Jesse Pepijn Geerts

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Education

Ph.D. in Computational and Cognitive Neuroscience University College London, 2021
Dissertation: *"Hippocampal predictive maps of an uncertain world"*
Advisor: *Neil Burgess* | Examiners: *Athena Akrami & Peter Dayan*

M.Sc. in Brain and Mind Sciences University College London & ENS Paris, 2016
Graduated with Distinction

B.Sc. in Natural Sciences & Neuroscience University of Amsterdam, 2014
Graduated with Honors, minor in Philosophy

Research Experience

Senior Research Fellow | Computational Neuroscience Lab, Imperial | January 2024 – Present

- Research on **relational reasoning in humans and AI models**, focusing on transitive inference
- **Setting up and leading collaborative project** between Imperial, Columbia University and DeepMind
- Collaborative project on deep learning model of motor learning and generalization
- **Co-wrote EPSRC grant application** for Clopath lab (pending)
- Organised weekly lab meetings

Research Associate | Space & Memory Lab, UCL | March 2021 – September 2023

- Developed Reinforcement Learning models for **collaborative project with experimental neuroscience** study on dopamine prediction errors, published in Nature
- Used **machine learning to study neural time series and behaviour data**, developed custom analysis pipelines and computational models to capture animal behaviour

PhD Researcher | Sainsbury Wellcome Centre, UCL | September 2017 – March 2021

- Developed **RL model explaining contextual decision making**, published in Psych Review.
- Designed novel RL framework for **modelling spatial cognition**, published in PNAS.
- **Organised renowned seminar series** SWC Annual Symposium with international speakers
- Presented **8+ poster and talks** at international conferences such as **ICLR, Cosyne** and **CCN**.

Masters Student | Institut du Cerveau et de la Moelle Epinière / Brain and Spine Institute | 2016

- **Analysed fMRI data** of neurological patients that suffered from motor problems

Masters Student | Theoretical Neurobiology Lab, UCL | 2015

- Co-developed a model for estimating causal effects across cortical layers, published in NeuroImage

Undergraduate Student | Psychology Department, UvA | 2014

- Conducted **human behavioural and EEG research** on cognitive control, published in NeuroImage

Teaching experience

Academic teaching

(Upcoming) Aug 2025 **Invited lecturer at Computational Neuroscience Workshop** | Gl. Avernæs, DK
- Developed lectures and tutorials

Mar 2024 – present **Lecturer at Statistical Neuroscience course** | SWC, UCL
- Developed and delivered lectures and tutorial exercises
- Engaged with teaching meetings and collected feedback from students

Jun 2024 **Invited lecturer at NeuroAI summerschool** | Amsterdam, NL
- Developed and delivered lecture series on applying AI to understand the brain
- Developed and delivered tutorial on Reinforcement Learning

Mar 2024 **Lecturer in neural dynamics MSc course** | Imperial
- Delivered lecture on advanced topics in computational neuroscience

Jul 2024 **Mentor for computational neuroscience group project** | Neuromatch academy
- Led online tutorial groups for student group projects
- Engaged in teaching meetings with other TAs

Sep 2021 – Mar 2023 **Teaching assistant for Neural Computation course** | UCL
- Led tutorial groups
- Marked student assignments

Sep 2022 – Jan 2023 **Lecturer for ICN Matlab course** | ICN, UCL
- Developed and delivered lectures on computational modelling & machine learning
- Developed Matlab programming exercises

Sep 2017 – Aug 2019 **Teacher on Python course PyStarters** | SWC, UCL
- Developed and led tutorials on Pythonic programming practices

Sep 2017 – Mar 2018 **Teaching Assistant for Systems & Theoretical Neuroscience** | SWC, UCL
- Developed novel course material for new PhD-level module
- Delivered interactive tutorials to students
- Organised teaching meetings
- Communicated student feedback to PhD programme organisers

Sep 2013 – Mar 2014 **Teaching assistant, Statistics in R** | University of Amsterdam
- Led group tutorials for first-year BSc students

Sep 2013 – Mar 2014 **Teaching assistant, Maths for neuroscience** | University of Amsterdam
- Led group tutorials for first-year BSc students

Mentoring

Sep 2024 – present Su Isil Sokmen, MSci student | Imperial
Sep 2022 – present Laura Convertino, PhD student | UCL
Sep 2020 – Jun 2021 Jessica Paslack, PhD rotation student | UCL

Teacher volunteering & outreach

Mar 2025 – present English teacher for asylum seekers | Together Better Hackney
2019 – present Ocassional author/contributor to the Dutch Review of Books | Amsterdam
2017 – 2021 Committee member for Systems Seminars Series | SWC, UCL
2017 – 2021 Committee member of Public Engagement Network | SWC, UCL
Mar 2018 Volunteer teacher at BrainCamp | Pristina, Kosovo
Oct 2013 – Mar 2014 Committee member, BetaBreak | Amsterdam

Publications

In prep / preprint

[1] **Zhang W [...] Geerts JP [...] Jacobs J** *"Linking Transformer Architectures to Human Hippocampal Function in a Two-Armed Bandit Task."* in prep, submitted to SfN.

[2] **Geerts JP, Chan SCY, Clopath C. & Stachenfeld KLS** *"Relational reasoning and inductive bias in transformers trained on a transitive inference task."* submitted to Neurips 2025.

[3] **Greenstreet F*, Geerts JP*, Gallego JA & Clopath C.** *"Learned action embeddings explain striatal and cortical representations during motor learning."* accepted at RLDM 2025.

[4] **Convertino L, Geerts JP & Burgess N**. *"Temporal context and semantic similarity explain item recall probability."* in prep.

