James McAllister – CV

PhD Researcher – Intelligent Systems Research Centre, Ulster University
Computational Neuroscience, Neural Dynamics, Machine Learning
Associate Member of the Institute of Mathematics & Applications

Email
LinkedIn
Webpage
GitHub

Education

PhD Theoretical & Computational Neuroscience 2023–2026
Intelligent Systems Research Centre, Ulster University
Visiting PhD Researcher at University of Bristol, Neural Dynamics Group (2024)

Associate Fellowship of Higher Education Authority (AFHEA) 2024–2025
Doctoral College, Ulster University

Masters of Research (MRes) 2022–2023
Queen's University Belfast, Distinction

PGCE (Mathematics) 2018–2019
Queen's University Belfast, GTCNI Star Award and E. Fulton Prize for Mathematics

MA (Dubl) Mathematics 2014–2018
Trinity College Dublin, First Class Honours with Gold Medal

Experience

Lecturing: Intelligent Systems Research Centre (Ulster University) 2024 – 2025
Mathematics modules, topics including Linear Algebra, Differential Equations, and Statistics

Co-Supervision of Final Year Projects (Ulster University) 2024 – present
Computational Neuroscience and Machine Learning

Visiting Researcher (University of Bristol) 2024
Neural Dynamics Group, School of Engineering Mathematics & Technology

Postgraduate Teaching Assistant (Ulster University) 2023 – present
Leading undergraduate & postgraduate tutorials in Mathematics, Algorithms, & Data Science.
This involves teaching module content to small groups & assisting with material.

Teacher of Mathematics (Wellington College Belfast) 2019 – 2022
Mathematics, Further Mathematics, and Physics – Teaching up to A-Level Further Mathematics, including topics in Complex Numbers, Differential Equations, Group Theory, Vectors & Matrices.

Research

Non-random brain wiring enables robust neural network function under high sparsity 2026

Paper: **J. McAllister**, C. Houghton, J. Wade, C. O'Donnell, *(In preparation.)*

This paper presents brain-based recurrent neural networks by implementing the connectivity from the larval and adult *Drosophila* fruit fly connectomes in echo state networks. Using analysis and simulation of structure and dynamics, we show that connectome-based networks are robust to structural and parameter changes, in spite of their high levels of connectivity sparsity. This robustness is seen in general dynamics and specific computations across various tasks. This work gives insight into questions surrounding non-random brain network structure and function.

Layer- and region-specific synapse dynamics in the nascent cortical hierarchy 2026

Paper: L. Discepolo, **J. McAllister**, R. Russell, S. Apilado, G. Margetts-Smith, D. Franchini, S.G. Grant, C. O'Donnell, M.C. Ashby, P. Anastasiades, bioRxiv, *(Submitted to eLife.)*

This paper is a collaboration with experimentalists in the University of Bristol. It analyses the dynamics of synapse formation, development, and maturation in mouse cortical regions. I designed and analysed a novel mathematical model of synapse population and weight dynamics to explain aspects of the group's experimental data.

Topological and simplicial features in reservoir computing networks 2024

Conference Paper: **J. McAllister**, J. Wade, C. Houghton, C. O'Donnell, UKCI

https://doi.org/10.1007/978-3-031-78857-4_5

This paper studies the roles of different network topologies and simplicial features in reservoir networks for memory, decision making, and chaotic time-series prediction tasks. It investigates ring, lattice, and fully random networks, and incorporates directed simplicial cliques within reservoirs, finding that the reservoir framework is remarkably robust and highlighting the importance of randomness, particularly for the memory task.

Exact dynamics of linear recurrent neural networks in cognitive tasks 2025 – present

Ongoing PhD project

This project explores how an analytical treatment of linearised dynamics in fixed recurrent neural networks enables a better understanding of the geometry of network activity (the "neural representations") during memory, decision-making, and fixation-response tasks. This allows one to construct theory or data-based linear readout layers in interpretable ways, or using biophysically-realistic unsupervised, local, generalised Hebbian learning.

Synaptic regularisation of learning via heterosynaptic plasticity 2024–2025

PhD research project

This project examined how heterosynaptic plasticity mechanisms may regularise learning and stabilise synaptic representations, showing improvement over homosynaptic (Hebbian) learning in single neuron and neural network settings.

