Paul Soulos

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Education

2019–Present	Johns Hopkins University (JHU) Ph.D. in Cognitive Science | Expected 2025 | GPA: 4.0/4.0 M.A. in Cognitive Science | 2020 | GPA: 4.0/4.0 Advisors: Paul Smolensky, Leyla Isik
2009–2012	Johns Hopkins University *Graduated with honors* B.S. in Computer Science | GPA: 3.85/4.0 | Departmental Honors B.S. in Applied Mathematics | GPA: 3.74/4.0 Minor in Business

Research Experience

2019–Present	**Research Assistant at JHU's Neurosymbolic Computation Lab** PI: Paul Smolensky Researching methods to model and interpret compositionality in neural networks.
2024	**Research Scientist Intern at IBM Research's In-memory Computing Group** Improving neural network generalization on formal and natural languages.
2022–2024	**Collaborating Researcher at Microsoft Research's Deep Learning Group** Improving compositionality and systematicity through designing novel neural network architectures.
2020–2022	**Research Assistant at JHU's Computational Cognitive Neuroscience Lab** PI: Leyla Isik Researching methods to integrate disentangled neural network models into visual fMRI analysis to better capture factors of variation in the brain.
2020–2021	**Microsoft Research** Role: Intern and Part-time Researcher Worked as part of the Deep Learning Group to improve Transformer models by integrating neurosymbolic methods.

2017–2018 **Research assitant at UC Berkeley's Computational Cognitive Science Lab**
PI: Tom Griffiths
Assisted on projects to improve deep neural networks by researching the effects of multi-level labels on generalization and representation learning.

Other Experience

2017–2019 Fitbit | Senior Software Engineer
Worked on the Health & Wellness team to improve sleep tracking and deliver new user features.

2013–2016 Google | Software Engineer

Android Wear | October 2014 – June 2016
Created and designed Google apps for Android Wear, defined APIs and libraries for third party developers, and helped with core operating system functionality. Worked closely with the Google Fit team to build the fitness experience for wearables. Involved with a cross functional team to promote accessories and personalization.

Android Apps | March – October 2014
Built the Contacts experience on Android Lollipop with one other engineer. Responsibilities included implementing the app using Google's Material Design and maintaining Contacts at the system level.

Google App Engine & Gmail | Intern | Summer 2013
Worked on cloud infrastructure to support Google's mobile application offerings and built tools for third party mobile developers to utilize Google App Engine. Assisted on improvements for Gmail search functionality and auto-complete.

2011–2012 Persistent Systems | Android Developer | Summer 2011/12 & Winter 2012
Developed an Android application to interface with Persistent Systems' wireless radio systems used in a diverse set of markets including military, agriculture, government, mining, and first responders.

Publications

2024 **Soulos, P.**, Conklin, H., Opper, M., Smolensky, P., Gao, J., & Fernandez, R. Compositional Generalization Across Distributional Shifts with Sparse Tree Operations. In *Thirty-seventh Conference on Neural Information Processing Systems.*

- **Selected for a Spotlight Award**.

2024 McCurdy, K., **Soulos, P.**, & Smolensky, P. Toward Compositional Behavior in Neural Models: A Survey of Current Views. In *Proceedings of the 2024 Conference on Empirical Methods in Natural Language Processing.*

2024 **Soulos, P.**, & Isik, L. Disentangled Deep Generative Models Reveal Coding Principles of the Human Face Processing Network. In *PLOS Computational Biology*.

- Also published at *2022 Conference on Cognitive Computational Neuroscience*.
- Also published as "Disentangled Face Representations in Deep Generative Models and the Human Brain" at the NeurIPS 2020 Workshop Shared Visual Representations in Human and Machine Intelligence.

2023 **Soulos, P.**, Hu, E., McCurdy, K., Chen, Y., Fernandez, R., Smolensky, P., & Gao, J. Differentiable Tree Operations Promote Compositional Generalization. In *Proceedings of the 40th International Conference on Machine Learning. PMLR*.

- Also published in *Proceedings of the Society for Computation in Linguistics: Vol. 6*.
- Also published at the ICML 2023 Workshop Differentiable Almost Everything.

