# Paul S. Scotti, Ph.D

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## EXPERIENCE & EDUCATION

**Stability AI**                                                                                           Nov. 2023 – Present

Head of NeuroAI, Principal Investigator of the MedARC Neuroimaging & AI Lab (https://medarc.ai/fmri)

Published in NeurIPS and ICML, reconstructing seen images from fMRI brain activity using contrastive learning and denoising diffusion models. Fine-tuned the Stable Diffusion XL model to attain SOTA unCLIP performance.

**Princeton Neuroscience Institute**

Visiting research scientist                                                                                Nov. 2023 – Present
Postdoctoral research associate (PI: Dr. Ken Norman)                                           Apr. 2022 – Nov. 2023

Collaborating with Princeton labs on open research AI projects, training a foundation model on large-scale brain data.

**The Ohio State University**                                                                              Oct. 2017 – Apr. 2022

Vision and Cognitive Neuroscience Lab | Cognitive Control Lab (PI: Dr. Julie Golomb | Dr. Andy Leber)

Ph.D. dissertation on "Computational Models to Observe Visual Memory Distortions and Reconstruct Content from the Brain"

**The George Washington University**                                                              Sep. 2014 – May 2017

Attention and Cognition Lab | Visual Cognition Lab (PI: Dr. Sarah Shomstein | Dr. Steve Mitroff)

Undergraduate researcher (distinguished/honors scholar, magna cum laude, 2017 commencement speaker)

## GRANTS, FELLOWSHIPS, & AWARDS

- Princeton Innovation Fund for New Industrial Collaborations ($250,000)
- NSF Graduate Research Fellowship ($102,000)
- OSU University Fellowship ($26,316)
- Luther Rice Undergraduate Research Fellowship

## PRESS

- FujiFilm collaboration: mental imagery reconstruction
- Cognitive Revolution Podcast on mind reading
- Established industrial partnership between Stability AI x Princeton University to support neuroAI
- Our work mentioned in US Senate hearing on AI and Intellectual Property

## PROJECTS (curated selection)

MindEye2: Shared-Subject Models Enable fMRI-To-Image With 1 Hour of Data
First-author publication in ICML 2024
  o SOTA performance in reconstruction of seen images from fMRI brain activity
  o Novel approach to shared-subject modeling enables high-quality results with 40x less training data
  o Fine-tuned Stable Diffusion XL to achieve SOTA unCLIP performance

AI Alibis: Multi-Agent LLM Murder Mystery *(reached #1 on Hacker News)*
Open-source browser game demonstrating novel prompting techniques to bypass pink elephant problem in LLMs
  o Used by the state policy of Germany (NRW) for Gamescom convention (modified for translation + branding)

Reconstructing the Mind's Eye: fMRI-to-Image with Contrastive Learning and Diffusion Priors
First-author publication in NeurIPS 2023 (spotlight)
  o Novel soft contrastive loss inspired by knowledge distillation
  o Large-scale FAISS retrieval from brain embeddings to image embeddings nearest neighbor

EduCortex: Browser-Based 3D Brain Visualization of fMRI Meta-Analysis Maps
First-author publications in JOSE 2020 and Frontiers for Young Minds 2021
  o Browser-based visualization of human brain to help users understand brain anatomy and functional specialization

Enhanced Inverted Encoding Modeling for Neural Reconstructions
  o Created a python package for neuroimaging stimulus reconstructions via inverted encoding modeling (PyPI)

**SKILLS**

- Python, PyTorch
  - neural networks, large language models, denoising diffusion models, encoding/decoding models
  - multi-node / multi-gpu distributed training (DDP, FSDP, Deepspeed)
- HPC computing / cloud computing
  - Slurm HPCs, Amazon ECS, Microsoft Azure
  - created webdataset format large-scale datasets stored on AWS s3 to support large-scale model training
- Computational neuroimaging (fMRI and behavioral)
  - designing experiments, collecting data, pre-/post-processing; SPM, FSL, AFNI, Nipype, Freesurfer, Fmriprep
- Front-end web development (HTML, CSS, JavaScript, Node.js, React)
- Hierarchical Bayesian modeling (PyMC3, JAGS)
- Eye-tracking (experience using/designing behavioral psychology experiments for EyeLink 1000 Plus)

