

M Ganesh Kumar, Ph.D.

m_ganeshkumar@u.nus.edu | [mgkumar138.github.io](https://github.com/mgkumar138) | Citizenship: Singapore

RESEARCH PROGRAMME

My research aims to explain how the brain **assigns credit and learns from feedback**, determine how these processes are altered in psychopathology, and identify interventions that can improve learning and decision-making under uncertainty. I pursue these aims by developing **computational models** and testing them against behavioral and neural data and large-scale simulations of artificial agents. This approach generates experimentally *testable* predictions, *accelerates* hypothesis testing, and enables *precise measurement* of individual differences and intervention outcomes.

Keywords: Computational neuroscience, Reinforcement learning, Computational psychiatry

APPOINTMENTS

2026 – present	Research Scientist , Department of Computational Neuroscience Max Planck Institute for Biological Cybernetics, Germany. Advisor: Peter Dayan
2023 – 2025	Postdoctoral Fellow , School of Engineering and Applied Sciences Harvard University, United States. Advisor: Cengiz Pehlevan
2022 – 2023	Research Scientist I , Centre for Frontier AI Research (CFAR) A*STAR, Singapore.
2017 – 2018	Research Engineer , A*STAR Artificial Intelligence Initiative (A*AI) A*STAR, Singapore

EDUCATION AND MENTORS

2018 – 2023	Ph.D. in Computational Neuroscience , National University of Singapore (NUS) Integrative Sciences and Engineering Programme, NUS Graduate School Thesis: <i>Biologically Plausible Computations Underlying One-Shot Learning of Paired Associations</i> Advisors: Andrew Tan , Shih-Cheng Yen , Thomas Yeo (Thesis committee)
2013 – 2017	B.Sc. (Honours with Distinction) in Life Sciences (Biomedical Sciences) , NUS Double Minors: University Scholars Programme and Special Programme in Science Honours thesis: <i>Wheelchair Control Using Motor-Imagery-Based Electroencephalogram (EEG)</i>

Additional training

2024	Summer School in Analytical Connectionism, Flatiron Institute, Simons Foundation
2021	Graduate Exchange in Early Childhood Education, National Institute of Education, NTU
2019	Summer School, Center for Brains, Minds and Machines, Massachusetts Institute of Technology

GRANTS, FELLOWSHIPS AND AWARDS

2025, 2026	Young NUS Fellow, NUS Development Grant (SGD 40,000). Funds two research assistants.
2025	Spotlight talk and Travel Award (EUR 1,000), Computational Psychiatry Conference
2025	Spotlight poster and Travel Award (USD 500), COSYNE
2023	Postdoctoral Fellowship in Computer Science, Harvard University
2019	Fujitsu Laboratories Fellow, MIT Center for Brains, Minds and Machines
2018	NUS Graduate School Scholarship (Ph.D.)
2017	NUSS Gold Medal for Outstanding Achievement
2017	University Scholars Programme Senior Honour Roll
2013	A*STAR Undergraduate Scholarship

PEER-REVIEWED PUBLICATIONS

A note on venues. In machine learning, peer-reviewed ICML, NeurIPS, ICLR and ICCV proceedings are highly selective (< 30% acceptance) archival publications equivalent to journal articles.

* equal contribution; + see contribution note.

