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

Rule, **J. S.**, Goddu, M. K., Chu, J., Pinter, V., Reagan, E. R., Bonawitz, E., Gopnik, A., & Ullman, T. (under review). *Fun isn't easy: 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.*

Piantadosi, S. T., Muller, D. C. Y., **Rule**, **J. S.**, Kaushik, K., Gorenstein, M., Leib, E. R., & Sanford, E. (2024). *Why concepts are (probably) vectors. Trends in Cognitive Sciences.*

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.

Rule, **J. S.**, Piantadosi, S. T., Cropper, A., Ellis, K., Nye, M., & Tenenbaum, J. B. (2024). *Symbolic metaprogram search improves learning efficiency and explains rule learning in humans. Nature Communications*, *15*(1).

Srivastava, A., Rastogi, A., Rao, A., Shoeb, 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