

Charley M. Wu

Curriculum Vitae

AI Research Building
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Nationality: Canadian

Academic Background

Current Position

2020 – **Independent Research Group Leader**, *Human and Machine Cognition Lab*, University of Tübingen, Tübingen, Germany.
Jointly funded by the Excellence Cluster “Machine Learning for Science” and the Tübingen AI center.

Previous Positions

- 2019 – 2020 **Post-Doctoral Fellow**, *Department of Psychology*, Harvard University, Cambridge, MA.
2019 **Post-Doctoral 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 Fellow**, *Center for Adaptive Rationality (ARC) and Center for Adaptive Behavior and Cognition (ABC)*, 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

- 2021 **Compositionality in Minds and Machines** (Mini-graduate School), *Innovation Fund Program of the Cluster of Excellence “Machine Learning: New Perspectives for Science”*, University of Tübingen (Co-PI: Martin Butz), ~ €114k.

- 2021 **Machine Learning for Education** (Mini-graduate School), *Innovation Fund Program of the Cluster of Excellence "Machine Learning: New Perspectives for Science"*, University of Tübingen (Co-PI: Álvaro Tejero-Cantero), ~ €114k.
- 2019 **Dean's Competitive Fund for Promising Research**, *Harvard University*, Cambridge, MA (written with and awarded to Sam Gershman), \$33,353 (USD).
- 2019 **Glushko and Samuelson Student Travel Grant**, *40th Annual Conference of the Cognitive Science Society*, Montreal, QC, \$500 (USD).
- 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, ~€100k.
- 2011-2012 **Joseph-Armand Bombardier Canada Graduate Scholarship**, *Social Sciences and Humanities Research Council of Canada (SSHRC)*, Canada, \$17,500 (CAD), *Declined*.

Publications

In Prep

submitted Ciranka, S., Linde-Domingo, J., Padezhki, I., Wicharz, C., **Wu**, C. M., & Spitzer, B. (submitted). Asymmetric learning facilitates human inference of transitive relations. *bioRxiv*. doi:[10.1101/2021.04.03.437766](https://doi.org/10.1101/2021.04.03.437766)

Wu, C. M., Ho, M. K., Kahl, B., Leuker, C., Meder, B., & Kurvers, R. H. (submitted). Specialization and selective social attention establishes the balance between individual and social learning. doi:[10.1101/2021.02.03.429553](https://doi.org/10.1101/2021.02.03.429553)

Peer reviewed

2021 Meder, B., **Wu**, C. M., Schulz, E., & Ruggeri, A. (2021). Development of directed and random exploration in children. *Developmental Science*, e13095. doi:[10.1111/desc.13095](https://doi.org/10.1111/desc.13095)

Zuberer, A., Kucyi, A., Yamashita, A., **Wu**, C. M., Walter, M., Valera, E. M., & Esterman, M. (2021). Integration and segregation across large-scale intrinsic brain networks as a marker of sustained attention and task-unrelated thought. *NeuroImage*, 229, 117610. doi:[10.1016/j.neuroimage.2020.117610](https://doi.org/10.1016/j.neuroimage.2020.117610)

2020 Brändle, F., **Wu**, C. M., & Schulz, E. (2020). What are we curious about? *Trends in Cognitive Science*. doi:[10.1016/j.tics.2020.05.010](https://doi.org/10.1016/j.tics.2020.05.010)

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*, 16, 1–28. doi:[10.1371/journal.pcbi.1008149](https://doi.org/10.1371/journal.pcbi.1008149)

Wu, C. M., Schulz, E., & Gershman, S. J. (2020). Inference and search on graph-structured spaces. *Computational Brain & Behavior*. doi:[10.1007/s42113-020-00091-x](https://doi.org/10.1007/s42113-020-00091-x)

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., Bouhlel, 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 Bouhlel, 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.