Manuscripts in preparation

1. **M Ganesh Kumar**, Peter Dayan. A Computational Model for Attribution Theory During Skill Inference. Target: *Nature Communications*. Preprint early 2027.
2. Jorin Overwiening, **M Ganesh Kumar**, Haim Sompolinsky. Hierarchical Spiking Computation With Feedback Alignment for Task-Driven Learning. Target: *Nature Neuroscience*. Preprint early 2027.
3. Aditya Singh*, Maximilian Weichart*, Kai Rothe, Mohammad Abbas Ansari, Roxana Zeraati, Peter Dayan, **M Ganesh Kumar**. Scalable Yet Interpretable Meta-RL for Decision-Making With Uncertainty. Target: *International Conference on Machine Learning (ICML)*. Preprint Early 2027.
4. Yuyang Huang, **M Ganesh Kumar**, Peter Dayan, Simon N. Jacob. Stable Yet Volatile Representational Drift Facilitates Continual Learning. Target: *NeurIPS 2027*. Preprint mid 2027.
5. Kevin Chua, **M Ganesh Kumar**, Sajikumar Sreedharan. Transcranial Direct Current Stimulation Rescues Metaplasticity in Hippocampal CA2 After Juvenile Stress. Target: *Nature Neuroscience*. Preprint mid 2027.
6. Yuzhe Han, Mohammad Yaghoubi, Mark P. Brandon, Peter Dayan, **M Ganesh Kumar**. Feature Learning in the Hippocampus Encodes Prediction Errors. Target: *Nature Neuroscience*. Preprint late 2027.
7. Jiachuan Wang, **M Ganesh Kumar**, Camilo Libedinsky, Shih-Cheng Yen, Andrew Yong-Yi Tan. Heterogeneity Affords Stimulus-Association Learning. Target: *Neural Networks*. Preprint late 2027.
8. **M Ganesh Kumar**, Peter Dayan. Depressive Symptoms Shift Credit for Failure from Task to Self. Target: *Nature Human Behaviour*. Preprint early 2028.

Research Articles

9. Mohammad Yaghoubi, **M Ganesh Kumar***, Andres Nieto-Posadas, Coralie-Anne Mosser, Thomas Gisiger, Emmanuel Wilson, Cengiz Pehlevan, Sylvain Williams, Mark P. Brandon (2026). Predictive Coding of Reward in the Hippocampus. *Nature* 651, 414–420. doi.org/10.1038/s41586-025-09958-0
+ My contribution: I developed the theory and ran all model simulations, as documented in the Author Contributions. First published in Kumar et al. (ICML 2025; paper 13) and cited by the Nature paper, the theory predicted that reward-coding place fields would shift backward to pre-emptively fire before the reward, analogous to dopaminergic reward-prediction-error coding theory. The experiments confirmed my prediction.
10. **M Ganesh Kumar**, Cheston Tan, Camilo Libedinsky, Shih-Cheng Yen, Andrew Yong-Yi Tan (2026, accepted). One-Shot Learning of Paired Association Navigation With Biologically Plausible Schemas. *Journal of Neuroscience*. arxiv.org/abs/2106.03580
11. Vachan Jagadeesh Shetru*, Jiachuan Wang*, **M Ganesh Kumar**, Camilo Libedinsky, Shih-Cheng Yen, Andrew Yong-Yi Tan, Jai S Polepalli (2026, accepted). Hippocampal Neurogenesis With Cbln4 Deletion Impairs Fear Conditioning. *Communications Biology*.
12. Adam Lee*, **M Ganesh Kumar***, Blake Bordelon, Cengiz Pehlevan (2026). CompleteP for RL: Mitigating Inconsistencies When Scaling Reinforcement Learning. *International Conference on Machine Learning (ICML)*, Seoul. openreview.net/forum?id=3uXAGWqCny
13. **M Ganesh Kumar**, Blake Bordelon, Jacob Zavatore-Veth, Cengiz Pehlevan (2025). A Model of Place Field Reorganization During Reward Maximization. *International Conference on Machine Learning (ICML)*, Vancouver. proceedings.mlr.press/v267/kumar25a.html
14. **M Ganesh Kumar**, Adam Manoogian, Billy Qian, Cengiz Pehlevan†, Shawn A. Rhoads† (2025). Neurocomputational Underpinnings of Suboptimal Beliefs in Reinforcement Learning Agents. *Cognitive Computational Neuroscience (CCN)*, Amsterdam. doi.org/10.32470/3kpf810
15. Clarence Lee*, **M Ganesh Kumar***, Cheston Tan (2023). DetermiNet: A Large-Scale Diagnostic Dataset for Complex Visually Grounded Referencing Using Determiners. *International Conference on Computer Vision (ICCV)*, Paris. arxiv.org/abs/2309.03483

