

Joshua S. Rule

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Research Interests

Computational cognitive science, conceptual development, mathematical development, probabilistic modeling, program induction, programming language theory, foundations of computation

Academic Positions

- 2020–PRES. University of California, Berkeley
Postdoctoral Scholar
Advisors: Alison Gopnik, Steven T. Piantadosi
- 2013–2020 Massachusetts Institute of Technology
Graduate Student
Advisor: Joshua B. Tenenbaum
- 2010–2013 Georgetown University
Research Assistant & Lab Manager
Advisor: Maximilian Riesenhuber
- 2009 University of Illinois, Urbana-Champaign
Research Assistant
Advisor: Dan Roth

Education

- 2020 Massachusetts Institute of Technology
PhD, Brain & Cognitive Sciences, *Thesis Advisor: Joshua B. Tenenbaum*
- 2009 University of Illinois Urbana-Champaign
BS, Computer Science, *Summa cum Laude*
BA, Philosophy, *Magna cum Laude*

Awards & Honors

- 2016 Angus MacDonald Award for Excellence in Undergraduate Teaching, MIT
- 2015 Glushko Student Travel Award, Cognitive Science Society
- 2014 Graduate Research Fellowship, National Science Foundation
Eugene Stark Graduate Fellowship, MIT
- 2013 Leventhal Graduate Fellowship, MIT
- 2010 University Honors, UIUC, *top 3% of graduating class*

Journal Articles & Book Chapters

- Piantadosi, S. T., Muller, D. C. Y., **Rule, J. S.**, Kaushik, K., Gorenstein, M., Leib, E. R., & Sanford, E. (in press). *Why concepts are probably vectors*.
- Rule, J. S.**, Goddu, M. K., Chu, J., Pinter, V., Reagan, E. R., Bonawitz, E., Gopnik, A., & Ullman, T. (under review). *Children selectively manipulate task difficulty when “playing for fun” vs. “trying to win”*.

- Rule, J. S.**, & Piantadosi, S. T. (under review). *The end of radical concept nativism*.
- Rule, J. S.**, Piantadosi, S. T., Cropper, A., Ellis, K., Nye, M., & Tenenbaum, J. B. (in press). *Symbolic metaprogram search improves learning efficiency and explains rule learning in humans*.
- Piantadosi, S. T., **Rule, J. S.**, & Tenenbaum, J. B. (2024). Learning as Bayesian inference over programs. In T. L. Griffiths, N. Chater, & J. B. Tenenbaum (Eds.), *Bayesian models of cognition: Reverse-engineering the mind*. MIT Press.
- Srivastava, A., Rastogi, A., Rao, A., Shoen, A. A. M., Abid, A., Fisch, A., Brown, A. R., Santoro, A., Gupta, A., Garriga-Alonso, A., Kluska, A., Lewkowycz, A., Agarwal, A., Power, A., Ray, A., Warstadt, A., Kocurek, A. W., Safaya, A., Tazarv, A., ... Wu, Z. (2023). *Beyond the imitation game: Quantifying and extrapolating the capabilities of language models*. *Transactions on Machine Learning Research*.
- Rule, J. S.**, & Riesenhuber, M. (2021). *Leveraging prior concept learning improves ability to generalize from few examples in computational models of human object recognition*. *Frontiers in Computational Neuroscience*.
- Rule, J. S.**, Piantadosi, S. T., & Tenenbaum, J. B. (2020). *The child as hacker*. *Trends in Cognitive Sciences*.
- Glezer, L. S., Kim, J., **Rule, J.**, Jiang, X., & Riesenhuber, M. (2015). *Adding words to the brain's visual dictionary: Novel word learning selectively sharpens orthographic representations in the VWFA*. *Journal of Neuroscience*, 35(12).

Conference Papers

- Rule, J.**, Schulz, E., Piantadosi, S. T., & Tenenbaum, J. B. (2018). *Learning list concepts through program induction*. *Proceedings of the Cognitive Science Society*.
- Rule, J.**, Dechter, E., & Tenenbaum, J. B. (2015). *Representing and learning a large system of number concepts with Latent Predicate Networks*. *Proceedings of the Cognitive Science Society*.
- Sammons, M., Vydiswaran, V. G. V., Vieira, T., Johri, N., Chang, M.-W., Goldwasser, D., Srikumar, V., Kundu, G., Tu, Y., Small, K., **Rule, J.**, Do, Q., & Roth, D. (2009). *Relation alignment for textual entailment recognition*. *Proceedings of the Textual Alignment Conference*.

