# LEILA WEHBE

## EDUCATION:

- 2009 - 2015: PhD in Machine Learning, Carnegie Mellon University
  with Special Track in the Center for the Neural Basis of Cognition.
  Thesis: *The Time and Location of Natural Reading Processes in the Brain*
  Advisor: Tom Mitchell.
- 2005- 2009: B.Eng. in Electrical and Computer Engineering, American University of Beirut
  with Minors in Biology and Biomedical Engineering

## EMPLOYMENT:

- 2018 - now: Assistant Professor, Machine Learning Department & Neuroscience Institute, Carnegie Mellon University. Affiliated with the Psychology Department and the Computational Biology Department.
- 2015 -2018: Postdoctoral Researcher, Helen Wills Neuroscience Institute, University of California, Berkeley. Advisor: Jack Gallant.

## PUBLICATION LIST

PEER REVIEWED PAPERS - PUBLISHED

1. Luo A, Henderson M, Tarr M, **Wehbe L**. BrainSCUBA: Fine-Grained Natural Language Captions of Visual Cortex Selectivity. *International Conference on Learning Representations, (ICLR)* 2024.
2. Wang A, Kay K, Naselaris T, Tarr M, **Wehbe L**. Natural language supervision with a large and diverse dataset builds better models of human high-level visual cortex. *Nature Machine Intelligence*, 2023.
3. Luo A, Henderson M, **Wehbe L**$^*$, Tarr M$^*$. Brain Diffusion for Visual Exploration: Cortical Discovery using Large Scale Generative Model. *Neurips 2023, oral presentation*.
4. Sarch H, Tarr M, Fragkiadaki K$^*$, **Wehbe L**$^*$. Brain Dissection: fMRI-trained Networks Reveal Spatial Selectivity in the Processing of Natural Images. *Neurips 2023*.
5. Ye J, Collinger J, **Wehbe L**, Gaunt R. Neural Data Transformer 2: Multi-context Pretraining for Neural Spiking Activity. *Neurips 2023*.
6. Henderson M, Tarr M, **Wehbe L**. A texture statistics encoding model reveals hierarchical feature selectivity across human visual cortex. *Journal of Neuroscience*, 2023.

7. Henderson M, Tarr M, **Wehbe L**. Low-level tuning biases in higher visual cortex reflect the semantic informativeness of visual features. *Journal of Vision*, 2023.

8. Deniz F*, Tseng C*, **Wehbe L**, Dupre la Tour T., Gallant J. Semantic representations during language comprehension are affected by context. *Journal of Neuroscience*, 2023.

9. Jain N, Wang A, Henderson MM, Lin R, Prince JS, Tarr MJ, **Wehbe L**. Selectivity for food in human ventral visual cortex. *Nature Communications Biology*, 2023.

10. Jain S, Vo V, **Wehbe L**, Huth A. Computational language modeling and the promise of *in silico* experimentation. *Neurobiology of Language*, 2023.

11. Herholz P, Fortier E, Toneva M, Farrugia N, **Wehbe L**, Borghesani V. A roadmap to reverse engineering real-world generalization by combining naturalistic paradigms, deep sampling, and predictive computational models. *Neurons, Behavior, Data Science, and Theory*, 2023.

12. Toneva M, Mitchell T, **Wehbe L**. Combining computational controls with natural text reveals aspects of meaning composition. *Nature Computational Science*, 2022.

13. Wu S, Ramdas A and **Wehbe L**. Brainprint: identifying individuals from Magnetoencephalography. *Nature Communications Biology*, 2022.

14. Toneva M.*, Williams J.*, Bollu A., Dann C. and **Wehbe L**. Same Cause; Different Effects in the Brain, *Proceedings of the Conference on Causal Learning and Reasoning (CLeaR)*, 2022.

15. Reddy A and **Wehbe L**. Can fMRI reveal the representation of syntactic structure in the brain? *Proceedings of the Conference on Neural Information Processing Systems (NeurIPS)*, 2021.

16. Ravishankar S, Toneva M, **Wehbe L**. Single-trial MEG data can be denoised through cross-subject predictive modeling. *Frontiers In Computational Neuroscience*, 2021.

17. **Wehbe L**, Blank I, Shain C, Futrell R, Levy R, von der Malsburg T, Smith N, Gibson E, Fedorenko E. Incremental language comprehension difficulty predicts activity in the language network but not the multiple demand network. *Cerebral Cortex*, 2021.