16. **M Ganesh Kumar**, Cheston Tan, Camilo Libedinsky, Shih-Cheng Yen, Andrew Yong-Yi Tan (2022). A Nonlinear Hidden Layer Enables Actor–Critic Agents to Learn Multiple Paired Association Navigation. *Cerebral Cortex* 32(18), 3917–3936. doi.org/10.1093/cercor/bhab456

Book chapter

17. **M Ganesh Kumar**, Shamini Ayyadury, Elavazhagan Murugan (2024). Trends, Innovations and Challenges in Employing Interdisciplinary Approaches to Biomedical Sciences. In *Translational Research in Biomedical Sciences: Recent Progress and Future Prospects*, Chapter 20. Springer Nature. doi.org/10.1007/978-981-97-1777-4_20

Short papers (under 8 pages, peer reviewed)

18. Jiachuan Wang, Vachan Jagadeesh Shetru, **M Ganesh Kumar**, Camilo Libedinsky, Shih-Cheng Yen, Andrew Yong-Yi Tan, Jai S Polepalli (2026). Unsupervised Hebbian Learning Drives Biologically Interpretable Pattern Separation in a Hippocampal–Striatal Network. *AAAI Workshops*, Singapore. Spotlight.

19. Aditya Singh, **M Ganesh Kumar** (2026). Tiny Personal Critic: A Lightweight Critic for Low-Compute Language Model Personalization. *AAAI Workshops*, Singapore.

20. Zijun Lin, **M Ganesh Kumar**, Cheston Tan (2025). Human-Like Compositional Learning of Visually Grounded Concepts Using Synthetic Environments. *ICLR Workshops*, Singapore. openreview.net/forum?id=vq39RX6xIU

21. Nathan Cloos, **M Ganesh Kumar**, Adam Manoogian, Christopher Cueva, Shawn A. Rhoads (2024). Generating and Validating Agent and Environment Code for Simulating Realistic Personality Profiles With Large Language Models. *NeurIPS Workshop on Foundation Models for Science*, Vancouver. openreview.net/pdf?id=oelvS0ULNI

22. Zijun Lin*, Haidi Azaman*, **M Ganesh Kumar**, Cheston Tan (2024). Compositional Visual Grounding of Word Concepts Through Embodied Reinforcement Learning. *CVPR Workshops*, Seattle. arxiv.org/abs/2309.04504

23. **M Ganesh Kumar**, Kai Keng Ang, Rosa Q. So (2017). Reject Option to Reduce False Detection Rates for EEG Motor-Imagery-Based BCI. *IEEE Engineering in Medicine and Biology Conference (EMBC)*, Korea. doi.org/10.1109/EMBC.2017.8037479

