Ji-An Li

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Research Interests

Computational Neuroscience, Computational Cognitive Science

Education

University of California, San Diego — California, USA
Doctoral Study in Neurosciences — 2020 – Present
Advisor: Marcelo Mattar, Marcus Benna — GPA: 4.0/4.0

University of Science and Technology of China — Anhui, China
M.S. in Applied Statistics — 2016 – 2019
Advisor: Xiaochu Zhang — GPA: 4.1/4.3 (1^{st} of 28 students)

B.S. in Biological Science — 2012 – 2016
Advisor: Xiaochu Zhang — GPA: 4.0/4.3 (1^{st} of 76 students)
Shitsan Pai Talent Program in Life Sciences (Honor)

B.E. in Computer Science and Technology (Dual) — 2012 - 2016
Advisor: Shangfei Wang — GPA: 4.0/4.3 (1^{st} of 46 students)

Honors

Interpretability Hackathon 3.0, First Place — 2023
Innovative Research Grants Award (Kavli Institute, UCSD) — 2022
Outstanding Research Paper Award (USTC) — 2020
Graduate Scholarship, Grade 1 (USTC) — 2018
Suzhou Industrial Park Scholarship (USTC) — 2017
Outstanding Undergraduate Thesis (USTC) — 2016
Guo Moruo Scholarship (USTC, Highest Honor) — 2015
National Scholarship (Chinese Ministry of Education) — 2014
Outstanding Student Scholarship, Gold Medal (USTC) — 2013
Outstanding Freshman Scholarship (USTC) — 2012
China High School Biology Olympiad, Nationwide, Silver Medal — 2011
China High School Biology Olympiad, Anhui Province, First Prize — 2011
National Olympiad in Informatics, Anhui Province, First Prize — 2010

Publications

L Ji-An, MK Benna, MG Mattar. Automatic Discovery of Cognitive Strategies with Tiny Recurrent Neural Networks. *bioRxiv.* 2023

L Ji-An, F Stefanini, MK Benna, S Fusi. Face familiarity detection with complex synapses. *iScience.* 2023

M Molano-Mazón, J Barbosa, J Pastor-Ciurana, M Fradera, RY Zhang, J Forest, J Pozo, L Ji-An, CJ Cueva, J Rocha, D Narain, GR Yang. NeuroGym: An open resource for developing and sharing neuroscience tasks. *PsyArXiv, aqc9n.* 2022

JA Li, D Dong, Z Wei, Y Liu, Y Pan, F Nori, X Zhang. Quantum Reinforcement Learning during Human Decision Making. *Nature Human Behaviour.* 2020

Y Cheng, J Bu, N Li, JA Li, H Gou, S Sun, C Liu, Z Jin, C He, C Fan, C Liu, X Zhang. Dysfunctional resting-state EEG microstate correlated with the severity of cigarette exposure in nicotine addiction. *Science China Information Sciences.* 2020

S Minni*, L Ji-An*, T Moskovitz, G Lindsay, K Miller, M Dipoppa, GR Yang. Understanding the Functional and Structural Differences across Excitatory and Inhibitory Neurons. *bioRxiv, 680439.* 2019

R Zha, J Bu, Z Wei, L Han, P Zhang, J Ren, JA Li, Y Wang, L Yang, S Vollstädt-Klein, X Zhang. Transforming brain signals related to value evaluation and self-control into behavioral choices. *Human brain mapping.* 2019

* = equal contributions

Conference papers

HD Xiong*, L Ji-An*, MG Mattar, RC Wilson. Distilling human decision-making dynamics: a comparative analysis of low-dimensional architectures. *NeurIPS Workshop AI4Science 2023*

HD Xiong*, L Ji-An*, MG Mattar, R Wilson. Neural network modeling reveals diverse human exploration behaviors via state space analysis. **Contributed talk**. *Cognitive Computational Neuroscience 2023*

L Ji-An, MG Mattar. What do meta-reinforcement learning networks learn in two-stage decision-making? Poster. *Cosyne 2022*

GR Yang, J Pastor-Ciurana, M Fradera, RY Zhang, J Forest, J Pozo, J Barbosa, L Ji-An, CJ Cueva, A Compte, J Rocha, M Molano-Mazon. Neurogym: An open resource to developing and sharing neuroscience tasks. Poster. *Cosyne 2021*

S Minni*, L Ji-An*, T Moskovitz, G Lindsay, K Miller, M Dipoppa, GR Yang. Understanding the functional and structural differences across excitatory and inhibitory neurons. Poster. *Cosyne 2020*

JA Li, F Stefanini, MK Benna, S Fusi. A Face Familiarity Detection System with Complex Synapses. Poster. *Cosyne 2019*

JA Li, Z Wei, X Zhang. Behavioral and neural evidence for quantum reinforcement learning during decision making. Poster. *Society for Neuroscience 2018*