**MENTORSHIP**

Seungwan (Kevin) Son, Stephenie Chen, Karit (Keith) Matanachai, Ashutosh Narang, Cesar Torrico, Mihir Tripathy, Atmadeep Banerjee, Stepan Shabalin, David Weisberg, Foyez Alauddin, Nathalie Verlinde, Anisha Babu, Molly McKinney

**AD HOC REVIEWING**

Nature Neuroscience; NeuroImage; Communications Biology; Imaging Neuroscience; Scientific Reports; Psychonomic Bulletin & Review; Journal of Experimental Psychology: General; Journal of Experimental Psychology: Learning, Memory, and Cognition; Attention, Perception, & Psychophysics; Memory; Memory & Cognition; Journal of Open Source Education

**OUTREACH / PROFESSIONAL DEVELOPMENT / TEACHING**

- MedARC, Principal investigator of the Neuroimaging & AI Lab                                  2023 – Present
  Leading neuroimaging open research projects, mentoring international online community of volunteers
- fMRI Playground: Simple summaries & simulations of neuroimaging methods                      2023
  Interactive textbook on computational neuroimaging methods using Python examples with simulated data
- OnNeuro, Founder                                                                            2017 – 2022
  Hosting/sharing open-access research talks in the fields of psychology and neuroscience
- Center for Cognitive and Behavioral Brain Imaging Student Org, Technical Director            2017 – 2022
  Organizing interdisciplinary workshops and guest speaker presentations at Ohio State Univ.
- Center for Cognitive and Brain Sciences Undergraduate Summer Institute (CUSI)                2018/2019/2021
  Lectured on lab organization, questionable research practices, open science, and pre-registration
- NeuroHackademy                                                                              Summer 2019
  Led a team of researchers to create EduCortex, an educational brain viewer
- Guest Lecturer (Ohio State University)                                                       Fall 2019
  Introduction to Psychology (PSYCH 1001)
- Course Assistant (Ohio State University)
  Sensation and Perception (PSYCH 3310)                                                        Spring 2019
  Cognitive Psychology Laboratory (PSYCH 4510)                                                 2018 – 2019
  Introduction to Social Psychology (PSYCH 3325)                                               Autumn 2018

