

Zhenrui Liao

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Citizenship: USA

Education & Training

- 2017–2024 MD (expected), 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

- 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. Szoboszlai*, 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

- 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

- 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

PREPRINTS

- 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>
- 2022 **Z. Liao***, D. Hadjiabadi*, S. Terada, I. Soltesz, and A. Losonczy. An inhibitory plasticity mechanism for world structure inference by hippocampal replay. *bioRxiv*, 2022c. doi: 10.1101/2022.11.02.514897. URL <https://www.biorxiv.org/content/early/2022/11/03/2022.11.02.514897>

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

- 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

- 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 \$171,010
	<ul style="list-style-type: none"> • Support amount • 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 \$56,135
	<ul style="list-style-type: none"> • Support amount • 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

2023	Douglas Chalmers Graduate Scholar
2022-2023	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 (university-wide position)
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

2022-	Theoretical Computer Science x Neuroscience Reading Group	Founder, organizer
2020-2021	Columbia COVID-19 Service Corps	Volunteer Vaccinator
2017-2023	CoSMO Medical Student Free Clinic	Junior clinician
2017-2023	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 <ul style="list-style-type: none">• 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 <ul style="list-style-type: none">• 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