- Dec. 2020 *Generalization guided exploration*, Computational Cognitive Science Colloquium, TU Darmstadt, Online
- Aug. 2020 *Learning in vast and social environments*, Social and Cognitive Computational Neuroscience Lab, Boston College, Online
- Jul. 2020 *Bridging the Gap Between Human and Machine Learning*, Causality in Cognition Lab Stanford University, Online
- Jul. 2020 *Bridging Human and Machine Learning*, Machine Learning in Science Symposium, University of Tübingen, Online
- Feb. 2020 *The Computational Principles of Efficient Human Exploration*, University of California, Irvine Irvine, CA.
- 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*, Babel, 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

- Jul. 2020 **Wu, C.M.**, Vélez, N., Ho, M.k., & Goldstone, R.L., *Cognition, Collectives, and Human Culture.*, Workshop organized for CogSci 2020, Toronto, CA. [\[Website with viewable talks\]](#).
- 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*, Talk presented at CogSci 2019, Montreal, QB.
- Jul. 2019 Tump, A.N., **Wu, C.M.**, Bouhleb, I., & Goldstone, R.L., *The Evolutionary Dynamics of Cooperation in Collective Search*, Talk presented at CogSci 2019, Montreal, QB.
- Jul. 2019 **Wu, C.M.**, Schulz, E., Gerbaulet, K., Pleskac, T.J., & Speekenbrink, M., *Time pressure influences attitudes towards uncertainty*, Talk presented at 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*, Talk presented at CogSci 2018, Madison, WI.
- Jul. 2018 Bouhleb, I., **Wu, C.M.**, Hanaki, N., & Goldstone, R.L., *Sharing is not erring: Pseudo-reciprocal sharing in collective search*, Talk presented at 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*, Talk presented at 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.*, Talk presented at 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*, Talk presented at 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.**, *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.
- Aug. 2015 **Wu, C.M.**, Meder, B., Nelson, J.D., & Filimon, F., *The effect of presentation formats on rational information search*, Talk presented at 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*, Talk presented at 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

- 2021 **Generalization in Reinforcement Learning**, *Guest lecture: Introduction to Cognitive Psychology*, University of Ghent, Ghent, Belgium (via Zoom) [[Slides](#)].
- 2020 **Scientific Thinking: the Art of Communicating Ideas**, *"Becoming a good scientist" workshop*, 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

Theses Supervised

Anna Giron. Department of Cognitive Science, University of Tübingen. Masters Thesis: *Changes in exploration and generalization over the lifespan* (2020-Present)

Theresa Horn. Department of Cognitive Science, University of Tübingen. Bachelors Thesis: *Visual attention in social learning* (2021-Present)

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)

Graduate Student Projects

Sebastian Breit. *Memory-related changes in exploration and generalization over the lifespan.* Department of Cognitive Science, University of Tübingen (2021-Present)

Tobias Ludwig. *Planning and generalization on generative graph-structured bandits.* Graduate Training Center for Neuroscience, University of Tübingen (2020-Present)

Susanne Haridi. *The scalability of human inference.* Max Planck School of Cognition (2020-Present)

Franziska Brändle. *A computational theory of fun.* Max Planck Institute for Biological Cybernetics (2020-Present)

Tobias Ludwig. *Planning and decision-making in generative bandit tasks.* Graduate Training Center for Neuroscience, University of Tübingen. (2020-Present)

Imen Bouhlel. *Sharing is not erring: How environments can encourage pseudo-reciprocity in collective human search.* Department of Economics, Université de Nice. (2016-2019)

Alan Novaes Tump. *The evolutionary dynamics of cooperation in collective search.* Center for Adaptive Rationality, Max Planck Institute for Human Development. (2018-2020)

Kimberly Gerbaulet. *The informational bandit: Learning to navigate uncertainty.* Institute of Cognitive Science, University of Osnabrück. (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)

Undergraduate Student Projects

Grace Deng. *Cumulative cultural evolution drives the rise and decline of virtual online communities.* Brown University (2020-2021)

Professional Service

Organizer of Cognition, Collectives, and Human Culture Workshop (part of CogSci 2020), Toronto, Canada (2020)

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 Communications (1), Nature Human Behaviour (1), Scientific Reports (1), Cognitive Psychology (1), Computational Brain and Behavior (1), Cognitive Science (1), Cognitive Computational Neuroscience (6), Cognitive Science Society (15), Mind & Society (1), and Futures & Foresight Science (1)

Technical Skills

Programming Languages: R, Python, Matlab, Julia, JavaScript, HTML, jQuery, PHP, CSS, and L^AT_EX.

Additional Software Skills: MongoDB, MySQL, Tensorflow, SKlearn, GenSim, NLTK, Redis, and Adobe Creative Suite.

Languages: English (Native), German (B2), Chinese (Mandarin/Shanghainese; mother tongue), French

(B1), Spanish (B1), and Russian (A1)

References

Prof. Dr. Fiery Cushman
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Prof. Dr. Samuel J. Gershman
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Prof. Dr. Björn Meder
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Prof. Dr. Jonathan D. Nelson
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