## PUBLICATIONS

1. Luppi, A., Achterberg, J., Schmidgall, S., Bilgin, I., Herholz, P., Sprang, M., Fockter, B., Ham, A., Thorat, S., Ziaei, R., Milisav, F., Proca, A., Tolle, H., Suarez, L., **Scotti, P.S.**, & Gellersen, H. (in-press). Trainees' perspectives and recommendations for catalyzing the next generation of NeuroAI researchers. *Nature Communications*.
2. **Scotti, P. S.,** Tripathy, M., Torrico, C., Kneeland, R., Chen, T., Narang, A., Santhirasegaran, C., Xu, J., Naselaris, T., Norman, K. A., & Abraham, T. M. (2024). MindEye2: Shared-Subject Models Enable fMRI-To-Image With 1 Hour of Data. *ICML*. doi.org/10.48550/arXiv.2403.11207.
3. **Scotti, P. S.,** Banerjee, A., Goode, J., Shabalin, S., Nguyen, A., Cohen, E., Dempster, A. J., Verlinde, N., Yundler, E., Weisberg, D., Norman, K. A., & Abraham, T. M. (2023). Reconstructing the Mind's Eye: fMRI-to-Image with Contrastive Learning and Diffusion Priors. *NeurIPS **spotlight***. doi.org/10.48550/arXiv.2305.18274. *US Senate hearing on AI and Intellectual Property **discusses our work as an example AI medical application.***
4. Babu, A., **Scotti, P. S.,** & Golomb, J. D. (2023). The dominance of spatial information in object identity judgments: A persistent congruency bias even amidst conflicting statistical regularities. *Journal of Experimental Psychology: Human Perception and Performance.* doi.org/10.1037/xhp0001104
5. Wallace, G., Polcyn, S., Brooks, P. P., Mennen, A., Zhao, K., **Scotti, P. S.,** Michelmann, S., Li, K., Turk-Browne, N. B., Cohen, J. D., Norman, K. A. (2022). RT-Cloud: A Cloud-based Software Framework to Simplify and Standardize Real-Time fMRI. *NeuroImage.* doi.org/10.1016/j.neuroimage.2022.119295
6. **Scotti, P. S.,** Chen, J., & Golomb, J. D. (2022). An improved method for evaluating inverted encoding models. *bioRxiv.* doi.org/10.1101/2021.05.22.445245.
7. **Scotti, P. S.** & Maxcey, A. M. (2022). Directed forgetting of pictures of everyday objects. *Journal of Vision*. doi.org/10.1167/jov.22.10.8
8. Maxcey, A. M., Mancuso, E., **Scotti, P. S.,** Spinelli, E., & Woodman, G. F. (2022). How to induce the forgetting of pictures. *Visual Memory* (Routledge). Eds. Wilma Bainbridge & Timothy Brady. ISBN 9780367744878.
9. **Scotti, P. S.,** Kulkarni, A., Mazor, M., Klapwijk, E., Huth, A. G. (2021). Interactive 3d brain helps you learn how the brain is organized. *Frontiers for Young Minds*. doi.org/10.3389/frym.2021.575131
10. **Scotti, P. S.,** Chen, J., & Golomb, J. D. (2021). An enhanced inverted encoding model for neural reconstructions. *bioRxiv.* doi.org/10.1101/2021.05.22.445245
11. **Scotti, P.S.** & Maxcey, A. M. (2021). What do laboratory-forgetting paradigms tell us about use-inspired forgetting? *Cognitive Research: Principles and Implications*. doi.org/10.1186/s41235-021-00300-6
12. Chen, J., **Scotti, P. S.,** Dowd, E. W., & Golomb, J. D. (2021). Neural representations of task-relevant and task-irrelevant features of attended objects. *bioRxiv.* doi.org/10.1101/2021.05.21.445168
13. **Scotti, P. S.,** Hong, Y., Leber, A. B., & Golomb, J. D. (2021). Visual working memory items drift apart due to active, not passive, maintenance. *Journal of Experimental Psychology: General.* doi.org/10.1037/xge0000890
14. **Scotti, P. S.,** Hong, Y., Golomb, J. D., & Leber, A. B. (2021). Statistical regularities as a reference point for memory distortions: Swap and shift errors. *Attention, Perception, & Psychophysics,* 1-21. doi.org/10.3758/s13414-020-02236-3
15. **Scotti, P. S.,** Kulkarni, A., Mazor, M., Klapwijk, E., Yarkoni, T., Huth, A. G. (2020). EduCortex: browser-based 3D brain visualization of fMRI meta-analysis maps. *Journal of Open Source Education*, 3(26), 75. doi.org/10.21105/jose.00075
16. **Scotti, P. S.,** Janakiefski, L., & Maxcey, A. M. (2020). Recognition-induced forgetting of schematically related pictures. *Psychonomic Bulletin & Review*, 27, 357–365. doi.org/10.3758/s13423-019-01693-8
17. **Scotti, P. S.,** Collegio, A., & Shomstein, S. (2019). Object-based attention is resilient to low-level (boundary) or high-level (semantic) disturbances, but not both. *PsyArXiv.* doi.org/10.31234/osf.io/yxqju
18. Collegio, A., Nah, J., **Scotti, P. S.,** & Shomstein, S. (2019). Attention scales according to inferred real-world object size. *Nature Human Behavior*, 3(1), 40-47. doi.org/10.1038/s41562-018-0485-2

