Anthony Strock

Curiculum Vitae

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Education

2021-Present **Postdoc in Computational Psychiatry**, *Stanford University*
2017-2020 **PhD in Computational Neuroscience**, *Inria Bordeaux & Université de Bordeaux*
2015-2017 **MSc in Computer Science**, *ENS Rennes & Université de Rennes*
2015-2016 **BSc in Mathematics**, *ENS Rennes & Université de Rennes*
2014-2015 **BSc in Computer Science**, *ENS Rennes & Université de Rennes*

Research Experience

2021-Present **Stanford University**, *Postdoctoral scholar*, mentored by Vinod Menon

- **[Computational Modeling] Development of Numerical Representations in Children**
  - Lab project aiming at characterizing how numerical representations develop in children by analogy with how it develops in biologically inspired neural network models, by comparing children's behavior and functional Magnetic Resonance Imaging (fMRI) brain recordings while children perform numerical tasks with artificial neural networks solving similar numerical tasks
  - Co-developed with *P. K. Mistry* a biologically inspired neural network model of non-symbolic numerical cognition using convolutional neural networks trained to count quantities [J1]
    - Co-discovered a substantial reorganization of number neurons after numerical training suggesting a substantial reorganization of number neurons during children development
    - Co-discovered the robust emergence after numerical training of distributed numerical representations containing anchor points similar to those observed during children development
  - Developed a biologically and developmentally inspired neural network model of the generalization of numerical symbolic comparisons from numerical non-symbolic comparisons [S1]
    - Discovered a semantic generalization occurring from indirect mapping through mixed comparison, but not from direct mapping through classification with common number labels
    - Discovered the robust emergence of a number line representation when solving comparison tasks
    - Highlighted the role of the alignment of non-symbolic and symbolic number lines in generalization
- **[Computational Modeling] Neural Causes of Behavioral Individual Differences**
  - Lab project aiming at characterizing the role of Excitation/Inhibition imbalances in the individual differences observed both at the behavioral and neural level in different clinical groups
  - Developed a biologically inspired neural network model of mathematical learning disabilities (MLD) using convolutional neural networks trained to perform visually presented arithmetic task, studying the effect of neural excitability on performance and representations [S3]
    - Discovered a causal role of neural hyper-excitability on the deterioration of behavioral performance and neural representation reflecting behavioral, neural and representational differences observed in children with MLD, predicting long-lasting representational deficits in MLD
- **[Computational Modeling] Interpretability of Feature Attribution in fMRI Classifications**
  - Lab project aiming at exploring how to interpret the feature attribution of models trained to discriminate between clinical populations (e.g. Autism vs. Neurotypical), notably as potential sources of Excitation/Inhibition (E/I) imbalances.
  - Co-developed with Trang-Anh E. Nghiem multiple biologically inspired neural models in which local E/I balances can be altered, developed models that learn to detect the presence of the E/I imbalance, and compared how multiple attribution methods can detect its localization [S2]
    - Discovered that the localization of the E/I imbalance can be robustly detected across feature attribution methods, even under challenging scenarios (e.g. weak E/I imbalances, strong noise)
- **Academic Outcomes**
  - 1 peer-reviewed journal article [J1] & 3 preprints [S1–S3]
  - 3 seminar talks & 1 invited talk

2017-2020 **Inria Bordeaux & Université de Bordeaux**, *Summer research intern & PhD student researcher*, mentored by Nicolas Rougier and Xavier Hinaut

- **[Computational Modeling] Working Memory**
  - PhD project aiming at explaining how dynamically unstable neurons support working memory
  - Developed a robust model explaining how working memory can be dynamically maintained in virtually any population of neurons using random recurrent neural networks [J4, C2]
  - Discovered underlying simple generic circuitry allowing to robustly maintain information [J4]
  - Extended model to explore short-term to long-term memory mappings [J2, C1]
  - Replicated with *T. Boraud* the findings of another previous model of working memory [J3]
- **Academic Outcomes**
  - 3 peer-reviewed journal articles [J2–J4] & 2 peer-reviewed conference proceedings [C1, C2]
  - 2 contributed talks & 1 seminar talk & 3 poster presentations
  - 1 Master thesis & 1 PhD thesis [T1]

2016 **Max Planck Institute for Human Cognitive and Brain Sciences**, *Summer research intern*, mentored by Burkhard Maess

- **[Brain Signal Processing] Physiological Noise in Magnetoencephalography (MEG)**
  - Summer intern project aiming at giving recommendation on how to use Independent Component Analysis (ICA) to remove physiological noise (e.g. heartbeat, eye movements) from MEG brain recordings
  - Compared multiple ways to use ICA

2015 **Inria Rennes**, *Summer research intern*, mentored by Anatole Lécuyer

- **[Brain Computer Interfaces (BCIs)] Frustration and ease of BCI use**
  - Summer intern project aiming at characterizing the effect of user frustration on ease of use of Steady-State Visual-Evoked Potentials (SSVEP) based BCIs
  - Developed, collected, and analyzed data for a SSVEP-based BCI experiment
  - Discovered a link between participant frustration level and success in using BCIs
- **Academic Outcome**
  - 1 peer-reviewed conference proceedings [C3]