18. Toneva M*, Stretcu O*, Poczos B, **Wehbe L**, Mitchell T. Modeling Task Effects on Meaning Representation in the Brain via Zero-Shot MEG Prediction. *Proceedings of the Conference on Neural Information Processing Systems (NeurIPS)*, 2020.

19. Zha X, **Wehbe L**, Sclabassi R, Mace Z, Liang Y, Yu A, Leonardo J, Cheng B, Hillman T, Chen D, Riviere C. A Deep Learning Model for Automated Classification of Intraoperative Continuous EMG. *IEEE Transactions on Medical Robotics and Bionics*, 2020.

20. Toneva M, **Wehbe L**. Interpreting and improving natural-language processing (in machines) with natural language-processing (in the brain). *Proceedings of the Conference on Neural Information Processing Systems (NeurIPS)*, 2019.

21. Schwartz D, Toneva M, **Wehbe L**. Inducing brain-relevant bias in natural language processing models. *Proceedings of the Conference on Neural Information Processing Systems (NeurIPS)*, 2019.

22. Wang A, Tarr M and **Wehbe L**. Neural Taskonomy: Inferring the Similarity of Task-Derived Representations from Brain Activity. *Proceedings of the Conference on Neural Information Processing Systems (NeurIPS)*, 2019.

23. Chen H, Hu C, **Wehbe L**, Lin S. Self-Discriminative Learning for Unsupervised Document Embedding. *Proceedings of the Conference of the North American Chapter of the ACL (NAACL)*, 2019, oral presentation.

24. Fyshe A, Sudre G, **Wehbe L**, Rafidi N, Mitchell T. The Semantics of Adjective Noun Phrases in the Human Brain. *Human Brain Mapping*, 2019.

25. Ramdas A*, **Wehbe L***. Nonparametric Independence Testing for Small Sample Sizes. *Proceedings of the International Joint Conference on Artificial Intelligence (IJCAI)*, 2015, oral presentation.

26. **Wehbe L**, Ramdas A, Steorts R, Shalizi C. Regularized Brain Reading with Shrinkage and Smoothing. *Annals of Applied Statistics*, 2015.

27. Fyshe A, **Wehbe L**, Talukdar P, Murphy B, Mitchell T. A Compositional and Interpretable Semantic Space. *Proceedings of the Conference of the North American Chapter of the ACL (NAACL)*, 2015, oral presentation.

28. **Wehbe L**, Vaswani A, Knight K, Mitchell T. Aligning context-based statistical models of language with brain activity during reading. *Proceedings of the Conference on Empirical Methods in Natural Language Processing (EMNLP)*, 2014, oral presentation.

29. **Wehbe L**, Murphy B, Talukdar P, Fyshe A, Ramdas A, Mitchell T. Simultaneously uncovering the patterns of brain regions involved in different story reading subprocesses. *PLOS ONE*, 2014.

30. Sudre G, Pomerleau D, Palatucci M, **Wehbe L**, Fyshe A, Salmelin R, Mitchell T. Tracking neural coding of perceptual and semantic features of concrete nouns. *Neuroimage*, 2012.

## CHAPTERS IN BOOKS

31. **Wehbe L**, Fyshe A, Mitchell T. Language processing in the brain: Mapping neural activity to language meaning. **Language in Interaction: the human language faculty from genes to behavior**, MIT Press, 2019.

32. Murphy B, **Wehbe L**, Fyshe A. Decoding Language from the Brain. **Language, Cognition, and Computational Models**, Cambridge University Press, 2018.

## PEER REVIEWED PAPERS - IN REVIEW

33. Williams J, **Wehbe L**. Behavior measures are predicted by how information is encoded in an individual's brain.

34. Khosla M, **Wehbe L**. High-level visual areas act like domain-general filters with strong selectivity and functional specialization.

35. Luo A, **Wehbe L**, Tarr M, Henderson M. Neural Selectivity for Real-World Object Size In Natural Images.

36. Lin R, Naselaris T, Kay K, **Wehbe L**. Stacked regressions and structured variance partitioning for interpretable brain maps.

37. Zhou Y, Liu E, Neubig G, **Wehbe L**. Discovering Divergences between Language Models and Human Brains.

OTHER PUBLICATIONS

38. **Wehbe L**, Huth A, Deniz F, Kieseler M, Gallant J. BOLD predictions: automated simulation of fMRI experiments. NeurIPS 2016 demonstration track. Demonstration of the online engine: https://boldpredictions.gallantlab.org/.

