

# Charley M. Wu

## Curriculum Vitae

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Nationality: Canadian

## Academic Background

### Current Position

2019 – **Post-Doctoral Fellow**, *Department of Psychology*, Harvard University, Cambridge, MA.  
Present

### Previous Positions

- 2019 **Post-Doctoral Research Fellow**, *Center for Adaptive Rationality (ARC)*, Max Planck Institute for Human Development, Berlin, Germany.
- 2018 **Visiting Research Fellow**, *Computational Cognitive Neuroscience Lab*; hosted by Samuel J. Gershman, Harvard University, Cambridge, MA.
- 2016-2019 **Pre-Doctoral Research Fellow**, *Center for Adaptive Rationality (ARC)*, Max Planck Institute for Human Development, Berlin, Germany.
- 2014-2015 **Research Assistant**, *Center for Adaptive Behavior and Cognition (ABC)*, Max Planck Institute for Human Development, Berlin, Germany.
- 2014 **Student Research Scientist**, *PetaByte Research*, Budapest, Hungary.
- 2013-2014 **Research Assistant**, *Intelligent Software Agents and New Media Group*, Austrian Institute for Artificial Intelligence (OFAI), Vienna, Austria.
- 2009 **Research Assistant**, *Center for Human Evolution, Cognition, and Culture (HECC)*, University of British Columbia, Vancouver, Canada.

## Education

- 2016-2019 **Dr. rer. nat. (Ph.D.) Psychology**, *Humboldt University of Berlin*, Berlin, Germany, *Summa Cum Laude*.
- 2013-2015 **M.Sc. Cognitive Science**, *University of Vienna*, Vienna, Austria, *with Distinction*.
- 2004-2009 **B.A. Philosophy**, *University of British Columbia*, Vancouver, Canada, *Dean's List*.

## Honors and Awards

- 2019 **Dean's Competitive Fund for Promising Research**, *Harvard University*, Cambridge, MA, \$33,353 (written with and awarded to Sam Gershman).
- 2019 **Glushko and Samuelson Student Travel Grant**, *40th Annual Conference of the Cognitive Science Society*, Montreal, QC, \$500.

- 2016-2019 **Pre-Doctoral Fellowship**, *International Max Planck Research School on Adapting Behavior in a Fundamentally Uncertain World*, Joint PhD Fellowship in Psychology, Economics, and Law, ~€100,000.
- 2011-2012 **Joseph-Armand Bombardier Canada Graduate Scholarship**, *Social Sciences and Humanities Research Council of Canada (SSHRC)*, Canada, \$17,500, *Declined*.

## Publications

### In Prep

submitted Meder, B., **Wu**, C. M., Schulz, E., & Ruggeri, A. (submitted). Development of directed and random exploration in children. *PsyArXiv*. doi:[10.31234/osf.io/7zhxv](https://doi.org/10.31234/osf.io/7zhxv)

**Wu**, C. M., Schulz, E., Garvert, M. M., Meder, B., & Schuck, N. W. (submitted). Similarities and differences in spatial and non-spatial cognitive maps. *bioRxiv*. doi:[10.1101/2020.01.21.914556](https://doi.org/10.1101/2020.01.21.914556)

**Wu**, C. M., Schulz, E., & Gershman, S. J. (submitted). Inference and search on graph-structured spaces. *bioRxiv*. doi:[10.1101/2020.03.06.981399](https://doi.org/10.1101/2020.03.06.981399)

### Peer reviewed articles

2019 Analytis, P. P., **Wu**, C. M., & Gelastopoulos, A. (2019). Make-or-break: chasing risky goals or settling for safe rewards? *Cognitive Science*, 43, e12743. doi:[10.1111/cogs.12743](https://doi.org/10.1111/cogs.12743)

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*, 30(11), 1561–1572. doi:[10.1177/0956797619863663](https://doi.org/10.1177/0956797619863663)

Tump, A. N., **Wu**, C. M., Bouhrel, I., & Goldstone, R. L. (2019). The evolutionary dynamics of cooperation in collective search. In A. Goel, C. Seifert, & C. Freksa (Eds.), *Proceedings of the 41st Annual Conference of the Cognitive Science Society* (pp. 883–889). Montreal, QB: Cognitive Science Society. (Joint first authorship.)

