Charley M. Wu

Curriculum Vitae

AI Research Building
Maria-von-Linden-Str. 6
72076 Tübingen, Germany
1 (857) 498 8893
charley.wu@uni-tuebingen.de
hmc-lab.com
Nationality: Canadian

Academic Background

Current Position

2020 – present **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.
Advised by Fiery A. Cushman and Samuel J. Gershman.

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*.

Funding

2023 **Computational Summer School on Modeling Social and Collective Behavior (COSMOS) Konstanz 2023**, *William K. and Katherine W. Estes Fund*, Co-Organizer: Wataru Toyokawa, $11k (USD).

2022 **Exploring the Role of Approximate Causal Models in Human Decision-Making**, *Reinhard-Frank Stiftung*, Collaboration with MIT, €27,860 (EUR).

2022 **Computational Summer School on Modeling Social and Collective Behavior (COSMOS) Konstanz 2022**, *William K. and Katherine W. Estes Fund*, Co-Organizer: Wataru Toyokawa, $18k (USD).

2021 **Cumulative Culture in AI** (Postdoc funding), *Tübingen AI Center, supported by the Federal Ministry of Education and Research (BMBF)*, Co-PI: Claudio Tennie, ∼ €115k.

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 Cognitice 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 Giron, A. P., Ciranka, S., Schulz, E., van den Bos, W., Ruggeri, A., Meder, B., & **Wu**, C. M. (submitted). Developmental changes resemble stochastic optimization. *PsyArXiv*. doi:10.31234/osf.io/9f4k3

Haridi, S., **Wu**, C. M., Dasgupta, I., & Schulz, E. (submitted). The scaling of mental computation in a sorting task. *PsyarXiv*. doi:10.31234/osf.io/8hqtv

Smith, A. L., Heuschkel, S., Keplinger, K., & **Wu**, C. M. (submitted). Constructing and deconstructing bias: modeling privilege and mentorship in agent-based simulations. *arXiv*. doi:10.48550/arXiv.2304.02351

in press Collins, R. N., Mandel, D. R., Karvetski, C. W., **Wu**, C. M., & Nelson, J. D. (in press). The wisdom of the coherent: improving correspondence with coherence-weighted aggregation. *Decision*. doi:10.31234/osf.io/fmnty

Rubino, V., Hamidi, M., **Dayan**, P., & Wu, C. M. (in press). Compositionality under time pressure. In M. Goldwater, F. Anggoro, B. Hayes, & D. Ong (Eds.), *Proceedings of the 45th Annual Conference of the Cognitive Science Society*. Sydney, Australia: Cognitive Science Society.

Witt, A., Toyokawa, W., Lala, K., Gaissmaier, W., & **Wu**, C. M. (in press). Social learning with a grain of salt. In M. Goldwater, F. Anggoro, B. Hayes, & D. Ong (Eds.), *Proceedings of*

the 45th Annual Conference of the Cognitive Science Society. Sydney, Australia: Cognitive Science Society.

Peer reviewed

2022 Ciranka, S., Linde-Domingo, J., Padezhki, I., Wicharz, C., **Wu**, C. M., & Spitzer, B. (2022). Asymmetric learning facilitates human inference of transitive relations. *Nature Human Behaviour*. doi:https://doi.org/10.1038/s41562-021-01263-w

Dezza, I. C., Schulz, E., & **Wu**, C. M. (Eds.). (2022). *The Drive for Knowledge: The Science of Human Information-Seeking*. Cambridge: Cambridge University Press. doi:https://doi.org/10.1017/9781009026949

Ludwig, T., **Wu**, C. M., & Schulz, E. (2022). Connecting exploration, generalization, and planning in correlated trees. In *Proceedings of the 44rd Annual Conference of the Cognitive Science Society*. Toronto, Canada: Cognitive Science Society.

Vélez, N., **Wu**, C. M., & Cushman, F. A. (2022). Representational exchange in social learning: blurring the lines between the ritual and instrumental. *Behavioral and Brain Sciences*, *45*, e271. doi:10.1017/S0140525X22001339

Wu, C. M., Schulz, E., Pleskac, T. J., & Speekenbrink, M. (2022). Time pressure changes how people explore and respond to uncertainty. *Scientific Reports*, *12*, 1–14. doi:https://doi.org/10.1038/s41598-022-07901-1

Wu, C. M., Vélez, N., & Cushman, F. A. (2022). Representational exchange in human social learning: Balancing efficiency and flexibility. In I. C. Dezza, E. Schulz, & C. M. Wu (Eds.), *The Drive for Knowledge: The Science of Human Information-Seeking*. Cambridge: Cambridge University Press.

2021 Humaidan, D., Otte, S., Gumbsch, C., **Wu**, C. M., & Butz, M. V. (2021). Latent event-predictive encodings through counterfactual regularization. In T. Fitch, C. Lamm, H. Leder, & K. Teßmar-Raible (Eds.), *Proceedings of the 43rd Annual Conference of the Cognitive Science Society* (pp. 1726–1731). Vienna, Austria: Cognitive Science Society. eprint: 2105.05894

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

Wu, C. M., Ho, M. K., Kahl, B., Leuker, C., Meder, B., & Kurvers, R. H. (2021). Specialization and selective social attention establishes the balance between individual and social learning. In T. Fitch, C. Lamm, H. Leder, & K. Teßmar-Raible (Eds.), *Proceedings of the 43rd Annual Conference of the Cognitive Science Society* (pp. 1921–1927). Vienna, Austria: Cognitive Science Society. doi:10.1101/2021.02.03.429553

Wu, C. M., Schulz, E., & Gershman, S. J. (2021). Inference and search on graph-structured spaces. *Computational Brain & Behavior*, 125–147. doi:10.1007/s42113-020-00091-x

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

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

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

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

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

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

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

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

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

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.

