JAY A. HENNIG

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ACADEMIC POSITIONS

2021- **Postdoctoral Fellow, Department of Psychology**
Harvard University
Advisor: Samuel Gershman | *Collaborators:* Naoshige Uchida, Scott Linderman

EDUCATION

2015 - 2021 **Ph.D. in Neural Computation and Machine Learning**
Carnegie Mellon University
Thesis: "Structure and time course of neural population activity during learning"
Advisors: Byron Yu, Steven Chase | *Committee:* Aaron Batista, Robert Kass, Eric Shea-Brown

2008 - 2011 **B.S. in Mathematics, with Highest Honors**
University of Texas at Austin
Overall GPA: 3.99/4.0, Major GPA: 4.0/4.0

PUBLICATIONS

In preparation

2024 **"A theory of brain-machine interface learning via low-dimensional control"**
Menéndez, J.A., Hennig, J.A., Batista, A.P., Chase, S.M., Yu, B.M., Latham, P.E.

2024 **"Correlated subfields yield beneficial noise correlations in visual area MT"**
Hennig, J.A., Pillow, J.W., Huk, A.C., Yates, J.L.

Under review

2024 **"The role of prospective contingency in the control of behavior and dopamine signals during associative learning"**
*Qian, S., *Burrell, M., Hennig, J.A., Matias, S., Murthy, Venkatesh, N., Gershman, S.J., Uchida, N.
bioRxiv 2024.02.05.578961 (under review at *Nature Neuroscience*)

2022 **"Learning alters neural activity to simultaneously support memory and action"**
Losey, D.M., Hennig, J.A.†, Oby, E.R.†, Golub, M.D., Sadtler, P.T., Quick, K.M., Ryu, S.I., Tyler-Kabara, E.C., *Batista, A.P., *Yu, B.M., *Chase, S.M.
bioRxiv 2022.07.05.498856 (under review at *Current Biology*)

Published

2023 **"Emergence of belief-like representations through reinforcement learning"**
Hennig, J.A., Romero-Pinto, S.A., Yamaguchi, T., Linderman, S.W., Uchida, N., Gershman, S.J.
PLOS Computational Biology (2023) 19 (9): e1011067

2021 **"How learning unfolds in the brain: toward an optimization view"**
Hennig, J.A., Oby, E.R., Losey D.M., *Batista, A.P., *Yu, B.M., *Chase, S.M.
Neuron (2021), 109 (23), 3720-3735

2021 **"Learning is shaped by abrupt changes in neural engagement"**
Hennig, J.A., Oby, E.R., Golub, M.D., Bahureksa, L.A., Sadtler, P.T., Quick, K.M., Ryu, S.I., Tyler-Kabara, E.C., *Batista, A.P., *Chase, S.M., *Yu, B.M.
Nature Neuroscience (2021), 24 (5), 727-736

2020 **"Intracortical brain-machine interfaces"**
Oby, E.R., Hennig, J.A., *Batista, A.P., *Yu, B.M., *Chase, S.M.
In Neural Engingeering, Springer, Cham, 2020 (pp. 185-221).

2018 **"Constraints on neural redundancy"**
Hennig, J.A., Golub, M.D., Lund, P.J., Sadtler, P.T., Oby, E.R., Quick, K.M., Ryu, S.I., Tyler-Kabara, E.C., *Batista, A.P., *Yu, B.M., *Chase, S.M.
eLife, 7 (2018): e36774.

2019 **"New neural activity patterns emerge with long-term learning"**
Oby, E.R., Golub, M.D., Hennig, J.A., Degenhart, A.D., Tyler-Kabara, E.C., *Batista, A.P., *Yu, B.M., *Chase, S.M.
Proceedings of the National Academy of Sciences, 116.30 (2019): 15210-15215.

2017 **"A Classifying Variational Autoencoder with Application to Polyphonic Music Generation"**
Hennig, J.A., Umakantha, A. Williamson, R. C.
arXiv preprint arXiv:1711.07050

2015 **"A Distinct Mechanism of Temporal Integration for Motion through Depth"**
Katz, L.N., Hennig, J.A., Cormack, L.K., Huk, A.C.
The Journal of Neuroscience. 35(28), 10212-10216.