**Wu**, C. M., Schulz, E., Gerbaulet, K., Pleskac, T. J., & Speekenbrink, M. (2019). Under pressure: The influence of time limits on human exploration. In A. Goel, C. Seifert, & C. Freksa (Eds.), *Proceedings of the 41st Annual Conference of the Cognitive Science Society* (pp. 1219–1225). Montreal, QB: Cognitive Science Society. (Joint first authorship.)

**Wu**, C. M., Schulz, E., & Gershman, S. J. (2019a). Generalization as diffusion: human function learning on graphs. In A. Goel, C. Seifert, & C. Freksa (Eds.), *Proceedings of the 41st Annual Conference of the Cognitive Science Society* (pp. 3122–3128). Montreal, QB: Cognitive Science Society.

**Wu**, C. M., Schulz, E., & Gershman, S. J. (2019b). Searching for rewards in graph-structured spaces. In *Proceedings of the 2019 Conference on Cognitive Computational Neuroscience*. doi:[10.32470/CCN.2019.1041-0](https://doi.org/10.32470/CCN.2019.1041-0)

2018 Bouhrel, I., **Wu**, C. M., Hanaki, N., & Goldstone, R. L. (2018). Sharing is not erring: pseudo-reciprocity in collective search. In T. T. Rogers, M. Rau, X. Zhu, & C. W. Kalish (Eds.), *Proceedings of the 40th Annual Conference of the Cognitive Science Society* (pp. 156–161). Austin, TX: Cognitive Science Society. (Joint first authorship.)

Schulz, E., **Wu**, C. M., Huys, Q. J., Krause, A., & Speekenbrink, M. (2018). Generalization and search in risky environments. *Cognitive Science*, 42, 2592–2620. doi:[10.1111/cogs.12695](https://doi.org/10.1111/cogs.12695)

**Wu**, C. M., Schulz, E., Garvert, M. M., Meder, B., & Schuck, N. W. (2018a). Connecting conceptual and spatial search via a model of generalization. In T. T. Rogers, M. Rau, X. Zhu, & C. W. Kalish (Eds.), *Proceedings of the 40th Annual Conference of the Cognitive Science Society* (pp. 1183–1188). Austin, TX: Cognitive Science Society.

**Wu**, C. M., Schulz, E., Speekenbrink, M., Nelson, J. D., & Meder, B. (2018b). Generalization guides human exploration in vast decision spaces. *Nature Human Behaviour*, 2, 915–924. doi:[10.1038/s41562-018-0467-4](https://doi.org/10.1038/s41562-018-0467-4)

2017 **Wu**, C. M., Meder, B., Filimon, F., & Nelson, J. D. (2017). Asking better questions: how presentation formats influence information search. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 8, 1274–1297. doi:[doi:10.1037/xlm0000374](https://doi.org/10.1037/xlm0000374)

**Wu**, C. M., Schulz, E., Speekenbrink, M., Nelson, J. D., & Meder, B. (2017). Mapping the unknown: the spatially correlated multi-armed bandit. In G. Gunzelmann, A. Howes, T. Tenbrink, & E. J. Davelaar (Eds.), *Proceedings of the 39th Annual Meeting of the Cognitive Science Society* (pp. 1357–1362). Austin, TX: Cognitive Science Society.

2016 Barkoczi, D., Analytis, P. P., & **Wu**, C. M. (2016). Collective search on rugged landscapes: a crossenvironmental analysis. In A. Papafragou, D. Grodner, D. Mirman, & J. Trueswell (Eds.), *Proceedings of the 38th Annual Conference of the Cognitive Science Society* (pp. 918–923). Austin, TX: Cognitive Science Society.