2021 **Soulos, P.**, Rao, R., Smith, C., Rosen, E., Celikyilmaz, A., McCoy, R. T., Jiang, Y., Haley, C., Fernandez, R., Palangi, H., Gao, J., & Smolensky, P. Structural Biases for Improving Transformers on Translation into Morphologically Rich Languages. In *Proceedings of the 4th Workshop on Technologies for Machine Translation of Low Resource Languages (LoResMT2021)*.

2021 Jiang, Y., Celikyilmaz, A., Smolensky, P., **Soulos, P.**, Rao, S., Palangi, H., Fernandez, R., Smith, C., Bansal, M., & Gao, J. (2021). Enriching Transformers with Structured Tensor-Product Representations for Abstractive Summarization. In *Proceedings of the 2021 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies*.

2020 **Soulos, P.**, McCoy, R. T., Linzen, T., & Smolensky, P. Uncovering the compositional structure of vector representations with Role Learning Networks. In *BlackboxNLP: Analyzing and Interpreting Neural Networks for NLP*.

- Also published at the NeurIPS 2019 Workshop Context and Compositionality in Biological and Artificial Neural Systems.

2019 Peterson, J. C., **Soulos, P.**, Nematzadeh, A., & Griffiths, T. L. Learning to generalize like humans using basic-level object labels. *Journal of Vision*.

- Also published as "Learning Hierarchical Visual Representations in Deep Neural Networks Using Hierarchical Linguistic Labels" in *Proceedings of the 40th Annual Conference of the Cognitive Science Society*

Honors and Awards

2023 Selected lightning talk for *Differentiable Tree Operations Promote Compositional Generalization* at Johns Hopkins AI-X Foundry Fall 2023 Symposium.

2019 Spotlight oral presentation for *Discovering the Compositional Structure of Vector Representations with Role Learning Networks* at NeurIPS 2019 Workshop on Context and Compositionality in Biological and Artificial Neural Systems.

2017 Living Tapestry artwork selected for the NIPS 2017 Workshop on Machine Learning for Creativity and Design.

2017 Invited for a trial period in the Interaction Design department at Fabrica.

2016 Presented at Google I/O on building apps for Android Wear 2.0.

2016 Filed a patent for "Context-aware system for providing fitness information".

Invited Talks

October 2022	MIT's Neurosymbolic Reading Group
September 2022	UC Berkeley's Computation and Language Lab

Teaching

Fall 2022 — Johns Hopkins University
Role: Teaching Assistant
Course: Language and Mind
Lecture Instructor: Julia Yarmolinskaya
Led weekly lab sessions and graded assignments.

Spring 2022 — Johns Hopkins University
Role: Teaching Assistant, Lab Instructor
Course: Foundations of Neural Network Theory
Lecture Instructor: Paul Smolensky
Led weekly lab sessions and graded assignments.

Spring 2021 — Johns Hopkins University
Role: Teaching Assistant
Course: Foundations of Cognitive Science
Lecture Instructor: Paul Smolensky
Led one seminar discussion and graded assignments.

Fall 2020 — Johns Hopkins University
Role: Teaching Assistant
Course: Cracking the Code Theory and Modeling of Information Coding in Neural activity
Lecture Instructor: Michael Bonner
Led one seminar discussion and graded assignments.

Spring 2014 — Johns Hopkins University
Role: Head Teaching Assistant
Course: User Interfaces and Mobile Applications
Lecture Instructor: Joanne Selinski
Helped produce the class syllabus and schedule. Led weekly lab sessions and graded assignments.

Mentoring

2022 — Zihan Wang
Mentored Zihan through summer internship opportunities and the PhD application process. Zihan interned with Dr Tomer Ullman at Harvard's Psychology Department.

2021 — Gabriel Kressin Palacios
Mentored Gabriel through course selection and the PhD application process. Gabriel matriculated at Johns Hopkins University in the Psychology department.

Service

2022–2023 — Student Lead for the JHU Cognitive Science Diversity and Representation Committee

2020–2022 Student representative for the JHU Cognitive Science Diversity and Representation Committee