The capacity and accuracy of a triple-well Hopfield model 2023

Group Research Project & Presentation: ISRC Computational Neuroscience Autumn School

A discrete attractor model of decision making 2023

Group Research Project & Presentation for Neuromatch Academy Summer School

A review & statistical analysis of the effect of formative assessment in mathematics 2023

Research Project & Dissertation, Distinction, Queen's University Belfast

A multilevel analysis of high-stakes examination results in mathematics 2021

Paper: Cantley, I., & McAllister, J. *https://doi.org/10.1007/s11199-021-01234-5*

Complex analysis in mathematics education 2018

Final Year Maths Education Project. First class (distinction). Trinity College Dublin

Trigonometric series and the emergence of transfinite set theory 2018

Final Year Research Dissertation & Poster. First class (distinction). Trinity College Dublin

Talks and Posters

Talk: *All Ireland Computational Neuroscience Symposium*, Queen's University Belfast — Dec 2025

Talk: *NI High Performance Computing Conference*, Queen's University Belfast, *Link* — Nov 2025

Talk: *Dynamical Systems and Neuroscience*, Mathematical Sciences, Nanyang University, *Link* — Oct 2025

Talk: *Recent Trends in Rough Analysis & Dynamical Systems*, Liverpool University, *Link* — July 2025

Poster: *UK Neural Computation,* Imperial College London — July 2025

Seminar: *Ignite Sessions,* Intelligent Systems Research Centre — June 2025

Talk: *Cambridge University,* CBL Lab, *https://talks.cam.ac.uk/talk/index/232441* — June 2025

Poster: *Festival of Research,* Ulster University — June 2025

Poster: *CoSyNe, Montreal & Mont-Tremblant, https://doi.org/10.5281/zenodo.15350011* — March 2025

Talk: *Intelligent Systems Research Centre,* COIN Club — Feb 2025

Talk: *Workshop UK Computational Intelligence,* UKCI 2024 — Sep 2024

Talk: *Computational Neuroscience, Neurotechnology & NeuroAI Summer School* — Aug 2024

Poster: *UK Neural Computation, Sheffield, https://doi.org/10.5281/zenodo.13303677* — July 2024

Poster: *Conf. Mathematical Neuroscience, Dublin, https://doi.org/10.5281/zenodo.13303384* — June 2024

Seminar: *Intelligent Systems Research Centre* — May 2024

Talk: *Intelligent Systems Research Centre,* COIN Club — May 2024

Talk: *Cambridge University,* British Society for Research into Learning Mathematics — March 2020

Skills and Interests

Languages: English, German, French, British Sign Language

Programming Languages: Julia (main), Python, MATLAB, R, SPSS

Other Developer Tools: High Performance Computing, LaTeX, Microsoft, Google Suite

Areas of Interest: Theoretical neuroscience, Mathematical modelling, Network theory, Dynamical systems, Complex systems, Mathematics of Machine Learning, Assessment theory

Achievements and Awards

Best Poster Prize, PhD Festival of Research, Ulster University	June 2025
Travel Grant, Computational and Systems Neuroscience (CoSyNe)	March 2025
Best Student Paper Award, UK Computational Intelligence, Belfast	Sep 2024
Visiting Scholarship, University of Bristol	Feb 2024
PhD Scholarship, Northern Ireland Department for the Economy	2023–26
E. Fulton Prize for Mathematics, QUB	Sep 2019
GTCNI Star Award, PGCE, QUB	July 2019
Gold Medal, Trinity College Dublin	Nov 2018
Trinity College Dublin First Class Prize	2015, 2016, 2017
Naughton Foundation Scholarship	2014–2018
Exhibition Award, Trinity College Dublin	Sep 2014
Trinity College Dublin Sizarship	2014–2018

Courses and Training

Fundamentals of Accelerated Computing with Modern CUDA C/C++, NVIDIA & NI-HPC	2025
Hausdorff Mathematics Centre, Statistical mechanics of spin glasses, neural networks & learning	2025
Associate Fellow of the Higher Education Authority (AFHEA), First Steps to Teaching	2024–25
Various Training Sessions for the Northern Ireland High Performance Computing system	2023–2025
Computational Neuroscience Autumn School, Intelligent Systems Research Centre, UU	2023, 2024
Computational Neuroscience Neuromatch Academy Summer School	2023
INCF (International Neuroinformatics Coordinating Facility): Python-based modelling course	2023
British Sign Language Level 1	2019

Academic and Professional Service

Peer Reviewer: PLOS Computational Biology, Neural Networks	2025 –
Treasurer: Irish Branch, Institute of Mathematics and its Applications	2025 –
Volunteering: Northern Ireland Maths Fest	2025, 2026
Speaking: Mathematics PGCE Events, Queen's University Belfast	2019, 2020
Assistant: British Society for Research into Learning Mathematics, Queen's University Belfast	2019

Referees

Dr Cian O'Donnell,
Senior Lecturer in Computational Neuroscience and Data Analytics, Ulster University
c.odonnell2@ulster.ac.uk

Dr John Wade,
Lecturer in Electrical and Mechanical Engineering, Atlantic Technological University
john.wade@atu.ie

Dr Conor Houghton,
Reader in Mathematical Neuroscience, University of Bristol
conor.houghton@bristol.ac.uk