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## Invited Talks

- Feb. 2020 *The Computational Principles of Efficient Human Exploration*, University of California, Irvine Irvine, California.
- Feb. 2020 *Principles of Human Exploration and Generalization*, Max Planck Institute for Biological Cybernetics Tübingen, Germany.
- Feb. 2020 *The Foundations of Efficient Human Exploration*, University of Konstanz Konstanz, Germany.
- Jan. 2020 *Cognitive Mechanisms of Social Learning*, iSearch Retreat, Schloss Ringberg. Kreuth, Germany.
- Nov. 2019 *Domain General Principles of Efficient Human Exploration*, SimTech Colloquium, University of Stuttgart. Stuttgart, Germany.
- Nov. 2019 *Domain General Principles of Generalization and Exploration*, Cognitive Brain and Behavior Lunch, Harvard University. Cambridge, MA.
- May. 2019 *Navigating Vast Decision Spaces with the Principle of Generalization*, Machine Learning in Cognition at UCL (MLCog-UCL) Academic Society, University College London. London, UK.
- Jan. 2019 *Collective Search in Immersive Virtual Environments*, MPRG: iSearch Retreat, Schloss Ringberg. Kreuth, Germany.
- Jan. 2019 *The Successor Representation*, MPRG: NeuroCode, Max Planck Institute for Human Development. Berlin, Germany.

- Nov. 2018 *Guiding Exploration Through Generalization*, Cog Lunch, Department of Brain and Cognitive Sciences, MIT. Cambridge, MA.
- Nov. 2018 *Generalization in Vast Spaces*, Concats, New York University. New York City, NY.
- Nov. 2018 *Generalization Guides Exploration in Vast Spaces*, Fiery Cushman and Joshua Greene labs, Harvard University. Cambridge, MA.
- Sept. 2018 *Guiding Exploration Through Generalization*, Samuel Gershman Lab, Harvard University. Cambridge, MA.
- May. 2018 *Generalization and Exploration: Insights from a spatial search task*, Department of Psychiatry and Psychotherapy, Charité - Universitätsmedizin. Berlin, Germany.
- Sept. 2017 *Generalization and Exploration in Vast Spaces*, Centre for Mind/Brain Sciences (CIMEC), University of Trento. Trento, Italy.
- May. 2017 *Active Learning and Search in Unexplored Environments*, MPRGL iSearch lab meeting, Max Planck Institute for Human Development. Berlin, Germany.
- Apr. 2017 *Generalization Across Vast State Spaces: Human Exploration in Unknown Environments*, Cognition Lab, University of Zürich. Zürich, Switzerland.
- Mar. 2017 *Terra Incognita: Adaptive Learning and Information Search in Unknown Environments*, The Center for Adaptive Rationality (ARC), Max Planck Institute for Human Development. Berlin, Germany.
- Feb. 2017 *Adaptive Learning for Language Education*, Babbel, Lesson Nine GmbH. Berlin, Germany.
- Nov. 2016 *Mapping the Unknown: Human Spatial Exploration-Exploitation*, Learning & Decision Making Lab, University College London. London, UK.