## GRADUATE STUDENT ADVISING

PHD STUDENTS:

- Ruogu Lin, Computational Biology.
- Andrew Luo, joint MLD-PNC (co-advised with Michael Tarr).
- Tara Pirnia, joint MLD-PNC (co-advised with Bonnie Nozari).
- Joel Yu, PNC (co-advised with Robert Gaunt).
- Yuchen Zhou, Psychology (co-advised with Michael Tarr).

POSTDOCS AND PROJECT SCIENTISTS:

- Maggie Henderson (co-advised with Michael Tarr), Neuroscience Institute fellow.
- Isil Bilgin (remote postdoc at the University of Montreal - co-advised with Pierre Bellec).

ALUMNI:

**Previous PhD students:**

- Aria (Yuan) Wang, MLD-PNC (co-advised with Michael Tarr). Now at NIH.
- Jennifer Williams, Computational Biology, 2022. Now a Senior Data Scientist at CVS Health.
- Mariya Toneva, MLD (co-advised with Tom Mitchell), 2021. Now a tenure track assistant professor at the Max Planck Institute for Informatics.

**Previous Masters students:**

- Nathan Anderson, LTI (co-advised with Anna Fisher).
- Nidhi Jain, CSD, currently at Bubble.
- Anand Bollu, CSD, currently at Applied Intuition.
- Aniketh Reddy, MLD, currently a PhD student at EECS, UC Berkeley.
- Srinivas Ravishankar, MLD, currently at IBM research.

**Previous undergraduate students:**

- Kimberly Lo, SCS.
- William Yang, SCS.
- Stephanie You, SCS.
- Aditri Bhagirath, SCS.
- Zachary Nowak, SCS.

GRADUATE THESIS COMMITTEE SERVICE:

- Chaitanya Goswami, ECE CMU (PhD Thesis).
- Alexandre Pasquiou, INRIA & Neurospin (PhD Thesis).
- Amy Sentis, Medical Scientist Training Program, CMU  UPitt (PhD thesis).
- Arish Alreja, Neuroscience Institute and Machine Learning Department, CMU (PhD thesis).
- Nicholas Blauch, Neuroscience Institute, CMU (PhD thesis).
- Shailee Jain, Department of Computer Science, University of Texas at Austin (PhD thesis).
- Mostafa Abdou, Department of Computer Science, University of Copenhagen (PhD thesis).
- Robert Vargas, Psychology, CMU (PhD thesis).
- Stefan Andjelkovic, Computational Biology, UPitt (PhD Thesis).
- Daniel Schwartz, LTI, CMU (PhD thesis).
- Qiong Zhang, joint MLD-PNC, CMU (PhD thesis).
- Rui Sun, Biomedical Engineering, CMU (PhD thesis).
- Maryam Honari Jahromi, University of Victoria, (Master's thesis).

## UNIVERSITY, COLLEGE AND DEPARTMENT SERVICE

SERVICE IN CURRENT POSITION

- MLD representative at Faculty Senate. 2021-2024
- Member. Machine Learning Department Faculty Search Committee. 2023-2024.
- Member of Re-Imagining the CNBC committee. 2021-2022
- Member of DEI course steering committee. 2021-2022
- Member and main organizer. Machine Learning Department Diversity Equity and Inclusion Committee. 2020-2022.
- Member. School of Computer Science Diversity Equity and Inclusion Committee. 2020-2021.
- Member. Machine Learning Department Faculty Search Committee. 2020-2021.

- Member. Neuroscience Institute Faculty Search Committee. 2019-2020.
- Member. Machine Learning Department Faculty Search Committee. 2019-2020.
- Member. Machine Learning Department Admissions Committee. 2018-2019.

PREVIOUS SERVICE

- Member. President's Student Advisory Council. Carnegie Mellon University, 2013-2014.
- Member. Machine Learning Department Admissions Committee. Carnegie Mellon University, 2013-2014.

## EXTERNAL PROFESSIONAL SERVICE

REVIEWING

**Journals:** Proceedings of the National Academy of Sciences (PNAS), Nature Neuroscience, NeuroImage, Journal of Experimental Psychology: General, Journal of Neurolinguistics, Biological Psychiatry, Journal of Neuroscience, Neuroscience Biobehavioral Reviews, Scientific Reports, Language, Cognition and Neuroscience, Nature Communications, PLOS Computational Biology, Scientific Data, Transactions of the Association for Computational Linguistics(TACL), Neurobiology of Language, Nature Human Behavior.