Selected conference abstracts

- | | |
|------|---|
| 2026 | M Ganesh Kumar , Cengiz Pehlevan. Preserving TD-Driven Place-Field Reorganization at Scale: A Scaling-Limit Perspective. <i>COSYNE</i> , Lisbon. Poster. |
| 2026 | Jorin Overwiening, Hanming Ye, M Ganesh Kumar , Haim Sompolinsky. Tempotron Learning in Deep Neural Networks With Direct Feedback Alignment. <i>COSYNE</i> , Lisbon. Poster. |
| 2025 | M Ganesh Kumar* , Adam Manoogian*, Cengiz Pehlevan, Shawn A. Rhoads. Neurocomputational Underpinnings of Suboptimal Beliefs in Reinforcement Learning Agents. <i>Computational Psychiatry Conference</i> , Tübingen. Spotlight talk. |
| 2025 | M Ganesh Kumar , Blake Bordelon, Jacob Zavatore-Veth, Cengiz Pehlevan. A Model of Place Field Reorganization During Reward Maximization. <i>COSYNE</i> , Montreal. Spotlight poster. |
| 2024 | Clarence Lee*, Zijun Lin*, M Ganesh Kumar , Cheston Tan. Leveraging Synthetic Datasets to Advance Visual Grounding of Natural-Language Concept Comprehension. <i>16th Asia-Pacific Conference on Vision (APCV)</i> , Singapore. Talk. |
| 2022 | M Ganesh Kumar , Cheston Tan, Camilo Libedinsky, Shih-Cheng Yen, Andrew Yong-Yi Tan. One-Shot Learning of Paired Associations by a Reservoir Computing Model With Hebbian Plasticity. <i>COSYNE</i> , Lisbon. Poster. |
| 2021 | M Ganesh Kumar , Cheston Tan, Camilo Libedinsky, Shih-Cheng Yen, Andrew Yong-Yi Tan. One-Shot Learning of Paired Associations by a Reservoir Computing Model With Hebbian Plasticity. <i>Society for Neuroscience (SfN)</i> , virtual. Talk. |

INVITED TALKS

- | | |
|----------|--|
| Nov 2026 | Ministry of Education, Singapore. Workplan Seminar. <i>Learning, Memory and Meta-cognition</i> |
| Aug 2026 | Ministry of Education, Singapore. Keynote, Tamil Teachers Conference. <i>Minds, Machines and Mother Tongue: How Neuroscience and AI Can Support Learning</i> |
| Feb 2026 | Department of Physiology, National University of Singapore |
| Sep 2025 | Institute of Cognitive Neuroscience, University College London |
| Jun 2025 | LMU–Harvard Young Scientists’ Forum, Ludwig-Maximilians-Universität München |

Mar 2025	Department of Computational Neuroscience, Max Planck Institute for Biological Cybernetics
Mar 2025	Spring to Science, Kempner Institute for the Study of Natural and Artificial Intelligence, Harvard
Nov 2024	Annual Neuroscience Conference, Society for Neuroscience Singapore Chapter
Jun 2024	Neural Coding and Cognition Group, National University of Singapore
Apr 2023	Machine Learning Foundations Group, Harvard University
Dec 2022	Neuroscience Singapore 2022, Society for Neuroscience Singapore Chapter
Nov 2022	Senseable Intelligence Group, McGovern Institute for Brain Research, MIT
Oct 2022	Metaconscious Group, Department of Brain and Cognitive Sciences, MIT
Sep 2022	Department of Computational Neuroscience, Max Planck Institute for Biological Cybernetics
Jun 2022	Three Minute Thesis, Department of Physiology, NUS
Feb 2022	Biolins Group, Department of Brain and Cognitive Sciences, MIT
Sep 2021	Neurobiology Seminar, Life Sciences Institute, NUS

TEACHING

Jan–May 2025	Teaching Fellow, APMTH 50: Introduction to Applied Mathematics, Harvard University 60 students. Led weekly tutorials of 30 students, held office hours, marked weekly problem sets, and supervised group paper presentations and final project proposals.
2019	Guest Lecturer and Practical Facilitator, LSM4213: Systems Neurobiology, NUS Lecture on brain–computer interfaces. Facilitated the electromyography practical for 60 students.
2019–2020	Graduate Research Mentor, Special Programme in Science, NUS Interdisciplinary research programme for a cohort of 20 students. Supervised a group project on brain activity in schizophrenia.