Peer-reviewed publications

[5] **Greenstreet F [...] Geerts JP [...] Clopath C & Stephenson-Jones M**. *"Dopaminergic action prediction errors serve as a value-free teaching signal"*. Nature, 2025. article

[6] **Geerts JP, Gershman SJ, Burgess N & Stachenfeld KLS,** *"A probabilistic successor representation for context-dependent prediction."* Psychological Review, 2024. DOI

[7] **Geerts JP, Burgess N, Stachenfeld KLS,** *"Probalistic Successor Representatoins allow for flexible behaviour"* ICLR BAICS workshop, 2021

[8] **Geerts JP*, Chersi F*, Stachenfeld KLS & Burgess N.** *"A general model of hippocampal and dorsal striatal learning and decision making."* PNAS, 2020. DOI

[9] **Geerts JP, Stachenfeld KLS & Burgess N.** *"Probabilistic successor representations with Kalman temporal differences."* CCN, 2019, article

[10] **Jiang J, Correa CM, Geerts JP, van Gaal S.** *"The relationship between conflict awareness and behavioral and oscillatory signatures of immediate and delayed cognitive control"*. NeuroImage, 2018. article

[11] **Pinotsis, DA*, Geerts JP*, et al.** *"Linking canonical microcircuits and neuronal activity: Dynamic causal modelling of laminar recordings."* NeuroImage, 2017. DOI

[12] **Phillips MG, Lenzi SC & Geerts JP.** *Cortical Predictive Mechanisms of Auditory Response Attenuation to Self-Generated Sounds*. Journal of Neuroscience, 2017. DOI

Talks and posters

- Jun 2025 (upcoming) – **Learning representations of states and of actions for efficient generalization**
  Invited talk at Computational Neuroscience Workshop, Gl. Avernæs, DK
- Jun 2025 (upcoming) – **Learned action embeddings explain striatal and cortical representations during motor learning**
  Poster at RLDM, Dublin, IR
- January 2024 – **Understanding in-context learning and generalization in transformer neural networks**
  Invited talk at DeepMind Neurolab workshop, London, UK
- June 2023 – **Context-dependent prediction with probabilistic successor representations.**
  Poster at RLDM, Providence, RI

- January 2023 – **Updating multiple predictive maps under uncertainty**
  Invited talk at DeepMind Neurolab workshop, London, UK
- June 2022 – **Context-dependent prediction with multiple predictive maps.**
  Invited talk at Pouget, Gershman, Akrami, Paton, Botvinick, Pehlevan & Hermundstad labs
- January 2021 – **Prediction and uncertainty in the hippocampus.**
  Invited talk at Theoretical and Cognitive Neuroscience lab, UPF Barcelona
- April 2021 – **Probabilistic Successor Representations allow for flexible behaviour**
  Spotlight talk at ICLR "Bridging AI and Cognitive Science" workshop
- July 2020 – **Uncertainty and the hippocampal predictive map.**
  Invited talk at Gershman lab, Harvard University
- March 2020 – **Probabilistic Successor Representations allow for flexible behaviour.**
  Poster at Cosyne, Denver, CO
- January 2020 – **A probabilistic approach to learning Successor Representations.**
  Invited talk at Behrens lab, UCL / University of Oxford
- September 2019 – **Probabilistic Successor Representations with Kalman Temporal Differences.**
  Poster at CCN, Berlin, Germany
- July 2019 – **Value, Prediction and Uncertainty in Hippocampus and Striatum.**
  Talk at BCCN UCL Navigation Workshop, Tutzing, Germany
- March 2019 – **Modelling hippocampal and dorsolateral striatal contributions to learning across domains**.
  Talk at Cosyne Workshop, Lisbon, Portugal
- January 2019 – **Using Splitter Cell Representations for Reinforcement Learning**.
  Talk at DeepMind Experimental Neuroscience Meeting, London, UK
- June 2018 – **Modelling hippocampal and striatal contributions to reward-based navigation**.
  Poster at iNav Symposium, Mont Tremblant, QC, Canada
- June 2018 – **Splitter cells and hierarchical reinforcement learning**.
  Talk at Data Club, Sainsbury Wellcome Centre, London, UK

Awards & funding

- 2025 – **ENCODE AI for Science Fellowship** (invited for interview). £115k + £800k compute budget
- 2025 – **EPSRC Programme Grant** (pending). Co-wrote grant for Clopath Lab, Imperial.
- 2016-2021 – **SWC PhD Studentship** (£28,400 stipend + £10k / year research budget) – Gatsby Charitable Foundation & The Wellcome Trust, UK
- 2015 – **Descartes Excellence Scholarship** (€10k stipend) French embassy in The Hague, NL
- 2015 – **Winter School Grant** (€500) Berlin School of Mind and Brain, DE
- 2013 – **2nd Place Undergraduate Project Prize** Natural Sciences, University of Amsterdam, NL

Reviewing activities

- Reviewer for multiple scientific journals and conferences, including Cell reports, Nature Communications, Journal of Neuroscience, Cerebral Cortex, Neurips

Major collaborations

2024 - present	Dr Juan Gallego, Imperial – collaborated on motor learning and generalization
2024 - present	Sam Lippl, Dr Kenneth Kay, Daniel Levine – project on reasoning in large language models
2024 - present	Dr Stephanie Chan, DeepMind – collaborated on in-context learning in transformers
2020 - present	Prof Marcus Stephenson-Jones, SWC – collaborated on studies of dopamine function
2017 - present	Dr Kim Stachenfeld, DeepMind & Columbia – collaborated on neural RL modelling