# Eric Schulz

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## Employment History

since 2020 **Max Planck Research Group Leader.** Computational Principles of Intelligence Lab, MPI for Biological Cybernetics, Tübingen, Germany.

2017-2019 **Data Science Postdoctoral Fellow.** Harvard University, Cambridge, USA.

2013 **Volunteer.** Uganda Virus Research Institute, Entebbe, Uganda.

2012 – 2013 **Machine Learning Analyst.** Zalando, Berlin, Germany.

2008 – 2010 **Student Research Assistant.** MPI for Human Development, Berlin, Germany.

2006 – 2007 **Military Service.** United Nations Training Center, Hammelburg, Germany.

## Education

2014 – 2017 **PhD Experimental Psychology.** University College London, UK.

2013 – 2014 **MRes Computer Science.** University College London, UK.

2011 – 2012 **MSc Applied Statistics.** University of Oxford, UK.

2010 – 2011 **MSc Cognitive and Decision Sciences.** University College London, UK.

2007 – 2010 **Vordiplom Psychology.** Humboldt University, Berlin, Germany.

## Funding

2022-2024 **BMBF Tübingen AI Center Grant** on teaching machines how to create objects and sketches via human-inspired meta-learning.

**BMBF Tübingen AI Center Grant** to study multi-task representation learning.

2021-2025 **Volkswagen Artificial Intelligence and the Society of the Future Grant** to study curiosity in children and robots.

2021-2024 **Univerisity of Tübingen Machine Learning Mini Graduate School** to study compositionality in minds and machines.

2020-2025 **Max Planck Research Group** on Computational Principles of Intelligence.

2020-2023 **Jacobs Early Career Research Fellowship** for Highly talented young scholars working on child development.

2017-2019 **Harvard Data Science Postdoctoral Fellowship**.

## Awards

2020 **Jacobs Research Fellowship** for building algorithms that learn and explore like children.

2018 **Robert J. Glushko Award** for Outstanding Doctoral Dissertation in Cognitive Science.

2017 **Harvard Data Science Postdoctoral Fellowship**.

2016 **UCL Bogue Research Fellowship** funding 3 month visit to Harvard and MIT.

**EPS Grindley Award** to attend the International Conference of Thinking.

**SLMS Graduate School Conference Fund**.

2015 **UCL Sully Award** for best PhD upgrade talk.

**Cognitive Science Travel Award**

## Awards (continued)

2013 **ESPRC scholarship** funding both MRes and PhD at UCL by the Centre for Doctoral Training in Financial Computing and Analytics.

2011 **Haniel scholarship** funding MSc at the University of Oxford.

2010 **DAAD scholarship** funding MSc at University College London.

## Invited Talks

2022 **Max Planck Center for Computational Psychiatry.** Colloquium.

**Max Planck School of Cognition.** Colloquium.

**Leibniz IWM Tübingen.** Departmental Talk.

**MPI Leipzig.** Origins of Intelligence Lecture.

2021 **MPI Berlin.** Department for Humans and Machines.

**University of Cologne.** Peters Lab.

**University of Ghent.** Center for Cognitive Neuroscience.

**TU Darmstadt.** Center for Cognitive Science.

2020 **University of Tübingen.** Cognitive Science Colloquium.

**University of New South Wales.** Departmental Colloquium.

**University of Oxford.** Summerfield Lab Meeting.

**University of Warwick.** Cognitive Science Group.

**The University of Edinburgh.** Computational Cognitive Science Group.

2019 **Stanford University.** FriSem.

**Max Planck Institute for Human Cognitive and Brain Sciences.** Guest Lecture.

**Max Planck Institute for Biological Cybernetics.** MPRG Symposium.

**Cognitive Lunch.** MIT.

2018 **Ohio State Univeristy.** Brown bag seminar series. Invited by Jay Myung.

**Early Childhood Cognition Lab.** Lab Meeting at MIT.

**ONR Science of Autonomy.** Grant Review.

**Ecole Normale Supérieure.** Workshop organized by Stefano Palminteri.

**Cognitive Science Conference.** Symposium for Glushko award winners.

2017 **ConCats seminar series.** New York University.

**CBB Lunch.** Harvard University.

**Cognitive Psychology Colloquium.** University of Göttingen.

**Cognitive Science Colloquium.** University of Onsabrück.

2016 **London Judgement and Decision Making Seminar.** University College London.

**Gershman Lab Meeting.** Harvard University.

**Coffee and Tea Talk.** Max Planck Institute for Human Development.

2015 **Psychology Seminar Series .** City University.