## TALK / POSTER PRESENTATIONS (talks/workshops marked with *)

1. **Scotti, P. S.,** Tripathy, M., Torrico, C., Kneeland, R., Chen, T., Narang, A., Santhirasegaran, C., Xu, J., Naselaris, T., Norman, K. A., & Abraham, T. M. (2024). MindEye2: Shared-Subject Models Enable fMRI-To-Image With 1 Hour of Data. *ICML*. Vienna, Austria.
2. **Scotti, P. S.,** Tripathy, M., Torrico, C., Kneeland, R., Chen, T., Narang, A., Santhirasegaran, C., Xu, J., Naselaris, T., Norman, K. A., & Abraham, T. M. (2024). MindEye2: Shared-Subject Models Enable fMRI-To-Image With 1 Hour of Data. *ICLR Workshop on Representational Alignment (Re-Align).* Vienna, Austria.
3. **Scotti, P. S.,** Banerjee, A., Goode, J., Shabalin, S., Nguyen, A., Cohen, E., Dempster, A. J., Verlinde, N., Yundler, E., Weisberg, D., Norman, K. A., & Abraham, T. M. (2023). Reconstructing the Mind's Eye: fMRI-to-Image with Contrastive Learning and Diffusion Priors. *NeurIPS*. New Orleans, LA.
4. **Scotti, P. S.,** Hennings, A. C., Wallace, G., Polcyn, S., Brooks, P. P., Mennen, A., Zhao, K., Michelmann, S., Li, K., Turk-Browne, N. B., Cohen, J. D., Norman, K. A. (2023). Cloud-based Software Framework to Simplify and Standardize Real-time fMRI. *BRAIN Initiative.* Bethesda, MD.
5. ***Scotti, P. S.**, Hennings, A. C, Norman, K. A.. Conducting RT-fMRI Studies with the Realtime fMRI Cloud Framework (RT-Cloud). *Real-Time Functional Imaging and Neurofeedback Meeting*. New Haven, CT.
6. Wallace, G., **Scotti, P. S.,** Polcyn, S., Brooks, P. P., Mennen, A., Zhao, K., Michelmann, S., Li, K., Turk-Browne, N. B., Cohen, J. D., Norman, K. A. (2022). Cloud-based Software Framework to Simplify and Standardize Real-time fMRI. *BRAIN Initiative.* Virtual conference.
7. **Scotti, P. S.,** Chen, J., & Golomb, J. D. (2022, May). An enhanced inverted encoding model for neural reconstructions of visual perception, attention, and memory. *Vision Sciences Society*. Virtual conference.
8. **Scotti, P. S.,** Chen, J., & Golomb, J. D. (2021, June). An improved method for evaluating inverted encoding models. *Visual Working Memory Symposium.* Virtual conference.
9. **Scotti, P. S.,** Chen, J., & Golomb, J. D. (2021, May). An improved method for evaluating inverted encoding models. *Vision Sciences Society*. Virtual conference.
10. Chen, J., **Scotti, P. S.**, Dowd, E. W., & Golomb, J. D. (2021, May). Neural representations of task-relevant and task-irrelevant features of attended objects. *Vision Sciences Society*. Virtual conference.
11. **Scotti, P. S.,** Chen, J., & Golomb, J. D. (2021, March). An improved method for evaluating inverted encoding models. *Cognitive Neuroscience Society*. Virtual conference.
12. Jones, C. M., **Scotti, P. S.,** & Golomb, J. D. (2020, May). Feature-binding errors during saccadic remapping may affect perception of real-world objects. *Vision Sciences Society*. Virtual conference.