Teaching

2023 **General Principles of Human and Machine Learning**, *Lecture: Cognitive Science/Graduate Training Center for Neuroscience/Psychology/Computer Science*, University of Tübingen, [Course website].

2022-2023 **Cognitive maps and model-based reinforcement learning**, *Seminar: Cognitive Science/Graduate Training Center for Neuroscience*, University of Tübingen, [Course website].

2022 **Tutorial on Modeling Social Learning and Collective Behavior**, *The Computational Summer school on Modeling Social and collective behavior (COSMOS)*, Konstanz, DE, [Code notebooks].

2022 **Scientific reasoning: Crafting research questions and arguments**, *Computation and Cognition Tübingen Summer Internship (CaCTüS) workshop*, Max Planck Institute for Biological Cybernetics, Tübingen, Germany.

2021 **Generalization in Reinforcement Learning**, *Guest lecture: Introduction to Cognitive Psychology*, University of Ghent, Ghent, Belgium (via Zoom) [Slides].

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**, Max Planck Institute for Human Development, Berlin, Germany. (Teaching Assistant to Prof. Björn Meder).

2017 **Computational Models of Cognition**, *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.

Supervision

PhD Theses

Turan Orujlu. Department of Computer Science, University of Tübingen. PhD Thesis: *Curriculum learning for self-directed goal discovery in physical environments* (2022-Present)
Andria Smith. Department of Computer Science, University of Stuttgart. PhD Thesis: *Computational basis of organizational diversity and leadership* (2022-Present)
Hanqi Zhou. Department of Computer Science, University of Tübingen. PhD Thesis: *Assisting Adaptive Human Learning in Structured Domains* (2022-Present)
Alexandra Witt. Department of Computer Science, University of Tübingen. PhD Thesis: *The Neural and Behavioral Basis for Social Learning and Theory of Mind Inference.* (2021-Present)
Mani Hamidi. Department of Computer Science, University of Tübingen. PhD Thesis: *Keeping it Systematically Simple: Heuristics for the control of representation complexity over the course of learning* (2021-Present)
Jan-Philipp Fränken. College of Arts, Humanities and Social Sciences, University of Edinburgh. PhD Thesis: *Reasoning about quantities and concepts: studies in social learning* (2022). External examiner.

Master's and Bachelor's theses

Sebastian Breit. Department of Cognitive Science, University of Tübingen. Masters Thesis: *In search of lost memories: modeling forgetful generalization* (2021-Present)
Anna Giron. Department of Cognitive Science, University of Tübingen. Masters Thesis: *The Trajectory of Learning and Exploration Over the Lifespan* (2020-2021)
Theresa Horn. Department of Cognitive Science, University of Tübingen. Bachelors Thesis: *Use of Visual and Spatial Information in Human Search Behaviour* (2021)
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)

Thesis Advisory Committee

Gabriela Iawama. PhD student. Hertie Institute for Clinical Brain Sciences., University of Tübingen. (2022 - present)
Ori Press. PhD student. Computational Vision and Neuroscience, University of Tübingen. (2022 - present)
Manuel Traub. PhD student. Cognitive Modeling group, University of Tübingen. (2021 - present)
Ruiqi He. PhD student. Rationality Enhancement Group, Max Planck Institute for Intelligent Systems. (2020 - present)
Lovis Hendrich. PhD student. Rationality Enhancement Group, Max Planck Institute for Intelligent Systems. (2020 - present)
Christian Gumbsch. PhD student. Autonomous learning, Max Planck Institute for Intelligent Systems. (2019 - present)

Professional Service

Associate Editor. Open Mind, MIT Press
Steering Committee Member of the Cluster of Excellence – Machine Learning for Science, University of Tübingen (2021-2023)
Co-Organizer of The Computational Summer school on Modeling Social and collective behavior (COSMOS) 2022-2023, Konstanz, DE
Neuromatch mentor (2021)
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, Nature Human Behaviour, eLife, Scientific Reports, PLOS Computational Biology, Cognition, Cognitive Psychology, NeurIPS, Artificial Intelligence, Compu-

tational Brain and Behavior, Journal of Experimental Psychology: Learning, Memory, and Cognition, Child Development, Cognitive, Affective, and Behavioral Neuroscience, Cognitive Science, Cognitive Computational Neuroscience, Cognitive Science Society, Mind & Society, Futures & Foresight Science, and the National Science Foundation.

Technical Skills

Programming Languages: Python, R, Matlab, Julia, JavaScript, HTML, PHP, CSS, and LaTeX.

Languages: English (Native), German (C1), Chinese (Mandarin/Shanghainese; mother tongue), French (B1), Spanish (B1), and Russian (A1)

References

Prof. Dr. Peter Dayan
Max Planck Institute for Biological Cybernetics
Max-Planck-Ring 8, 72076 Tübingen
peter.dayan[at]tuebingen.mpg.de

Prof. Dr. Samuel J. Gershman
Department of Psychology and Center for Brain Sciences, University of Harvard
Northwest Lab Building, 52 Oxford Street, Cambridge, MA 02138
gershman[at]fas.harvard.edu

Prof. Dr. Fiery Cushman
Department of Psychology, University of Harvard
William James Hall, 33 Kirkland Street, Cambridge, MA 02138
cushman[at]fas.harvard.edu