2013 **"Signal Multiplexing and Single-Neuron Computations in Lateral Intraparietal Area During Decision-Making"**
Meister, M.LR., Hennig, J.A., Huk, A.C.
The Journal of Neuroscience, 33(6), 2254-2267.

† and * denote equal contribution.

PRESENTATIONS

Conference abstracts

2024 **"Neural dynamics in prefrontal regions as a candidate mechanism for instantiating belief states"**
S. A. Romero Pinto, J. A. Hennig, D. Okada, C. Benquet, M. Burrell, S. W. Linderman, N. Uchida, S. J. Gershman
Computational and Systems Neuroscience (Cosyne)

"A link between memory traces in motor cortex and savings"
J. Couras, E. R. Oby, A. Motiwala, S. E. Snyder, D. M. Losey, J. A. Hennig, B. M. Yu*, S. M. Chase*, A. P. Batista*
Cosyne

"Network models for distinguishing population-level learning mechanisms"
J. Sacks, E. R. Oby, J. A. Hennig, A. D. Degenhart, P. T. Sadtler, K. M. Quick, S. I. Ryu, E. C. Tyler-Kabara, S. M. Chase, B. M. Yu, A. P. Batista, M. D. Golub
Cosyne

2023 **"A link between memory traces in motor cortex and savings"**
J. Couras, E. R. Oby, A. Motiwala, S. E. Snyder, D. M. Losey, J. A. Hennig, B. M. Yu*, S. M. Chase*, A. P. Batista*
Society for Neuroscience

"Signatures of belief representations in recurrent neural networks and prefrontal cortex"
J. A. Hennig, S. A. Romero Pinto, S. W. Linderman, N. Uchida, S. J. Gershman
Cosyne

2021 **"Learning is shaped by an abrupt change in neural engagement"**
J. A. Hennig, E. R. Oby, M. D. Golub, L. A. Bahureksa, P. T. Sadtler, K. M. Quick, S. I. Ryu, E. C. Tyler-Kabara, A. P. Batista*, S. M. Chase*, B. M. Yu*
Cosyne

2020 **"Evidence of a memory trace in motor cortex after short-term learning"**
D. M. Losey, J. A. Hennig, E. R. Oby, M. D. Golub, P. T. Sadtler, K. M. Quick, S. I. Ryu, E. C. Tyler-Kabara, A. P. Batista*, B. M. Yu*, S. M. Chase*
Cosyne (invited talk)

"A motor cortical model of brain-machine interface learning, fast and slow"
J. A. Menendez, J. A. Hennig, M. D. Golub, E. R. Oby, A. P. Batista, S. M. Chase, B. M. Yu, P. E. Latham
Cosyne

2019 **"Evidence of a memory trace in motor cortex after short-term learning"**
D. M. Losey, J. A. Hennig, E. R. Oby, M. D. Golub, P. T. Sadtler, K. M. Quick, S. I. Ryu, E. C. Tyler-Kabara, A. P. Batista*, B. M. Yu*, S. M. Chase*
Society for Neuroscience

2018 **"Learning can generate new patterns of neural population activity"**
E. R. Oby, M. D. Golub, J. A. Hennig, A. D. Degenhart, E. C. Tyler-Kabara, B. M. Yu*, S. M. Chase*, A. P. Batista*
Cosyne (invited talk)

2017 **"Predicting neural activity in behaviorally-irrelevant dimensions"**
J. A. Hennig, Golub, M. D., P. J. Lund, P. T. Sadtler, K. M. Quick, S. I. Ryu, E. C. Tyler-Kabara, A. P. Batista, B. M. Yu*, S. M. Chase*
Cosyne

2016 **"Predicting neural activity in behaviorally-irrelevant dimensions"**
J. A. Hennig, M. D. Golub, P. J. Lund, P. T. Sadtler, K. M. Quick, S. I. Ryu, E. C. Tyler-Kabara, A. P. Batista, B. M. Yu*, S. M. Chase*
Society for Neuroscience

2010 **"The aperture problem in three dimensions"**
J. A. Hennig, T. B. Czuba, L. K. Cormack, A. C. Huk, B. Rokers
Vision Sciences Society

* denotes equal contribution.

