. Leskovec, A. Losonczy, K. Deisseroth, and I. Soltesz. Maximally selective single-cell target for circuit control in epilepsy models. *Neuron*, 2021

2019 G. F. Turi*, W.-K. Li*, S. Chavlis*, I. Pandi, J. O'Hare, J. B. Priestley, A. D. Grosmark, **Z. Liao**, M. Ladow, J. F. Zhang, et al. Vasoactive intestinal polypeptide-expressing interneurons in the hippocampus support goal-oriented spatial learning. *Neuron*, 101(6):1150–1165, 2019

2017 J. D. Zaremba, A. Diamantopoulou, N. B. Danielson, A. D. Grosmark, P. W. Kaifosh, J. C. Bowler, **Z. Liao**, F. T. Sparks, J. A. Gogos, and A. Losonczy. Impaired hippocampal place cell dynamics in a mouse model of the 22q11. 2 deletion. *Nature neuroscience*, 20(11):1612–1623, 2017

Reviews

2024 **Z. Liao** and A. Losonczy. Learning, fast and slow: Single- and many-shot learning in the hippocampus. *Annual Review of Neuroscience*, 2024

2024 **Z. Liao**, N. Mathur, V. Joshi, and S. Joshi. The Promise of Artificial Intelligence in Neuroanesthesia: An Update. *Journal of Neurosurgical Anesthesiology and Critical Care (accepted)*, 2024

2022 A. A. Liu, S. Henin, S. Abbaspoor, A. Bragin, E. A. Buffalo, J. S. Farrell, D. J. Foster, L. M. Frank, T. Gedankien, J. Gotman, J. Guidera, K. L. Hoffman, J. Jacobs, M. J. Kahana, L. Li, **Z. Liao**, J. J. Lin, A. Losonczy, ..., and G. Buzsáki. A consensus statement on detection of hippocampal sharp wave ripples and differentiation from other fast oscillations. *Nature communications*, 13(1):1–14, 2022a

Preprints

2023 J. C. Bowler, G. Zakka, H. C. Yong, W. Li, B. Rao, **Z. Liao**, J. B. Priestley, and A. Losonczy. behaviorMate: An intranet of things approach for adaptable control of behavioral and navigation-based experiments. *bioRxiv*, 2023. doi: 10.1101/2023.12.04.569989. URL https://www.biorxiv.org/content/early/2023/12/09/2023.12.04.569989

2023 K. C. Gonzalez, A. Negrean, **Z. Liao**, F. Polleux, and A. Losonczy. Synaptic basis of behavioral timescale plasticity. *bioRxiv*, 2023. doi: 10.1101/2023.10.04.560848. URL https://www.biorxiv.org/content/early/2023/10/05/2023.10.04.560848

Invited Talks & Workshops

2023 Replay for generalization in the hippocampus: Is inhibitory plasticity all you need? In *Simons Initiative for the Developing Brain Seminar Series*, Edinburgh, UK, 2023

2023 Building stories: Metric space learning in the hippocampus. In *Emeritus Professors in Columbia Graduate Lecturership*, New York, NY, 2023

2023 Building bridges via internationalization of medical education. In *#DWIHzeitgeist*, New York, NY (virtual), 2023

2022 Hyperdimensional computing: Theory and applications. In *Unsupervised Learning, guest lecture*, New York, NY, 2022

2022 Hippocampus learns metric spaces. In *Society for Neuroscience*, San Diego, CA, 2022

2022 A biologically plausible inhibitory plasticity rule for world-model learning in SNNs. In *Spiking Networks as Universal Function Approximators*, virtual, 2022

2022 Teaching Math: Challenges and perspectives in university-level quantitative pedagogy. In *Center for Teaching and Learning Workshop Series*, New York, NY, 2022

2022 Towards a Neuroscience of Stories: Metric space learning in the hippocampus. In *Columbia Neurobiology and Behavior Retreat*, Tarrytown, NY, 2022

2022 Use the FORCE: A Python package for training chaotic RNNs. In *Northeast Regional Conference on Complex Systems*, Buffalo, NY, 2022