**Krause Lab Meeting .** ETH Zürich.

**Oberauer Lab Meeting .** University of Zürich.

**Economic Psychology Colloquium .** University of Basel.

## Supervision

### Postdocs

2022- **Paula Kaanders**. The neural underpinnings of realistic decision making.
2021- **Mirko Thalmann**. Memory-efficient generalization.
2021- **Marcel Binz**. Resource-rational meta-learning.

### Doctoral Students

2022- **Kristin Witte**. Uncertainty in mal-adaptive reinforcement learning.
2022- **Julian Coda-Forno**. Cognitive theories of meta-reinforcement learning.
2022- **Surabhi Nath** (secondary supervisor). Computational creativity.
2021- **Tobias Ludwig**. Multi-task reinforcement learning.
2021- **Susanne Haridi**. Scaling laws of human inference.
2021- **Akshay Jagadish**. Meta-learning psychiatric symptoms.
2021- **Tankred Saanum**. Compositional reinforcement learning.
2020- **Franziska Brändle**. A computational theory of fun.
2020- **Shuchen Wu**. A resource-rational account of chunking.
2020- **Alexander Kipnis**. Program induction in minds and brains.
2020- **Lion Schulz** (secondary supervisor). Misinformation search.
2020- **Lara Bertram** (secondary supervisor). Perception of entropy.

## Professional Service

since 2012 **Reviewer.** Proceedings of the National Academy of Sciences, Psychonomic Bulletin and Review, Journal of Experimental Psychology: General, Journal of Cognitive Neuroscience, Neural Information Processing and Systems, Cognitive Science Society, PLOS: Computational Biology, Journal of Experimental Psychology: Learning, Memory, and Cognition, Journal of Mathematical Psychology, Nature Human Behaviour, PLOS One, Developmental Science, Nature Neuroscience, Nature Communications, Psychological Science, Psychological Review.

2023 **Program Chair.** Cognitive Computational Neuroscience Conference.

since 2021 **Ombudsperson for good scientific practice.** Max Planck Institute for Biological Cybernetics.

2021 **Workshop organizer.** Using Games to Understand Intelligence. Workshop at the Annual Meeting of the Cognitive Science Society.

2020 **Workshop organizer.** How to become a good scientist. Workshop at the Max Planck Institute for Biological Cybernetics.

2019 **Workshop organizer.** Heuristics, Hacks, and Habits. Workshop at the Annual Meeting of the Cognitive Science Society.

**Workshop organizer.** Structure for Efficient Reinforcement Learning. Workshop at Conference on Reinforcement Learning and Decision Making.

2018 **Workshop organizer.** Learning as program induction. Workshop at the Annual Meeting of the Cognitive Science Society.

2015-2017 **Seminar organizer.** London Judgement and Decision Making seminar series.

## Teaching Experience

2022 **Lecturer.** Computational Cognitive Science. University of Tübingen.

2021 **Lecturer/Organizer.** Seminar on Classics in Cognitive Science. Max Planck Institute for Biological Cybernetics.

2020 **Lecturer/Organizer.** Workshop on how to become a better scientist. Max Planck Institute for Biological Cybernetics.

2018 **Lecturer.** Programming for Data Science. Harvard University.