Abstracts & Posters

- Bowers, M. L., Lew, A., Qi, W., **Rule, J. S.**, Mansinghka, V., Tenenbaum, J., & Solar-Lezama, A. (2024). *Concept learning as coarse-to-fine probabilistic program induction* [Poster and abstract]. *Proceedings of the Cognitive Science Society*.
- Chu, J.*, **Rule, J. S.***, Goddu, M. K., Pinter, V., Reagan, E. R., Bonawitz, E., Gopnik, A., & Ullman, T. D. (2024). *Beyond explore-exploit: Creative curiosity in play* [Poster and abstract, *equal contribution]. *Proceedings of the 2024 Biennial Meeting of the Cognitive Development Society*.
- Kean, H. H., Fung, A., **Rule, J.**, Tenenbaum, J. B., Piantadosi, S., & Fedorenko, E. (2024). *Deductive and inductive processing dissociate in the human brain* [Poster and abstract]. *Proceedings of the Annual Conference on Cognitive Computational Neuroscience*.
- Rule, J. S.**, & Piantadosi, S. T. (2023). *Algorithmic foundations of mathematical development* [Symposium chair]. *Proceedings of the Mathematical Cognition and Learning Society*.
- Goddu, M. K., **Rule, J. S.**, Bonawitz, E., Gonik, A., & Ullman, T. (2022a). *Fun isn't easy: Children optimize for difficulty when "playing for fun" vs. "playing to win" in a game design task* [Talk and abstract]. *Budapest CEU Conference on Cognitive Development Programs and Abstracts*.
- Goddu, M. K., **Rule, J. S.**, Bonawitz, E., Gonik, A., & Ullman, T. (2022b). *Fun isn't easy: Children optimize for difficulty when "playing for fun" vs. "playing to win" in a game design task* [Poster and abstract]. *Cognitive Development Society Abstract Book*.

- Goddu, M. K., **Rule, J. S.**, Bonawitz, E., Gonik, A., & Ullman, T. (2022c). *Fun isn't easy: Children optimize for difficulty when "playing for fun" vs. "playing to win" in a game design task* [Poster and abstract]. *Society for Research in Child Development's Learning through Play and Imagination: Expanding Perspectives*.
- Rule, J. S.**, Piantadosi, S. T., & Tenenbaum, J. B. (2022). *Learning as programming: Efficient search in models of human concept learning* [Talk and abstract]. *Proceedings of the Cognitive Science Society*.
- Rule, J. S.**, Piantadosi, S. T., & Tenenbaum, J. B. (2019). *Learning a novel rule-based conceptual system* [Poster and abstract]. *Proceedings of the Cognitive Science Society*.
- Dechter, E., **Rule, J.**, & Tenenbaum, J. B. (2015). *Latent Predicate Networks: Concept learning with probabilistic context-sensitive grammars* [Poster and abstract]. *Proceedings of the AAAI Spring Symposium Series*.
- Dechter, E., **Rule, J.**, & Tenenbaum, J. B. (2014). *Unsupervised learning of probabilistic programs with Latent Predicate Networks* [Poster and abstract]. *Proceedings of the NIPS Workshop on Probabilistic Programming*.
- Glezer, L. S., Kim, J. S., **Rule, J.**, Jiang, X., & Riesenhuber, M. (2013). *Novel word learning selectively sharpens orthographic representations in the VWFA* [Poster and abstract]. *Neuroscience 2013 Abstracts*.

Dissertation

- 2020 *The child as hacker: Building more human-like models of learning*
Committee: Susan Carey, Steven T. Piantadosi, Laura Schulz (chair), Joshua B. Tenenbaum

Invited Talks

- June. 2024 *Efficient learning of rule-based concepts via metaprogram search*, Stanford, CSLI Workshop on Logic, Rationality, and Intelligent Interaction
- Mar. 2024 *Efficient learning of rule-based concepts via metaprogram search*, UC Berkeley, CS 294-258 guest lecture
- Oct. 2023 *The child as hacker*, Dagstuhl, Approaches and Applications of Inductive Programming
- Apr. 2022 *The child as hacker*, UC Berkeley, CogSci C131 guest lecture
- Oct. 2021 *The child as hacker*, UC Berkeley, Computational Cognitive Neuroscience Lab
- Mar. 2021 *Learning as hacking*, NSF Expeditions: Understanding the world through code, Cognitive science working group
- Jan. 2021 *The child as hacker*, MPI Tübingen, Computational Principles of Intelligence Lab
- Oct. 2020 *The child as hacker*, UC Berkeley, Institute for Human Development & Developmental Psychology Colloquium
- Feb. 2019 *Learning in a flexible language of thought*, UC Berkeley, Computation and Cognition Lab
- Jul. 2018 *Learning list concepts through program induction*, Cognitive Science Society, Learning as Program Induction Workshop
- May 2018 *Learning structured concepts through program induction*, MIT, Brain and Cognitive Sciences CogLunch
- Jul. 2015 *Representing and learning a large system of number concepts with Latent Predicate Networks*, Cognitive Science Society

Service

- Organizing** Dagstuhl Seminar *Approches and Applications of Inductive Programming 2025*
- Reviewing** Nature Human Behavior, Trends in Cognitive Sciences, Cognition, OpenMind, eLife, CogSci, IJCAI-ECAI Workshops

Mentoring

2024 – PRES. Francis Geng (Research Assistant)
2023 – PRES. Justine Krieger (Project Manager)
2022 Li Chenyi (BS), MSCS student at NYU Tandon
2020 – 2021 Shardul Chiplunkar (BS), PhD student at EFPL, Switzerland
2018 – 2019 Nicholas Alvarado (BS), Software Engineer, Google
2017 Benjamin Kaplan (BS), Data, Thrive Capital

Teaching

Fall 2015 9.660 - Computational Cognitive Science
Teaching Assistant with Joshua Tenenbaum, MIT
Fall 2014 9.660 - Computational Cognitive Science
Teaching Assistant with Joshua Tenenbaum, MIT
Spring 2009 CS225 - Data Structures
Teaching Assistant with Cinda Heeren, UIUC
Fall 2008 CS225 - Data Structures
Teaching Assistant with Cinda Heeren, UIUC
Spring 2008 CS225 - Data Structures
Teaching Assistant with Cinda Heeren, UIUC