JA Li, GR Yang, XJ Wang. Neural Mechanisms of Recurrent Neural Networks with Interneurons and Dendrites Performing Context-dependent Decision Making. Poster. *Society for Neuroscience 2018*

* = equal contributions

Submitted papers

L Ji-An, MK Benna, MG Mattar. Automatic Discovery of Cognitive Strategies with Tiny Recurrent Neural Networks. *Nature* (under review)

Research

Department of Neurosciences, UC San Diego

Advisor: Marcelo Mattar, Marcus Benna 2020 – Present

Automatic Discovery of Cognitive Strategies with Tiny Recurrent Neural Networks

Developed a novel modeling approach leveraging recurrent neural networks to automatically uncover the cognitive algorithms governing biological decision-making, shedding light onto neural mechanisms and providing novel insights into healthy and dysfunctional cognition.

Implicit Product Alignment Approximates Backpropagation
Developed a novel biologically plausible credit assignment algorithm that can approximate backpropagation, substantially outperforming existing algorithms such as feedback alignment and direct feedback alignment.

Relating Induction Heads in Transformers to Temporal Context Models of Human Episodic Memory
Established theoretical and empirical connections between the induction heads (crucial for in-context learning) in Transformer models and the temporal context model of human episodic memory, revealing their striking resemblances. (Won first place in Interpretability Hackathon 3.0)

School of Life Sciences, University of Science and Technology of China
Advisor: Xiaochu Zhang 2015 – 2020
Quantum Reinforcement Learning during Human Decision Making
Showed that quantum reinforcement learning, a mathematical formalism inspired by quantum probability theory, can model human value-based decision making. Discovered the representation of unique quantum-like variables in the medial frontal gyrus with model-based fMRI analysis. (Graduate thesis)

Hierarchical Bayesian Models for the Iowa Gambling Task
Undergraduate thesis for Bachelor of Science in Biological Science (Outstanding Undergraduate Thesis of USTC).

Zuckerman Institute, Columbia University
Advisor: Stefano Fusi 2018 – 2020
Face Familiarity Detection with Complex Synapses
Developed a modular face familiarity detection neural system with plastic complex synapses, serving as a feasible biological model for the brain's hippocampo-cortical circuits.

Advisor: Guangyu Robert Yang 2018 – 2020
Understanding the Functional and Structural Differences across Excitatory and Inhibitory Neurons
Developed the convolutional recurrent neural networks equipped with excitatory and inhibitory neurons, serving as a model for the visual cortex. Explored the necessary conditions for the networks to develop distinct selectivity and connectivity across cell types.

Center for Neural Science, New York University
Advisor: Xiao-Jing Wang 2017
Recurrent Neural Networks with Interneurons and Dendrites Performing Decision Making
Developed a neuronal circuit model of three types of interneurons and multicompartmental pyramidal cells using recurrent neural networks. Studied the sensory gating mechanisms of the network performing a context-dependent decision-making task.

Talks	AI for Brain Science, Tianqiao and Chrissy Chen Institute	2023
	Neurodinner, Neurosciences Graduate Program, UCSD	2023
	KIBM Symposium on Innovative Research, UCSD	2023
	Computational Psychiatry Seminar, Chinese Computational Psychiatry Network	2021
	Brain Science Institute, RIKEN, Japan	2018
Research Mentorship	Ruicheng Li, master student at UCSD, in the group of Marcelo Mattar	2022
	Huixing Gou, graduate student at USTC, in the group of Xiaochu Zhang	2020
Reviewer	eLife, Science Advances, CCN (Conference on Cognitive Computational Neuroscience)	
Teaching	Instructor, Department of Neurosciences, UCSD	2023
	NEU200C Cognitive Neuroscience	
	Teaching assistant, Department of Statistics and Finance, USTC	2018
	Regression Analysis, *Excellent Teaching Assistant Honor*	
Science Outreach	Presentation to students at High School Affiliated to Anhui Normal University, on China High School Biology Olympiad.	2013
Academic Activities	Volunteer, Neuromatch Academy	2023
	Volunteer, Neuromatch Academy	2022
	Student, Computational & Cognitive Neuroscience Summer School, Cold Spring Harbor Asia	2021
	Interactive-track student, Neuromatch Academy	2020
	Translator, *A Concise Handbook of TensorFlow*, supported by Google Developer Relations Team	2018
	Student, Japanese and Asian Youth Science Exchange Project	2015
	Intern student, Institute of Biophysics (Beijing), CAS	2013
Leadership	President, Computational Neuroscience Committee, UCSD	2023 – Present
	Vice President, Nature Protection Association, USTC	2015 – 2016
Programming	Python (TensorFlow, PyTorch), MATLAB, R, C++, Bash, SQL, AFNI	