**Conferences:** Neural Information Processing Systems (NeurIPS - Area Chair and Reviewer), Empirical Methods in Natural Language Processing (EMNLP - Area Chair), International Conference on Learning Representations (ICLR - Area Chair and Reviewer), International Joint Conferences on Artificial Intelligence (IJCAI - Reviewer), Cognitive Computational Neuroscience (CCN - Reviewer), International Conference on Machine Learning (ICML - Reviewer), Association for Computational Linguistics (ACL - Reviewer).

CONFERENCE, WORKSHOP AND SEMINAR ORGANIZATION

- Organized brAIn, a cross-university online seminar focused around research in neuro-AI.
- Tutorial Co-Chair, UAI 2022.
- Program Committee Member, Conference on Cognitive Computational Neuroscience, 2022.
- Co-organizer. ICLR How Can Findings About The Brain Improve AI Systems? Workshop, 2021.
- Co-organizer. CVPR Minds vs. Machines: How far are we from the common sense of a toddler? Workshop, 2020.
- Co-organizer. NeurIPS Context and Compositionality in Biological and Artificial Neural Systems Workshop, 2019.
- Main organizer. NeurIPS Representation Learning in Artificial and Biological Neural Networks Workshop, 2016.
- Co-organizer. NeurIPS Machine Learning and Interpretation in NeuroImaging Workshop, 2014-2015.

- Organizing member. Machine Learning Lunch Seminar (2011-2013) and chief organizer (2013-2014), Carnegie Mellon University.

## AWARDS AND RECOGNITIONS

CITATIONS AND AWARDS

- 2023 NSF CAREER award
- 2018 Google Faculty Research award
- 2017 Organization for Human Brain Mapping, Merit Award
- 2017 Computational and Systems Neuroscience, Travel Award
- 2011 Rothberg Research Award in Human Brain Imaging
- 2011 Multimodal Neuroimaging Training Program Fellowship, Carnegie Mellon University
- 2005 Full Merit Scholarship, American University of Beirut

SELECTED PRESS COVERAGE

- New Scientist. Brain scans reveal the areas that light up when we look at food, 2022.
- Covered in the NeurIPS conference AI research tour on ZDNet, 2019.
- Interviewed in Artificial Intelligence, Perspectives from Leading Practitioners in AI and the Science of the Brain, by Jack Clark, O'Reilly Media 2017.
- Associated Press. Lab-coated Muggles use Harry Potter to study brain, picked up by more than 300 news outlets, 2014.
- Time. Reading Harry Potter Provides Clues to Brain Activity, 2014.
- Scientific American. How our Brains Process Books, 2014.
- Futurity. Scans map the brain as people read 'Harry Potter', 2014.
- Bioscience Technology. Reading Leaves a Dramatic Imprint on the Brain, 2014.
- NSF Science Now. EPISODE 29.
- Science News for Students. Harry Potter reveals secrets of the brain, 2015.
- Huffington Post. What Harry Potter Can Teach Us About Neuroscience, 2014.
- Trib Live. Reading Harry Potter provides clues to brain activity, CMU researchers say, 2014.

INVITED TALKS

- Testing neurobiology of language theories in the wild with NLP. Society for the Neurobiology of Language conference, 2023.
- Characterizing complex meaning in the human brain. MIT CBMM seminar, 2023
- Response-optimized deep neural network models of higher-order visual cortex reveal strong semantic selectivity. Columbia University, Center for Theoretical Neuroscience, 2022.
- Relating brain representations to percepts and behavior. Machine Learning in Medicine at Cornell, 2022.
- Reverse engineering representations in real brains using artificial neural networks, BIRS workshop, 2022.
- Testing neurobiology-of-language theories in the wild with NLP, NYU Lingusitics, 2021.
- Can human brain recordings help us design better AI models? MBZUAI, 2021.
- Can human brain recordings help us design better AI models? Google, 2021.
- From language models to human brains and back again. University of Montreal, 2021.
- Neural networks and brains: going beyond simple alignment. Pitt Hackathon/BrainHack, 2020.
- From language models to human brains and back again. Facebook AI Brain meeting, 2020.
- From language models to human brains and back again. TTIC, 2020.
- Neural networks and brains: going beyond simple alignment. Janelia CT seminar, 2020.
- From language models to human brains and back again. SMILES workshop, 2020.
- Natural language in real brains and artificial neural networks. Sociedad Argentina de Investigación en Neurociencias, 2020.
- From language models to human brains and back again. NLP group seminar series, University of Washington, 2020.
- Natural language in real brains and artificial neural networks. LTI colloquium, 2020.
- Natural language in real brains and artificial neural networks. Montreal AI and Neuroscience (MAIN) conference, 2019.
- Using insights from the human brain to interpret and improve NLP models. Semantic Processing and Semantic Knowledge workshop, Dartmouth, 2019.
- Using insights from the human brain to interpret and improve NLP models. Mila, 2019.
- Machine Learning for automating analysis of big data in Neuroscience. Machine Learning in Neuroscience: Fundamentals and Possibilities, SfN online conference, 2019.
- Invited keynote. Language representations in human brains and artificial neural networks. Cognitive Modeling and Computational Linguistics NAACL workshop, 2019.