## Conference Presentations, Workshops, and Seminars

- Sep. 2019 **Wu, C.M.**, Schulz, E., & Gershman, S.J., *Searching for rewards in graph-structured spaces*, Poster presented at CCN 2019, Berlin, DE. [\[Poster\]](#).
- Jul. 2019 **Wu, C.M.**, Schulz, E., & Gershman, S.J., *Generalization as diffusion: human function learning on graphs*, Poster presented at CogSci 2019, Montreal, QB. [\[Poster\]](#).
- Jul. 2019 **Wu, C.M.**, Schulz, E., Gerbaulet, K., Pleskac, T.J., & Speekenbrink, M., *Under pressure: the influence of time limits on human exploration*, CogSci 2019, Montreal, QB.
- Jul. 2019 Tump, A.N., **Wu, C.M.**, Bouhlel, I., & Goldstone, R.L., *The Evolutionary Dynamics of Cooperation in Collective Search*, CogSci 2019, Montreal, QB.
- Jul. 2019 **Wu, C.M.**, Schulz, E., Gerbaulet, K., Pleskac, T.J., & Speekenbrink, M., *Time pressure influences attitudes towards uncertainty*, MathPsych 2019, Montreal, QB. [\[Slides\]](#).
- Dec. 2018 **Wu, C.M.**, *Inference over graph structures using a diffusion kernel*, Berlin Machine Learning Seminar, Berlin, Germany.
- Jul. 2018 **Wu, C.M.**, Schulz, E., Garvert, M.M., Meder, B., & Schuck, N.W., *Connecting conceptual and spatial search*, CogSci 2018, Madison, WI.
- Jul. 2018 Bouhlel, I., **Wu, C.M.**, Hanaki, N., & Goldstone, R.L., *Sharing is not erring: Pseudo-reciprocal sharing in collective search*, CogSci 2018, Madison, WI.
- Jul. 2018 **Wu, C.M.**, & Meder, B., Nelson, J.D., *Navigating uncertainty through information search*, Poster presented at CogSci 2018, Madison, WI. [\[Poster\]](#).
- Jul. 2018 **Wu, C.M.**, Schulz, E., Speekenbrink, M., Nelson, J.D., & Meder, B., *Guiding exploration through generalization*, MathPsych 2018, Madison, WI.

- Mar. 2017 **Wu, C.M.**, Schulz, E., Speekenbrink, M., Nelson, J.D., & Meder, B., *Mapping the Unknown: The spatially correlated multi-armed bandit.*, CogSci 2017, London, UK.
- Mar. 2017 **Wu, C.M.**, Schulz, E., Speekenbrink, M., Nelson, J.D., & Meder, B., *Mapping the Unknown: Model-based and Model-free Approaches Towards Spatial Reinforcement Learning*, TeaP 2017, Dresden, Germany.
- Mar. 2017 **Wu, C.M.**, *Everybody GANs Now: Tutorial on Generative Adversarial Networks*, Berlin Machine Learning Seminar, Berlin, Germany.
- Mar. 2017 **Wu, C.M.**, *Voyage into the Unknown: Adaptive Learning and Information Search*, IMPRS Thesis Workshop, Gut Gremmelin, Germany.
- Mar. 2017 **Wu, C.M.**, *Adversarial Training: Math and Methods Tutorial*, Center for Adaptive Behavior and Cognition (ABC), Berlin, Germany.
- Aug. 2016 **Wu, C.M.**, Jurányi, Z., Gulyas, L., & Kamps, G., *Blindfolded NLP: Unsupervised Learning for Automatically Generating Topic Labels*, Identification, Location and Temporal Evolution of Topics Workshop, Budapest, Hungary.
- Jul. 2016 **Wu, C.M.**, Schulz, E., Speekenbrink, M., Nelson, J.D., & Meder, B., *Exploring the Unknown: Modeling Human Exploration-Exploitation Behavior*, Poster presented at Computational and Mathematical Modeling of Cognition, Dobbiaco, Italy. [\[Poster\]](#).
- Mar. 2016 **Wu, C.M.**, *Gaussian Process Models: What do you do when you can't optimize?*, Berlin Machine Learning Seminar, Berlin, Germany.
- Feb. 2016 **Wu, C.M.**, *Exploring Fitness Landscapes: How to discover good solutions to complex problems*, IMPRS Thesis Workshop, Berlin, Germany.
- Feb. 2016 **Wu, C.M.**, Nelson, J.D., & Meder, B., *Characterizing Ruggedness in Fitness Landscapes*, ABC Conference, Berlin, Germany.
- Aug. 2015 **Wu, C.M.**, Meder, B., Nelson, J.D., & Filimon, F., *The effect of presentation formats on rational information search*, SPUDM 25, Budapest, Hungary.
- Jun. 2015 **Wu, C.M.**, Meder, B., Filimon, F., & Nelson, J.D., *The medium is the message: How presentation formats help people ask better questions*, MEi: CogSci Conference, Ljubljana, Slovenia.
- Feb. 2015 Meder, B., **Wu, C.M.**, Nelson, J. D., & Filimon, F., *Presentation formats and information search*, Workshop on "Information, search, and causes: Rational and cognitive approaches", Turin, Italy.
- Jun. 2014 **Wu, C.M.**, Skowron, M., & Petta, P., *Reading between the lines: a vector space model of language using semantic role structures*, Poster presented at MEi:CogSci Conference 2014, Kraków, Poland. [\[Poster\]](#).

