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

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

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 police of Germany (NRW) for Gamescom convention (modified for translation + branding)

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. (2024). Trainees' perspectives and recommendations for catalyzing the next generation of NeuroAI researchers. *Nature Communications*. doi.org/10.1038/s41467-024-53375-2

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.