Outreach and continuing education

2022	STEP NUS Braincamp, National University of Singapore
2021	NUS continuing education course, <i>Beginning AI Through Neuroscience</i>
2021	Neuroscience, AI and Medicine Workshop, National University of Singapore
2019	NUS Braincamp, National University of Singapore

MENTORING

* main supervisor

Current

2026 – present	*Rashi Singh, Research Assistant (funded by my NUS Development Grant). Juvenile stress and tDCS, with Kevin Chua and Sajikumar Sreedharan, NUS.
2026 – present	*Yuzhe Han, Master's thesis, University of Tübingen (funded by MPI). Feature learning in the hippocampus.
2026 – present	*Maximilian Weichart, Master's thesis, University of Tübingen (funded by MPI). Interpretable meta-reinforcement learning.
2025 – present	*Aditya Singh, Research Assistant (funded by my NUS Development Grant). Bachelor's graduate, Kalinga Institute of Industrial Technology. First-author AAAI 2026 workshop paper.
2024 – present	Jiachuan Wang, Ph.D. candidate, NUS

Past (current position)

2023 – 2024	*SUTD Capstone student team, wearable sensor prototypes for Nugen.ai (funded by Nugen.ai)
2023 – 2024	Leon Guertler, NTU Honours Project (now Research Engineer, xAI)
2023 – 2024	Zijun Lin, NTU Honours Project (now Ph.D. student, NTU)
2023	Haidi Azaman, NUS Honours Project (now M.Comp. student, NUS)
2022 – 2023	Clarence Lee, A*STAR Internship (now Ph.D. student, SUTD)
2021 – 2022	Xi Zhi Low, NUS Honours Project (now M.D. student, Duke-NUS)
2020 – 2021	Hema Prashaad, NUS Honours Project (now M.D. student, Duke-NUS)
2020 – 2021	Franklin Leong, NUS Honours Project (now Ph.D. student, ETH Zurich)

PROFESSIONAL SERVICE

Reviewer	Journals: <i>Nature Communications</i> , <i>Neural Networks</i> , <i>PLOS Computational Biology</i> , <i>Frontiers in Systems Neuroscience</i> , <i>IEEE Transactions on Cognitive and Developmental Systems</i> Conferences: NeurIPS, ICLR, ICML, CCN, COSYNE
Organizing	Organizing Committee, Society for Neuroscience Singapore Chapter (SfN.SG)

BEYOND RESEARCH

National Service leadership

I hold the rank of Major in the Singapore Armed Forces and, as a volunteer reservist, plan operations for a battalion of 700 National Servicemen. I am scheduled to assume command of the battalion as a Lieutenant Colonel in 2030. My aim is to collaborate with the Ministry of Defence to translate my research on learning and psychopathology into evidence-based approaches that strengthen the resilience, mental well-being and cognitive performance of National Servicemen.

Industry and innovation for education

I co-founded Nugen.ai to develop wearables that measure students' physiological states during learning and provide educators and parents with feedback on engagement and stress. We funded and mentored an SUTD Capstone team that built prototypes, and we conducted a preschool pilot. I also consult for Noova Tech, which develops locally deployed agentic AI systems for data security. My aim is to translate my research on learning into practical tools that help educators identify when students are engaged, stressed or in need of support.

Community

I organized a Tamil and AI symposium in 2019 with NUS and NTU, where students developed AI tools for Tamil education, and worked with AI Singapore to present the AI for Everyone series in Tamil. I have also given talks to Singapore's Ministry of Education on metacognition in learning and large language models for Tamil. At the Centre for Singapore Tamil Culture, I am leading an initiative to develop a language model with strong Tamil capabilities. My aim is to work with community partners to translate research in AI and learning into accessible tools, educational resources and language technologies that address priorities identified by Singapore communities.

REFERENCES

Prof. Dr. Peter Dayan

Max Planck Institute for Biological Cybernetics (current supervisor)

peter.dayan@tuebingen.mpg.de

Assoc. Prof. Cengiz Pehlevan

Harvard University (postdoctoral advisor)

cpehlevan@seas.harvard.edu

Asst. Prof. Andrew Tan

National University of Singapore (doctoral advisor)

phstya@nus.edu.sg

Dr. Cheston Tan

A*STAR (pre-doctoral advisor)

cheston-tan@i2r.a-star.edu.sg