Invited talks

2021 **"Learning is shaped by an abrupt change in neural engagement"**
IEEE EMBS Neural Engineering

2019 **"Constraints on neural redundancy"**
Carnegie Mellon Center for Neural Basis of Cognition Retreat

HONORS AND AWARDS

2019 **McClelland Prize: Outstanding Paper Award** for *Constraints on neural redundancy*
Center for the Neural Basis of Cognition, Carnegie Mellon University

2018 **Andrew Carnegie Prize in Mind and Brain Sciences Fellowship**
Carnegie Mellon University

2016 **2nd place in Qualcomm Neurohackathon** (included travel award)
Carnegie Mellon University

2015 - 2016 **Presidential Fellowship in the Life Sciences, Richard King Mellon Foundation**
Carnegie Mellon University

2011 **Phi Beta Kappa**
University of Texas at Austin

2007 **Valedictorian**
Booker T. Washington High School, Dallas, TX

TEACHING EXPERIENCE

Guest Lecturer, Neural Signal Processing Spring 2019
Electrical and Computer Engineering & Biomedical Engineering, Carnegie Mellon University

- Guest lecture on "Introduction to Clustering," covering k-means and Gaussian mixture models
- Graduate course (42-590/18-699), Instructor: Byron Yu

Teaching Assistant, Neural Signal Processing Spring 2018
Electrical and Computer Engineering & Biomedical Engineering, Carnegie Mellon University

- Graduate course (42-590/18-699), Instructor: Byron Yu

Teaching Assistant, Introduction to Machine Learning Fall 2017
Machine Learning, Carnegie Mellon University

- Graduate course (10-601), Instructor: Roni Rosenfeld

Academic and research mentor 2016 - present
Carnegie Mellon University & Harvard University

- Mentored multiple undergraduate, masters, and graduate students

PROFESSIONAL EXPERIENCE

Software developer and consultant 2011 - 2013
Biarri Optimisation *Melbourne, VIC, Australia*

- Designed a linear programming formulation and developed a working implementation, in C++ and Python, for optimizing the capacity of existing production facilities and the locations of new facilities. This tool was used by Australia Post, Australia's national postal service, to plan upgrades to their existing postal network.

- Contributed to development of a software tool in C++ for designing fiber optic networks to minimize materials cost. Used by NBN Co. as part of an Australian government project to provide high-speed internet to 98% of the nation.

ACADEMIC MENTORING & SERVICE

Mentor for Harvard Psychology's PPREP Program 2022, 2023

- Mentoring program for prospective Psychology graduate and RA students in underrepresented groups
- Psychology Department, Harvard University

Mentor for Carnegie Mellon's A.I. Mentoring Program 2019, 2020

- Mentoring program for undergraduates in underrepresented groups interested in machine learning
- Machine Learning Department, Carnegie Mellon University

PhD Admissions Committee member 2019/20, 2020/21

- Machine Learning Department, Carnegie Mellon University

ACADEMIC OUTREACH & EXTRACURRICULAR

Archiving academic paper summaries called 'tweeprints' 2019 - 2021

- Dataset: link
- @tweeprint: `https://twitter.com/tweeprint`

***Paper Trails*, an e-newsletter covering recent scientific research** 2018 - 2020

- I wrote a series of posts relating recent scientific research to non-scientific readers (100+ subscribers)
- `https://mobeets.github.io/paper-trails/`

***mpm*, a package manager for Matlab** 2018 - present

- I developed and maintain a package manager for Matlab
- `https://github.com/mobeets/mpm`

***Speak Neuron*, an educational comic about neural coding** 2011 - 2014

- I wrote and illustrated a mini graphic novel to introduce concepts of signal processing and neural coding.
- `https://mobeets.github.io/speak-neuron/`

REFERENCES

Samuel Gershman *Harvard University*
Byron Yu *Carnegie Mellon University*
Steven Chase *Carnegie Mellon University*
Aaron Batista *Carnegie Mellon University*