## Publications

**Google Scholar:** `https://scholar.google.com/citations?user=74Cj5GYAAAAJ`

### Journal Articles

1. Binz, M., Gershman, S. J., Schulz, E., & Endres, D. (2022). Heuristics from bounded meta-learned inference. *Psychological Review*.
2. Binz, M. & Schulz, E. (2022b). Reconstructing the einstellung effect. *Computational Brain and Behavior*.
3. Otto, A. R., Devine, S., Schulz, E., Bornstein, A. M., & Louie, K. (2022). Context-dependent choice and evaluation in real-world consumer behavior. *Scientific Reports*.
4. Brändle, F., Binz, M., & Schulz, E. (2021). Exploration beyond bandits.
5. Tomov, M., Schulz, E., & Gershman, S. J. (2021). Multi-task reinforcement learning in humans. *Nature Human Behaviour*.
6. Brändle, F., Wu, C. M., & Schulz, E. (2020). What are we curious about? *Trends in Cognitive Sciences*, *24*(9), 685–687.
7. Dasgupta, I., Schulz, E., Tenenbaum, J. B., & Gershman, S. J. (2020). A theory of learning to infer. *Psychological Review*, *127*(3), 412.
8. Schulz, E. & Dayan, P. (2020). Computational psychiatry for computers. *iScience*, 101772.
9. Schulz, E., Franklin, N. T., & Gershman, S. J. (2020). Finding structure in multi-armed bandits. *Cognitive Psychology*, *119*, 101261.
10. Schulz, E., Quiroga, F., & Gershman, S. J. (2020). Communicating compositional patterns. *Open Mind*, *4*, 25–39.
11. Stojić, H., Schulz, E., P Analytis, P., & Speekenbrink, M. (2020). It's new, but is it good? how generalization and uncertainty guide the exploration of novel options. *Journal of Experimental Psychology: General*.
12. Wu, C. M., Schulz, E., Garvert, M. M., Meder, B., & Schuck, N. W. (2020). Similarities and differences in spatial and non-spatial cognitive maps. *PloS Computational Biology*.
13. Schulz, E., Bhui, R., Love, B. C., Brier, B., Todd, M. T., & Gershman, S. J. (2019). Structured, uncertainty-driven exploration in real-world consumer choice. *Proceedings of the National Academy of Sciences*, *116*(28), 13903–13908.
14. Schulz, E. & Gershman, S. J. (2019). The algorithmic architecture of exploration in the human brain. *Current Opinion in Neurobiology*, *55*, 7–14.
15. Schulz, E., Wu, C. M., Ruggeri, A., & Meder, B. (2019). Searching for rewards like a child means less generalization and more directed exploration. *Psychological Science*.

16. Dasgupta, I., Schulz, E., Goodman, N. D., & Gershman, S. J. (2018). Remembrance of inferences past: Amortization in human hypothesis generation. *Cognition*, *178*, 67–81.

17. Schulz, E., Speekenbrink, M., & Krause, A. (2018). A tutorial on Gaussian process regression: Modelling, exploring, and exploiting functions. *Journal of Mathematical Psychology*, *85*, 1–16.

18. Schulz, E., Wu, C. M., Huys, Q. J. M., Krause, A., & Speekenbrink, M. (2018). Generalization and search in risky environments. *Cognitive Science*. doi:10.1101/227322

19. Wu, C. M., Schulz, E., Speekenbrink, M., Nelson, J. D., & Meder, B. (2018). Exploration and generalization in vast spaces. *Nature Human Behaviour*.

20. Dasgupta, I., Schulz, E., & Gershman, S. J. (2017). Where do hypotheses come from? *Cognitive Psychology*, *96*, 1–25.

21. Schulz, E., Konstantinidis, E., & Speekenbrink, M. (2017). Putting bandits into context: how function learning supports decision making. *Journal of Experimental Psychology: Learning, Memory, and Cognition*.

22. Schulz, E., Tenenbaum, J. B., Duvenaud, D., Speekenbrink, M., & Gershman, S. J. (2017). Compositional inductive biases in function learning. *Cognitive Psychology*, *99*, 44–79.

23. Cokely, E. T., Galesic, M., Schulz, E., Ghazal, S., & Garcia-Retamero, R. (2012). Measuring risk literacy: the berlin numeracy test. *Judgment and Decision Making*, *7*(1), 25.

24. Cokely, E. T., Ghazal, S., Galesic, M., Garcia-Retamero, R., & Schulz, E. (2012). How to measure risk comprehension in educated samples. *Transparent Communication of Health Risks*, 29–52.

25. Schulz, E., Cokely, E. T., & Feltz, A. (2011). Persistent bias in expert judgments about free will and moral responsibility: a test of the expertise defense. *Consciousness and Cognition*, *20*(4), 1722–1731.

## Conference Proceedings

1. Binz, M. & Schulz, E. (2022a). Exploration with a finite brain. In *Advances in Neural Information Processing Systems 36*.

2. Wu, S., Élteto, N., Dasgupta, I., & Schulz, E. (2022). Learning structure from the ground up: hierarchical representation learning by chunking. In *Advances in Neural Information Processing Systems 36*.

3. Brändle, F., Allen, K., Tenenbaum, J. B., & Schulz, E. (2021). Using games to understand intelligence. In *Proceedings of the 43rd Annual Meeting of the Cognitive Science Society*.

4. Saanum, T., Schulz, E., & Speekenbrink, M. (2021). Compositional generalization in multi-armed bandits. In *Proceedings of the 43rd Annual Meeting of the Cognitive Science Society*.

5. Bertram, L., Schulz, E., Hofer, M., & Nelson, J. D. (2020). The psychology of human entropy intuitions. American Psychological Association.

6. Schulz, E., Betram, L., Hofman, M., & Nelson, J. D. (2019). Exploring the space of human exploration using entropy mastermind. In *Proceedings of the Forty-first Annual Conference of the Cognitive Science Society*.