2022 Spiking neural network models in neuroscience (Teaching Assistant). In *COSYNE*, Lisbon, Portugal, 2022

2021 AI & the Brain: Learning about learning. In *Inspirit AI Spotlight Talks*, virtual, 2021

2021 Dissecting interictal epileptiform discharge diversity: A Bayesian topic modeling approach. In *American Epilepsy Society*, Chicago, IL, 2021

2021 Replay of world structure by CA3. In *Organization for Computational Neurosciences*, virtual, 2021

2021 Spectral and machine learning methods for detection of epileptiform electrophysiological events. virtual / Ripple Methods Consortium hosted by NYU, 2021

Conference presentations

Competitive selection

2024 **Z. Liao** *, S. Terada*, D. Hadjiabadi*, I. Raikov, I. Soltesz, and A. Losonczy. Inhibitory plasticity supports replay generalization in the hippocampus. In *COSYNE*, Lisbon, Portugal, 2024a

2023 **Z. Liao** and A. Losonczy. Metric space learning in the hippocampus. In *COSYNE*, Montreal, Canada, 2023

2022 **Z. Liao** and A. Losonczy. Towards a neuroscience of "Stories": Metric space learning in the hippocampus. In *International Conference on Machine Learning – Universal Reasoning Systems Workshop*, Baltimore, MD, 2022

2022 **Z. Liao** *, D. Hadjiabadi*, S. Terada, I. Soltesz, and A. Losonczy. A GABAergic plasticity mechanism for world structure inference by CA3. In *COSYNE*, Lisbon, Portugal, 2022a

2021 **Z. Liao**, A. Losonczy, and C. Papadimitriou. The excitability functionality trade-off: Random graph models of epilepsy. In *COSYNE*, virtual, 2021

First author

2024 **Z. Liao** *, D. Hadjiabadi*, S. Terada, I. Soltesz, and A. Losonczy. Inhibitory plasticity supports consolidation of generalizable memories. In *Federation of European Neuroscience Societies*, Vienna, Austria, 2024b

2022 **Z. Liao** *, D. Hadjiabadi*, S. Terada, I. Soltesz, and A. Losonczy. World structure inference by hippocampal replay. In *Federation of European Neuroscience Societies*, Paris, France (hybrid), 2022b

2021 D. Hadjiabadi*, **Z. Liao** *, Q. A. Nguyen, S. Terada, A. Losonczy, and I. Soltesz. Data-driven biophysical model of genetic epilepsy predicts loss of cue cell suppression during sharp-wave ripple associated memory replay. In *American Epilepsy Society*, Chicago, IL, 2021

2021 **Z. Liao** *, D. Hadjiabadi*, I. Soltesz, and A. Losonczy. Hebbian plasticity of GABAergic synapses sufficient for consolidation of world structure by ca3 replay. In *Society for Neuroscience*, virtual, 2021

2019 F. Sparks*, **Z. Liao** *, I. Soltesz, and A. Losonczy. Circuit level cell-type specific population dynamics within the dentate gyrus during interictal events in the kainic acid mouse model of temporal lobe epilepsy. In *Society for Neuroscience*, Chicago, IL, 2019b

2019 F. Sparks*, **Z. Liao** *, I. Soltesz, and A. Losonczy. Interictal events recruit distinct ensembles of adult-born and mature granule cells in the epileptic dentate gyrus. In *Park City Epilepsy Meeting*, Park City, UT, 2019a

2016 **Z. Liao** and A. Losonczy. A matched filtering algorithm for sharp-wave ripple detection in hippocampal local field potential recordings. In *38th International Conference of the IEEE Engineering in Medicine and Biology Society*, Orlando, FL, 2016. IEEE

Contributing author

2021 S. Terada, **Z. Liao**, D. Hadjiabadi, I. Soltesz, and A. Losonczy. A novel mechanism of adaptive stimulus selection for sharp wave ripple-related memory consolidation in the hippocampus. In *7th Annual BRAIN Initiative Meeting*, virtual, 2021b

2019 F. Sparks, S. Wiesenberger, **Z. Liao**, W.-K. Li, R. Nyilas, B. Vancura, H. Blockus, A. Vaziri, and A. Losonczy. Large-scale volumetric calcium imaging of hippocampal microcircuits during head-fixed spatial navigation and learning. In *Inhibition in the CNS - Gordon Research Conference*, Newry, ME, 2019

