FY 2025 Annual Report

Unit Name

Neural Coding and Brain Computing Unit
Professor Tomoki Fukai

Research Personnel

Milena Menezes Carvalho, Postdoctoral Scholar

Daniel Müller-Komorowska, Postdoctoral Scholar

Tomas Barta, Postdoctoral Scholar

Lihao Guo, Postdoctoral Scholar

Thomas Burns, Visiting Researcher

Yoshifumi Nishi, Visiting Researcher

Kumiko Nomura, Visiting Researcher

Milena Menezes Carvalho, Visiting Researcher

Roman Koshkin, Visiting Researcher

Giovanni Rabuffo, Visiting Researcher

Balashwethan S Chockalingam, PhD Student

Munenori Takaku, PhD Student

Gaston Sivori, PhD Student

Hugo Paul Musset, PhD Student

Lok Him Leung, Research Intern

Sofia Sanz Del, Research Intern

Yuuka Xiao Ying Foo, Research Intern

Collaborations

Dr. Kuniko Nomura, Toshiba Co. Research and Development Center, Japan, Neuromorphic devices for sequence processing

Gaston Sivori, PhD student, Neural Coding and Brain Computing Unit, OIST, Japan, Neuromorphic devices for sequence processing

Dr. Yoshifumi Nishi, Toshiba Co. Research and Development Center, Japan, Neuromorphic devices for sequence processing

Prof. Yutaka Sakai, Tamagawa University, Japan, Decision-making through rule inference

Prof. Takashi Takekawa, Kogakuin University, Japan, Decision-making through rule inference

Haruki Takahashi, ExaWizards Inc., Japan, Decision-making through rule inference

Prof. Kazumasa Tanaka, Memory Research Unit, OIST, Japan, Hippocampal memory replay during hibernation

Dr. Tomas Barta, Neural Coding and Brain Computing Unit, OIST, Japan, Hippocampal memory replay during hibernation

Dr. Yoshiyuki Kashiwase, OMRON Co. Ltd., Japan, Chunking sensorimotor sequences in human EEG

Dr. Masanori Hashikaze, OMRON Co. Ltd., Japan, Chunking sensorimotor sequences in human EEG

Prof. Keiichi Kitajo, National Institute for Physiological Sciences, Japan, Chunking sensorimotor sequences in human EEG

Dr. Shunsuke Takagi, OMRON Co. Ltd., Japan, Chunking sensorimotor sequences in human EEG

Dr. Noriaki Ohkawa, University of Toyama, Japan, "Idling Brain" project

Prof. Kaoru Inokuch, University of Toyama, Japan, "Idling Brain" project

Dr. Khaled Ghandour, University of Toyama, Japan, "Idling Brain" project

Dr. Masanori Nomoto, University of Toyama, Japan, "Idling Brain" project

Scholarly Contributions and Creative Productions (by Faculty)

Book Chapter

1. Fukai, T.

   第 5 章 ニューラルネットワークとガリステル–キング予想 (解説 折田奈甫)【指定討論】脳の記憶の特徴は多階層性と動的安定性？. In 言語能力は人工知能で解明できるか; Iwanami Shoten, Japan, 2025.

Journal Article

1. Sivori, G.; Fukai, T.

   Transient Boosting of Action Potential Backpropagation for Few-Shot Temporal Pattern Learning. PLoS Computational Biology, 21, e1013777 (2025).

2. Plesser, H. E. E.; Davison, A. P.; Diesmann, M.; Fukai, T.; Gemmeke, T.; Gleeson, P.; Knight, J. C.; Nowotny, T.; René, A.; Rhodes, O.; Roque, A. C.; Senk, J.; Schwalger, T.; Stadtmann, T.; Tiddia, G.; van Albada, S. J.

   Building on Models-a Perspective for Computational Neuroscience. Cerebral cortex, 35, bhaf295, (2025).

3. Burns, T. F.; Fukai, T.; Earls, C.

   Associative Memory Inspires Improvements for in-Context Learning Using a Novel Attention Residual Stream Architecture. Transactions on Machine Learning Research (2025).

4. Asabuki, T.; Fukai, T.

   Predictive Learning Rules Generate a Cortical-like Replay of Probabilistic Sensory Experiences. eLife, 13:RP92712 (2025).

5. Ghandour, K.; Haga, T.; Ohkawa, N.; Fung, C. C. A.; Nomoto, M.; Fayed, M. R.; Asai, H.; Sato, M.; Fukai, T.; Inokuchi, K.

   Parallel Processing of Past and Future Memories through Reactivation and Synaptic Plasticity Mechanisms during Sleep. Nature Communications, 16, 3618 (2025).

6. Müller-Komorowska, D.; Fujishige, T.; Fukai, T.

   Recurrent Interneuron Connectivity Does Not Support Synchrony in a Biophysical Dentate Gyrus Model. eNeuro, 12: ENEURO.0097-25.2025 (2025).

