

Omer Moussa

Doctoral Researcher in AI and Computational Neuroscience

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RESEARCH PROFILE

I am a PhD researcher at the Max Planck Institute for Software Systems working at the intersection of **speech and language modeling, computational neuroscience, and brain-aligned machine learning**. My research investigates how fine-tuning speech models on human fMRI responses can improve semantic representations, model interpretability, and cross-participant generalization. I am broadly interested in representation learning, speech processing, natural language understanding, and leveraging brain data to build more human-like AI systems.

PUBLICATIONS

- [1] **Omer Moussa**, Dietrich Klakow, Mariya Toneva. *Improving Semantic Understanding in Speech Language Models via Brain-tuning*. **ICLR 2025**.
- [2] **Omer Moussa**, Mariya Toneva. *Brain-tuned Speech Models Better Reflect Speech Processing Stages in the Brain*. **Interspeech 2025**.
- [3] **Omer Moussa**, Mariya Toneva. *Brain-tuning Improves Generalizability and Efficiency of Brain Alignment in Speech Models*. **NeurIPS 2025**.

EDUCATION

PhD Candidate in Informatics | MPI-SWS Sep 2024 – Present
Saarbrücken, Germany • *Bridging AI and Neuroscience (BrAIN) Group, advised by Mariya Toneva*

- Research focus: brain-tuning of speech and language models using fMRI data, with emphasis on semantic alignment, hierarchical processing, and cross-participant generalization.

CS@Max Planck Doctoral Program Oct 2022 – Sep 2024
Saarbrücken, Germany • *Preparatory phase at Saarland University & Max Planck Society*

- Completed doctoral research rotations and coursework (with Grade: 1,3) in NeuroAI, 3D computer vision, machine learning, reinforcement learning, computer vision, security, HCI, and risks of language models.

B.Sc. in Computer Engineering, Minor in Mathematics Aug 2017 – Jun 2022
The American University in Cairo, Egypt

- GPA: 3.98 / 4.00. Thesis: Enhancing the Quality of General Domain Text-to-Image Generation.

RESEARCH EXPERIENCE

Doctoral Researcher | MPI-SWS, BrAIN Group Sep 2024 – Present

- Developing and evaluating fine-tuning methods for speech language models using naturalistic fMRI recordings, with downstream analyses of semantics and model organization.
- Led projects on multi-participant training, cross-dataset generalization, and representation analyses of brain-tuned speech models.
- Published at ICLR 2025, Interspeech 2025, and NeurIPS 2025 within the first year of doctoral research.

Graduate Researcher | MPI-SWS, BrAIN Group Apr 2024 – Sep 2024

- Part of the research rotations provided by the CS@MaxPlanck fellowship
- Worked directly with Prof. Mariya Toneva on improving the semantic of speech models using fMRI brain data.

Graduate Researcher | MPI-INF, Department of Computer Vision (D2) Apr 2023 – Nov 2023

- Part of the research rotations provided by the CS@MaxPlanck fellowship

- Worked directly with Prof. Dr. Bernt Schiele on increasing the robustness of vision models to noise using fMRI data as regularisation constraints.

Machine Learning Research Engineer | SpreeAI

Jun 2022 – Apr 2023

USA (remote)

- Developed fast head-tracking and FLAME parameter estimation methods for real-time 3D head modeling.
- Built tri-plane-based 3D geometry generation and controllable hair editing pipelines using inpainting and StyleGAN inversion.

Research Assistant | MIT Urban Metabolism Group

Apr 2021 – Mar 2022

Massachusetts Institute of Technology

- Developed ML pipelines for global city typologies using spatial and non-spatial urban data; led clustering work that substantially improved cluster quality and contributed to large-scale GDP estimation.

Selected Earlier ML Research Roles | AUC / Dell Technologies / Mendel.ai

2020 – 2022

- Projects spanning 5G decision-making agents, clinical-text clustering, autonomous-driving attention models, paper summarization, and smart insulin prediction.

AWARDS & HONORS

- **CS@MaxPlanck PhD Fellowship** — (2022–2024).
- **AI Ghurair STEM Scholarship** — Full merit scholarship for high-achieving students (2017–2022).
- **AUC Undergraduate Research Grant** — Funded research on automated insulin injection systems (2021).
- **Best Performing Group, AUC National Math Competition** (2018, 2019).

TEACHING & MENTORING

Teaching Assistant, Machine Learning & Deep Learning | AUC

Sep 2021 – 2022

- Held weekly office hours and project support sessions; prepared tutorials on NumPy, scikit-learn, clustering, logistic regression, Bayesian networks, Q-learning, TensorFlow, and PyTorch.

Teaching Assistant, Algorithms Design | AUC

2020 & 2021

- Led support sessions on complexity analysis, Huffman encoding, backtracking, and dynamic programming.

TECHNICAL SKILLS

Programming	Python, C++, R, MATLAB, CUDA-C, SQL, PyTorch, TensorFlow, scikit-learn
Research Methods	Speech & language modeling, computational neuroscience, representation analysis, deep learning, computer vision, NLP
Tools	Linux, Git, LaTeX, NumPy, pandas, scientific writing & experimental design
Languages	Arabic (native), English (fluent), German (Intermediate)