13. **Scotti, P. S.,** Kulkarni, A., Mazor, M., Klapwijk, E., Yarkoni, T., Huth, A. G. (2019, December). EduCortex: browser-based 3D brain visualization of fMRI meta-analysis maps. **Awarded best poster,** *Center for Cognitive and Behavioral Brain Imaging Annual Research Days*, Columbus, OH.
14. ***Scotti, P. S.,** Hong, Y., Leber, A., B., & Golomb, J. D. (2019, November). Competition between similar visual working memory items underlies repulsion effects. *Object Perception, Attention, and Memory (OPAM),* Montreal, Quebec.
15. **Scotti, P. S.,** Janakiefski, L., & Maxcey, A. M. (2019, November). Recognition-Induced Forgetting Does Not Operate Over Superordinate Categories. *Psychonomic Society*, Montreal, Quebec.
16. **Scotti, P. S.**, Hong, Y., Leber, A., B., & Golomb, J. D. (2019, October). Competition Between Similar Visual Working Memory Items Produces Repulsion Effects. *Society for Neuroscience*, Chicago, IL.
17. **Scotti, P. S.,** Hong, Y., Golomb, J. D., Leber, A., B. (2019, May). Relational interactions between visual memory representations increase with maintenance duration. *Vision Sciences Society*, St. Pete Beach, FL.
18. Babu, A., **Scotti, P. S.,** Golomb, J. D. (2019, May). The dominance of spatial information in location judgments: A persistent congruency bias even amidst conflicting statistical regularities. *Vision Sciences Society*, St. Pete Beach, FL.
19. Janakiefski, L., Smerdell, M., **Scotti, P. S.,** Maxcey, A. (2019, March). Does recognition-induced forgetting operate over temporally-grouped objects? *CogFest*, Columbus, OH.
20. **Scotti, P. S.,** Hong, Y., Golomb, J. D., Leber, A., B. (2018, November). Statistical regularities during object encoding distort long-term memory. **Awarded best poster ($200)**, *Object Perception, Attention, and Memory (OPAM)*, New Orleans, LA.
21. **Scotti, P. S.,** Hong, Y., Golomb, J. D., Leber, A., B. (2018, September). Statistical regularities during object encoding distort long-term memory. *Center for Cognitive and Brain Sciences Fall Retreat*, Mt. Sterling, OH.
22. **Scotti, P. S.,** Hong, Y., Golomb, J. D., Leber, A., B. (2018, May). Statistical regularities during object encoding distort long-term memory. *Vision Sciences Society*, St. Pete Beach, FL.
23. Adamo, S., Nah, J., Collegio, A., **Scotti, P. S.,** Shomstein, S. (2018, May). The flux capacitor account: A new theoretical account of multiple target visual search errors. *Vision Sciences Society*, St. Pete Beach, FL.
24. ***Collegio, A., Nah, J., **Scotti, P. S.,** Shomstein, S. (2017, November). Real-world object size affects attentional allocation. *Object Perception, Attention, and Memory (OPAM),* Vancouver, BC.
25. **Scotti, P. S.,** Collegio, A., & Shomstein, S. (2017, November). Task-irrelevant object category guides attentional allocation. *Object Perception, Attention, and Memory (OPAM)*, Vancouver, BC.
26. **Scotti, P. S.,** Adamo, S., Mitroff, S., Shomstein, S. (2017, May). Repetition priming preferentially benefits infrequent targets. *Vision Sciences Society*, St. Pete Beach, FL.
27. Adamo, S., Nah, J., Collegio, A., **Scotti, P. S.,** Shomstein, S. (2017, May). Does orientation matter? Same or differently oriented targets in a multiple target search. *Vision Sciences Society*, St. Pete Beach, FL.
28. Collegio, A., Nah, J., **Scotti, P. S.,** Shomstein, S. (2017, May). Real-world object size affects attentional allocation. *Vision Sciences Society*, St. Pete Beach, FL.
29. **Scotti, P. S.,** Adamo, S., Mitroff, S., Shomstein, S. (2017, April). Repetition priming preferentially benefits infrequent targets. **1st place Psychology poster**, *GW Research Days event*, Washington, D.C.
30. **Scotti, P. S.,** Malcolm, G.L., Peterson, M., & Shomstein, S. (2016, November). Reality vs. Simplicity: The effects of real-world objects on attentional selection. *Object Perception, Attention, and Memory (OPAM)*, Boston, MA.
31. **Scotti, P. S.,** Malcolm, G.L., Peterson, M., & Shomstein, S. (2016, May). Reality vs. Simplicity: The effects of real-world objects on attentional selection. *Vision Sciences Society*, St. Pete Beach, FL.