Presentation at Conference

1. Fukai, T.

   How serious should we be about biological complexity in modeling brain computing? Biological, Artificial, and Quantum Intelligence 2026 International Workshop (BAQ2026), OIST, Onna, Japan (2026.03.03).

2. Fukai, T.

   Hippocampal mechanisms to learn spatially, temporally, and conceptually linked memories. BSI Seminar, Korea Institute of Science and Technology (KIST), Seoul, South Korea (2025.12.17).

3. Fukai, T.
   Spontaneous replay of memory assemblies in plastic spiking network models. Spiking Neural Networks as Universal Function Approximators (SNUFA) 2025, Online (2025.11.05).
4. Fukai, T.
   物理学、神経科学、機械学習の化学反応で探る脳の記憶 The 26th Kyoto University Informatics Symposium, Kyoto, Japan (2025.07.28).
5. Fukai, T.
   Neural mechanisms of memory linking and replay: inhibition matters. The van Vreeswijk Theoretical Neuroscience Seminar (VVTNS) series, Online (2025.05.14).

Scholarly Contributions (by Unit Members)

Name of Unit Member	Type	Title	Outlet	Publisher	Year Pub
Lok Him Leung, Kazumasa Tanaka and Tomoki Fukai	Poster Presentation at Conference	Hippocampal coactivity structure encodes multiple contextual identities at behavioral timescale	The NIPS Research Meeting 2025 "Frontiers in Memory and Learning Research through Multilayered Approaches"	Sapporo, Japan	2025
Daniel Müller-Komorowska, Tomoki Fukai	Poster Presentation at Conference	Discovering Mechanisms and Biomarkers of Brain Disorders using Simulation-Based Inference	The 48th Annual Meeting of the Japan Neuroscience Society	Niigata, Japan	2025
Tomas Barta, Tomoki Fukai	Poster Presentation at Conference	Homeostatic inhibitory plasticity improves spontaneous replay in autoassociative neural networks	The 48th Annual Meeting of the Japan Neuroscience Society	Niigata, Japan	2025
Hugo Musset, Tomoki Fukai	Poster Presentation at Conference	A microcircuit model for chunking reward-driven replay in the hippocampus	The 48th Annual Meeting of the Japan Neuroscience Society	Niigata, Japan	2025
Hugo Musset	Poster Presentation at Conference	A microcircuit model for chunking reward-driven replay in the hippocampus	COSYNE2026	Lisbon-Cascais, Portugal	2026
Tomas Barta, Tomoki Fukai	Poster Presentation at Conference	Assembly-specific inhibition improves replay diversity in spiking recurrent networks	SfN2025	San Diego, USA	2025
Daniel Müller-Komorowska*, Tomoki Fukai	Poster Presentation at Conference	Discovering Compensatory Mechanisms of Brain Disorders Using Simulation-Based Inference	Bernstein Conference	Frankfurt, Germany	2025
Daniel Müller-Komorowska	Presentation at Conference	Simulation-Based Inference and Compensation of Epileptogenic Dynamics in Spiking Microcircuit Models	Brain Dynamics Research: Current Topics and Future Directions	Online Workshop	2025
Milena Menezes Carvalho	Presentation at Conference	Connecting patterns: from neurons to research practices	JAIST×OIST Joint Symposium "Advanced Science and Technology × Gendered Innovation"	Sendai, Japan	2025

Name of Unit Member	Type	Title	Outlet	Publisher	Year Pub
Daniel Müller-Komorowska	Seminars	Compensation of Epileptogenic Dynamics using Simulation-Based Inference from Spiking Microcircuit Models	The Institute of Experimental Epileptology and Cognition Research	Bonn, German	2025
Daniel Müller-Komorowska	Seminars	Discovering Neuronal Mechanisms of Brain Disorders using Simulation-Based Inference	NPAS Seminars, Neuroscience Program of Academia Sinica	Taiwan	2025

Honors, Awards & Fellowships

Nov-2025 Best Paper Award, FY2025 The Japanese Neural Network Society, 2025 年度日本神経回路学会論文賞, The Japanese Neural Network Society (JNNS)

Kazuki Takahashi, Tomoki Fukai, Yutaka Sakai, Takashi Takekawa (CA), Goal-oriented inference of environment from redundant observations, Neural Networks, Volume 174, 106246 (2024)

Workshops and Seminars [Organized and Hosted by Faculty/Units]

Speaker Name(s)	Title	Location	Co-Organizers	Date
Dr. Douglas Feitosa Tomé	Distributed engrams enable parallelized orthogonal computations within and across brain regions	C209		25 Nov 2025
	OIST Computational Neuroscience Course 2025 (OCNC2025)	OIST Seaside House	Erik De Schutter, Kenji Doya, Tomoki Fukai, Bernd Kuhn, Gerald Pao	23 Jun-10 Jul 2025
Dr. Vladislav Sekulic	Plasticity and learning in a computational cortical network model with dendritic calcium-evoked bursting neurons	C209		19 June 2025
Prof. Masami Tatsuno	Information-geometric analysis of human EEG signals	C210		15 Apr 2025