## Teaching

- 2020 **Scientific Thinking: the Art of Communicating Ideas**, "Becoming a good scientist" workshop, (Organized by Eric Schulz), Max Planck Institute for Biological Cybernetics, Tübingen, Germany (via Zoom).
- 2020 **Computational Modeling**, Graduate student workshop, Max Planck Institute for Biological Cybernetics, Tübingen, Germany (via Zoom).
- 2019-2020 **Representation Learning in Reinforcement Learning Seminar**, Co-organizer and regular Speaker, Harvard University, Center for Brain Science, Cambridge, MA. [\[Notes\]](#).
- 2015-2019 **Berlin Machine Learning Seminar**, Regular Speaker, Berlin, Germany.

- 2018 **Introduction to Computational Modeling**, *Graduate and undergraduate workshop*, MPRG: iSearch Research Retreat, Bensdorf, Germany.
- 2018 **Intro to Cognitive Modeling**, *Course*, Max Planck Institute for Human Development, Berlin, Germany. (Teaching Assistant to Dr. Björn Meder).
- 2017 **Fast-and-frugal Trees and Models of Information Search**, *Workshop*, ABC Research Retreat, Schloss Ringberg, Germany.
- 2017 **Computational Models of Cognition**, *Graduate Lecture*, Berlin School of Mind and Brain (PhD Program), Humboldt University, Berlin, Germany.
- 2016-2017 **Math and Methods Tutorial Series**, *Organizer and regular speaker*, Center for Adaptive Behavior and Cognition (ABC), Berlin, Germany.
- 2016 **A Statistical Framework for Model Comparisons**, *Tutorial*, ABC Research Retreat, Gut Gremmelin, Germany.

## Supervision

### Graduate Student Projects

- Lucy Lai**. *Compositional sequence learning through generative structure learning*. Department of Neuroscience, Harvard University. (2019-Present)
- Marcel Binz**. *The emergence of compositional language through maximum entropy Reinforcement Learning*. Department of Psychology, Philipps-Universität Marburg. (2019-Present)
- Imen Bouhlef**. *Sharing is not erring: How environments can encourage pseudo-reciprocity in collective human search*. Department of Economics, Université de Nice. (2016-Present)
- Alan Novaes Tump**. *The evolutionary dynamics of cooperation in collective search*. Center for Adaptive Rationality, Max Planck Institute for Human Development. (2018-2019)
- Ahmad Dawud**. *Collective search and rugged landscapes*. Institute of Cognitive Science, University of Osnabrück. (2017-2019)
- Alexander Djamali**. *Information search: Finding better questions*. Department of Physics, Ludwig Maximilian University of Munich. (2016-2017)

### Dissertations

- Kimberly Gerbaulet**. Institute of Cognitive Science, University of Osnabrück. Masters Thesis: *Under pressure: the effect of time pressure on directed and random exploration*. (2018-2019)

## Professional Service

- Organizer** of the 17th annual Summer Institute on Bounded Rationality, Berlin, Germany (2018)
- PhD Representative** for the Max Planck Institute for Human Development (2017-2018)
- Ad-hoc Reviewer** for Nature Human Behaviour (1), Cognitive Computational Neuroscience (6), Cognitive Science Society (11), Mind & Society (1), and Futures & Foresight Science (1)

## Technical Skills

- Programming Languages:** R, Python, Matlab, Julia, JavaScript, HTML, jQuery, PHP, CSS, and  $\text{\LaTeX}$ .
- Additional Software Skills:** MongoDB, MySQL, Tensorflow, SKlearn, GenSim, NLTK, Redis, and Adobe Creative Suite.

## References

Prof. Dr. Fiery Cushman  
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Prof. Dr. Samuel J. Gershman  
Department of Psychology and Center for Brain Sciences, University of Harvard  
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