7. Wu, C. M., Schulz, E., Gerbaulet, K., Pleskac, T. J., & Speekenbrink, M. (2019). Under pressure: the influence of time limits on human exploration. In *Proceedings of the Forty-first Annual Conference of the Cognitive Science Society*.

8. Wu, C. M., Schulz, E., & Gershman, S. J. (2019). Generalization as diffusion: human function learning on graphs. In *Proceedings of the Forty-first Annual Conference of the Cognitive Science Society*.

9. Dasgupta, I., Schulz, E., Smith, K. A., Tenenbaum, J. B., & Gershman, S. J. (2018). Learning to act by integrating mental simulations and physical experiments. In *Proceedings of the Fortieth Annual Conference of the Cognitive Science Society*.

10. Jones, A., Schulz, E., Meder, B., & Ruggeri, A. (2018). Active function learning. In *Proceedings of the Fortieth Annual Conference of the Cognitive Science Society*.

11. Krusche, M., Schulz, E., Guez, A., & Speekenbrink, M. (2018). Adaptive planning in human search. In *Proceedings of the Fortieth Annual Conference of the Cognitive Science Society*.

12. Rule, J., Schulz, E., Piantadosi, S. P., & Tenebaum, J. B. (2018). Learning list concepts through program induction. In *Proceedings of the Fortieth Annual Conference of the Cognitive Science Society*.

13. Wu, C. M., Schulz, E., Garvert, M. M., Meder, B., & Schuck, N. W. (2018). Connecting conceptual and spatial search via a model of generalization. In *Proceedings of the Fortieth Annual Conference of the Cognitive Science Society*.

14. Dasgupta, I., Schulz, E., Goodman, N. D., & Gershman, S. J. (2017). Amortized hypothesis generation. In *Proceedings of the Thirty-Ninth Annual Conference of the Cognitive Science Society*.

15. Schulz, E., Klenske, E., Bramley, N. R., & Speekenbrink, M. (2017). Strategic exploration in human adaptive control. In *Proceedings of the Thirty-Ninth Annual Conference of the Cognitive Science Society*.

16. Wu, C. M., Schulz, E., Speekenbrink, M., Nelson, J. D., & Meder, B. (2017). Mapping the unknown: The spatially correlated multi-armed bandit. In *Proceedings of the Thirty-Ninth Annual Conference of the Cognitive Science Society*.

17. Schulz, E., Huys, Q. J., Bach, D. R., Speekenbrink, M., & Krause, A. (2016). Better safe than sorry: Risky function exploitation through safe optimization. In *Proceedings of the Thirty-Eighth Annual Conference of the Cognitive Science Society*.

18. Schulz, E., Speekenbrink, M., Hernández-Lobato, J. M., Ghahramani, Z., & Gershman, S. J. (2016). Quantifying mismatch in bayesian optimization. In *NIPS Bayesian Optimization workshop*.

19. Schulz, E., Speekenbrink, M., & Meder, B. (2016). Simple trees in complex forests: Growing Take The Best by Approximate Bayesian Computation. In *Proceedings of the Thirty-Eighth Annual Conference of the Cognitive Science Society*.

20. Schulz, E., Tenenbaum, J. B., Duvenaud, D., Speekenbrink, M., & Gershman, S. J. (2016). Probing the compositionality of intuitive functions. In *Advances in Neural Information Processing Systems*.

21. Parpart, P., Schulz, E., Speekenbrink, M., & Love, B. C. (2015). Active learning as a means to distinguish among prominent decision strategies. In *Proceedings of the Thirty-Seventh Annual Conference of the Cognitive Science Society*.

22. Schulz, E., Konstantinidis, E., & Speekenbrink, M. (2015). Exploration-exploitation in a contextual multi-armed bandit task. In *International Conference on Cognitive Modeling* (pp. 118–123).

23 Schulz, E., Konstantinidis, E., & & Speekenbrink, M. (2015). Learning and decisions in contextual multi-armed bandit tasks. In *Proceedings of the Thirty-Seventh Annual Conference of the Cognitive Science Society*.

24 Schulz, E., Tenenbaum, J. B., Reshef, D. N., Speekenbrink, M., & Gershman, S. J. (2015). Assessing the perceived predictability of functions. In *Proceedings of the Thirty-Seventh Annual Conference of the Cognitive Science Society*.

25 Schulz, E., Speekenbrink, M., & Shanks, D. R. (2014). Predict choice – a comparison of 21 mathematical models. In *Proceedings of the Thirty-Sixth Annual Conference of the Cognitive Science Society*.