Awards & Fellowships & Grants

2023 **HAI Seed Grant**, Co-Investigator in a lab Seed Grant

- With Percy K. Mistry, Ruizhe Liu and Vinod Menon, applied and obtained a seed grant ($75K) from the Stanford Institute for Human-Centered Artificial Intelligence (HAI)
- Title: Personalized AI Networks to Mitigate Neurotypicality Biases in Cognitive Tutoring for Children with Learning Difficulties

2022 **Collaboration travel grant**, *Built new collaboration between postdoc lab and PhD lab*

- Proposed to connect my postdoc lab at Stanford with my PhD lab at Inria Bordeaux
- Built a scientific project intersecting the interest of both labs
- Applied and obtained collaboration travel funding ($18K) from the France Stanford Center for Interdisciplinary Studies covering for visits of multiple senior and junior lab members
- Title: AI-based computational modeling tools with applications to psychiatric disorders

2020 **Scientific outreach award**, *Bordeaux University finalist of "Ma thèse en 180 secondes"*

2020 **PhD fellowship extension**, *LabEx BRAIN (2 months)*

2017 **PhD fellowship**, *Specific doctoral fellowship for normalien (3 years)*

- Built a PhD project with N. Rougier and X. Hinaut following up on the promising results of my master thesis work which got published in IJCNN conference proceedings
- Applied and obtained a 3-year funding to pursue this project

2015 **Undergraduate fellowship**, *Normalien at ENS Rennes*

- Selected through a nationwide competitive contest to be a paid intern civil servant (Normalien) at École Normale Supérieure (ENS) de Rennes in the Computer Science department

Scientific Outreach Experience

2020 **Ma thèse en 180 secondes**, *Scientific outreach contest*

- Participated to the scientific outreach contest *Ma thèse en 180 secondes* where I summarized in 3 mins the content of my PhD research work for non-scientists (online video in French)

2019 **Pint of Science**, *Scientific outreach talk*

- Introduced random recurrent neural networks and their use to non-scientists in a bar as an introductory talk for X. Hinaut's following talk on his language modeling work using these models

2017-2019 **Brain Week**

- Tending to a stand 3 years in a row during Brain Week, aiming at presenting the general concepts of computational neuroscience modeling approaches of the Mnemosyne team to non-scientists at the Institute of Neurodegenerative Diseases (IMN)

2017-2018 **Déclics**, *Scientific outreach to high school students*

- Participated two years in a row to the *Déclics* scientific outreach events where I presented to multiple small groups of highschoolers ($\sim$ 5 highschoolers), one after the other in a scientific speed dating format, my research and career path

Publications

Preprint

S1. **Strock**, **A.**, Liu, R., Mistry, P. & Menon, V. *Symbolic numerical generalization through representational alignment* in (Feb. 2025). https://astrock.fr/documents/preprint/cogsci_2025.pdf.

S2. **Strock**, **A.** *et al.* Explainable AI techniques for dynamic functional brain imaging: validation and analysis of E/I imbalance in autism. *bioRxiv.* http://doi.org/10.1101/2025.02.24.639808 (Feb. 2025).

S3. **Strock**, **A.**, Mistry, P. K. & Menon, V. Digital twins for understanding mechanisms of learning disabilities: Personalized deep neural networks reveal impact of neuronal hyperexcitability. *bioRxiv.* http://doi.org/10.1101/2024.04.29.591409 (May 2024).

Peer-reviewed Journal Publications

J1. Mistry, P. K., **Strock**, **A.**, Liu, R., Young, G. & Menon, V. Learning-induced reorganization of number neurons and emergence of numerical representations in a biologically inspired neural network. *Nature Communications* **14.** http://doi.org/10.1038/s41467-023-39548-5 (June 2023).

J2. **Strock**, **A.**, Rougier, N. P. & Hinaut, X. Latent Space Exploration and Functionalization of a Gated Working Memory Model Using Conceptors. *Cognitive Computation.* http://doi.org/10.1007/s12559-020-09797-3 (Jan. 2022).

J3. Boraud, T. & **Strock**, **A.** [Re] A Neurodynamical Model for Working Memory. *ReScience C* **7.** http://doi.org/10.5281/zenodo.4655870 (Apr. 2021).

J4. **Strock**, **A.**, Hinaut, X. & Rougier, N. P. A Robust Model of Gated Working Memory. *Neural Computation* **32,** 153–181. http://doi.org/10.1162/neco_a_01249 (Jan. 2020).

Peer-reviewed Conference Proceedings

C1. **Strock**, **A.**, Rougier, N. & Hinaut, X. *Using Conceptors to Transfer Between Long-Term and Short-Term Memory* in *Artificial Neural Networks and Machine Learning – ICANN 2019: Workshop and Special Sessions* (Springer International Publishing, Sept. 2019), 19–23. http://doi.org/10.1007/978-3-030-30493-5_2.