2016 G. Turi, **Z. Liao**, W.-K. Li, J. Zaremba, A. Grosmark, X. Luo, L. Topolnik, and A. Losonczy. Role of hippocampal VIP interneurons in reward-oriented spatial learning. In *Society for Neuroscience*, San Diego, CA, 2016

Funding

2020-2023 NIH Ruth L. Kirchenstein Fellowship (F31) Principal Investigator
- Support amount $171,010
- Project title: Dissecting microcircuit alterations in the epileptic dentate gyrus with functional imaging
- Competitive 3-year NIH research/training grant, won as a first-year graduate student
- Funding organization: NIH National Institute of Neurological Disease and Stroke
- Grant ID: 5F31-NS120783

2017-2020 NIH Medical Scientist Training Program Training Grant Appointee
- Support amount $56,135
- Project #1: Mathematical modeling of epileptiform interictal spikes
- Project #2: Two-photon imaging of interneurons in hippocampal area CA1
- Funding organization: NIH National Institute of General Medical Sciences
- Grant ID: 5T32GM007367-44

Honors & Awards

2024 Titus Munson Coan Prize, Best Manuscript in Biological Sciences
2024 Federation of European Neuroscience Societies (FENS) Forum Award
2023 Douglas Chalmers Graduate Scholar
2022 Center for Teaching and Learning Lead Teaching Fellowship
2021 American Epilepsy Society Faculty Stipend
2021 Society for Neuroscience Professional Development Award
2017 Latin Honors (Bachelor's, Master's of Science)
2017 Tau Beta Pi (Engineering Phi Beta Kappa, top 7% of class)

2013-2017 Dean's List (every eligible semester)
2013 National Merit Scholar

Teaching

Instructor

2023	Computational Neuroscience	Neuromatch (Project Mentor)
2022-2023	Lead Teaching Fellow	Columbia University
2022	Mathematics for Theoretical Neuroscience	with Danil Tyukmanov (semester course)
2021	Mathematics for Theoretical Neuroscience	with Danil Tyukmanov (semester course)
2021	Artificial Intelligence	InspiritAI (winter course)
2018, 2019	Pharmacokinetics & Pharmacodynamics	Columbia Student Success Network

Teaching Assistant

		Faculty
2022	Theoretical Neuroscience	Larry Abbott
2021	Computation and the Brain	Christos Papadimitriou
2020	Computation and the Brain	Christos Papadimitriou
2020	Advanced Machine Learning	Nakul Verma
2020	Machine Learning	Nakul Verma
2019	Unsupervised Learning	Nakul Verma
2018	Information Theory in Theoretical Computer Science	Omri Weinstein
2018	Machine Learning	Nakul Verma
2017	Machine Learning	Its'ik Pe'er
2016	Machine Learning	Daniel Hsu
2015	Professional Engineering	Esther Perea
2014	Analysis and Optimization	Davesh Maulik
2014	Calculus I-III	

Other

	Service	Position
2023-	Ad hoc reviewer	Communications Biology
2022-2023	Theoretical Computer Science x Neuroscience Reading Group	Founder, organizer
2020-2021	Columbia COVID-19 Service Corps	Volunteer Vaccinator
2017-2024	CoSMO Medical Student Free Clinic	Senior clinician
2017-2024	Columbia MD-PhD Advisory Committee	Class Representative

Healthcare Policy

2019 AMA MSS Interim 2019 Resolution 10: Promoting Early Access to Diabetes Care to Reduce the Incidence of End-Stage Renal Disease

- Lead author on resolution authored by all 7 AMA regions
- Result: Recommended for study by AMA MSS Policy Committee

2019 AMA MSS Interim 2019 Resolution 84: Increased Recognition and Treatment of Eating Disorders in Minority Populations

- Delivered Region 7's testimony in support
- Result: Adopted by AMA MSS

Professional society memberships

2017-	Society for Neuroscience
2021–	American Epilepsy Society
2019–	American Medical Association
2015-2018	Institute of Electrical and Electronics Engineers (IEEE)
	IEEE Engineering in Medicine and Biology Society (EMBS)
	IEEE Computational Intelligence Society

Certifications

2024-2026	Advanced Cardiac Life Support	American Heart Association
2019-2026	Basic Life Support	American Heart Association
2022	Teaching Development Program	Center for Teaching and Learning