- Language representations in human brains and artificial neural networks. Petuum, 2019.
- What do naturalistic language experiments offer us? CIMeC, University of Trento, 2018.
- Invited keynote. Language representations in human brains and artificial neural networks. First Blackbox NLP workshop, EMNLP 2018.
- Studying the brain basis of language with naturalistic experiments: opportunities, challenges and progress. Caltech, 2018.
- Studying the brain basis of language with naturalistic experiments: opportunities, challenges and progress. IBM research, 2018.
- Studying the brain basis of language with naturalistic experiments: opportunities, challenges and progress. Cornell University, 2018.
- Studying the brain basis of language with naturalistic experiments: opportunities, challenges and progress. Duke University, 2018.
- Studying the brain basis of language with naturalistic experiments: opportunities, challenges and progress. Stanford University, 2018.
- Language and the brain: opportunities, challenges and progress. ETH Zurich, 2018.
- Language and the brain: opportunities, challenges and progress. Carnegie Mellon University, 2018.
- Naturalistic language experiments: opportunities, challenges and progress. University of Michigan Ann Arbor, 2018.
- Modeling brain responses to natural language stimuli. University of Western Ontario, 2018.
- Language and the brain: naturalistic paradigms and complex prediction problems. Georgia Tech, 2018.
- Modeling brain responses to natural language stimuli. University of Illinois at Urbana-Champaign, 2017.
- Modeling brain responses to natural language stimuli. Society for the Neurobiology of Language conference, 2017.
- Modeling brain responses to natural language stimuli. Fordham University, 2017.
- Lecture. Language processing in the brain: Mapping neural activity to language meaning, with A. Fyshe. Language in Interaction summer school, Donders Institute, 2016.
- Mapping the Reading Brain. AI with the best online conference, 2016.
- Harry Potter and the Activity in the Brain. Learning and the Brain conference on the Science of Imagination, 2016.
- Oral Presentation. A spatio-temporal map of reading processes in the brain. NeurIPS WiML workshop, 2015.
- Oral Presentation. Nonparametric Independence Testing for Small Sample Sizes. IJCAI 2015.

- Oral Presentation. One-step hypothesis testing for functional neuroimaging. SAND7 2015.
- Uncovering Meaning Construction and Representation in the Reading Brain. Information Science Institute, University of Southern California, 2014.
- Oral Presentation. Aligning context-based statistical models of language with brain activity during reading. EMNLP 2014.
- Predicting Brain Activity During Story Reading, Kanwisher Lab, Brain and Cognitive Science Department. Massachusetts Institute of Technology, 2014.
- Invited talk to highlight Brain Initiative at Carnegie Mellon. Harry Potter and the Reading Brain. Ceilidh Weekend, 2014.
- Tracking Story Reading in the Brain. Reading and Learning Group, University of Pittsburgh, 2013.

## GRANTS AND GIFTS

### NSF IIS CAREER award

- PI, 2023-2028
- *Uncovering the brain circuitry of language and its interaction with other modalities*

### Human Frontier Science Program

- Co-PI, 2023-2026
- *Understanding the neural basis of early language development*

### NIH R01 - Collaborative Research in Computational Neuroscience (CRCNS)

- Co-PI, 2021-2026
- *Discovering Principles of Language Processing in the Brain using Neurocomputational Models*

### Google Faculty Research awards

- PI, Gift, 2018-open
- *Can natural {language processing} inform {natural language} processing?*