C2. **Strock**, **A.**, Rougier, N. P. & Hinaut, X. *A Simple Reservoir Model of Working Memory with Real Values* in *2018 International Joint Conference on Neural Networks (IJCNN)* (IEEE, July 2018). http://doi.org/10.1109/ijcnn.2018.8489262.

C3. Évain, A. *et al. Influence of Error Rate on Frustration of BCI Users* in *Proceedings of the International Working Conference on Advanced Visual Interfaces* (ACM, June 2016). http://doi.org/10.1145/2909132.2909278.

PhD thesis

T1. **Strock**, **A.** *Working memory in random recurrent neural networks* (Université de Bordeaux, Nov. 2020). `https://theses.hal.science/tel-03150354`.

Oral Presentations

Invited talk *Invitation from conference/workshop organizing committee*

2024 **"Neuroscience & AI" meeting of the French Neuroscience Society**
Understanding the origins of human behavioral deficits by developing AI that fails

Contributed talk *Journal/Conference paper selected for oral presentation*

2020 **International Conference on Development and Learning (ICDL) conference**
A Robust Model of Gated Working Memory

2018 **International Joint Conference on Neural Networks (IJCNN)**
A Simple Reservoir Model of Working Memory with Real Values

Seminar talk *Talk hosted by an institute/group*

2024 **Centre of Excellence in Artificial Intelligence at IIT Kharagpur**
Understanding the origins of human behavioral deficits by developing AI that fails

2023 **MIND team at Inria Paris Saclay**
Modeling Numerical Perception and Mathematical Learning Disabilities with ANNs

2023 **Vision Institute of Paris**, *co-presented with T.-A. E. Nghiem*
Modeling the Effect of Neural Excitation/Inhibition Imbalance on Sensory Processing and Learning in Autism Spectrum Disorder

2022 **Mnemosyne team at Inria Bordeaux**
Computational modeling of child brain development and associated neurodevelopmental disorders

2019 **Institute of Neurodegenerative Diseases in Bordeaux**
A Robust Model of Gated Working Memory

Poster *Journal/Conference paper selected for poster presentation*

2019 **International Conference on Artificial Neural Networks (ICANN)**
Using Conceptors to Transfer Between Long-Term and Short-Term Memory

2018 **Berstein Conference**
A Simple Reservoir Model of Working Memory with Real Values

2018 **Bordeaux Doctoral School of Mathematics and Informatics**
Poster selected to represent the variety of studies performed in the doctoral school

PhD Defense

2020 **Inria Bordeaux & Université de Bordeaux**
Working Memory in Random Recurrent Neural Networks

Teaching Experience

Total hourly volume: 192h

2017-2020 **Introduction to Computer Science**

- Duties
  - Lectured Python programming to first-year undergraduate students from science departments
  - While lecturing, led discussions on Python programming exercises on white board, and subsequently during computer practical sessions
  - Participated to the creation of exams & assessed exams & proctored exams
  - Created & assessed assignment
- Hourly volume: 72 h Combined Lectures & Exercise Discussions + 24 h Practical Sessions
- Student volume: ∼30 students per year

2017-2020 **Combinatorics, Probability, and Statistics**

- Duties
  - Led discussions on Combinatorics, Probability, and Statistics exercises on white board with second-year undergraduate students in math and computer science
  - Created assignments & participated to the creation of exams
- Hourly volume: 96 h Exercise Discussions
- Student volume: ∼15 students per year

Mentoring Experience

2024 **Neuromatch Academy**, *Professional Development Mentorship Program*

2023 **A. de Lecea**, *Undergraduate internship*
Validating feature attribution methods for use fMRI data

2023 **R. Iyer**, *Undergraduate internship*
Modeling mathematical developmental changes

2022 **A. V. Patil**, *Undergraduate internship*
Modeling abnormal ASD neural response to oddball/salient stimuli

2019 **T. Boraud**, *Bachelor internship*
Replicating a published neurocomputational model of working memory [J3]

Reviewing Experience

Journal

2025 **NCE**, *Neuromorphic Computing and Engineering*, IOP Trusted Reviewer

2024 **NCE**, *Neuromorphic Computing and Engineering*, IOP Trusted Reviewer

Conference

2025 **CogSci**, *Cognitive Science Society Conference*

2024 **ICANN**, *International Conference on Artificial Neural Networks*

Skill Summary

Research	■■■■■	Teamwork	*Involved in many collaborative projects*
	■■■■□	Communication	*Report/Article writing & Public speaking*
	■■■■□	Leadership	*Organized journal club in two labs*
Teaching & Mentoring	■■■■□		*Mentored 4 students & Taught for 192h*
Text editing	■■■■■	LaTeX	
	■■■■□	Word	
Programming	■■■■■	Python	*NumPy, SciPy, Matplotlib, PyTorch, PyTorch Lightning, TensorFlow, Keras, scikit-learn, ReservoirPy*
	■■■□□	others	*MATLAB, C/C++, Java, Ocaml, Prolog*
OS	■■■■□	Linux, Mac & Windows	
Language	■■■■■	French	*Mother tongue*
	■■■■□	English	*Fluent, including in scientific context*
	■■■□□	Spanish	*Conversationally fluent*