

Stanford

Shaul Druckmann

Associate Professor of Neurobiology, of Psychiatry and Behavioral Sciences and, by courtesy, of Electrical Engineering

Bio

ACADEMIC APPOINTMENTS

- Associate Professor, Neurobiology
- Associate Professor, Psychiatry and Behavioral Sciences
- Associate Professor (By courtesy), Electrical Engineering
- Member, Bio-X
- Member, Wu Tsai Neurosciences Institute

HONORS AND AWARDS

- McKnight Scholar, McKnight Foundation (2021)
- Sloan Research Fellow, Sloan Foundation (2021)

LINKS

- Druckmann lab website: <https://www.druckmannlab.com>

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Our research goal is to understand how dynamics in neuronal circuits relate and constrain the representation of information and computations upon it. We adopt three synergistic strategies: First, we analyze neural circuit population recordings to better understand the relation between neural dynamics and behavior, Second, we theoretically explore the types of dynamics that could be associated with particular network computations. Third, we analyze the structural properties of neural circuits.

Teaching

COURSES

2023-24

- Introduction to Mathematical Tools in Neuroscience: NEPR 209 (Win)
- Neuroscience Computational Core: NEPR 208 (Spr)

2022-23

- Introduction to Mathematical Tools in Neuroscience: NEPR 209 (Win)
- Neuroscience Computational Core: NEPR 208 (Spr)

2021-22

- Introduction to Mathematical Tools in Neuroscience: NEPR 209 (Win)
- Neuroscience Computational Core: NEPR 208 (Spr)

2020-21

- Neuroscience Computational Core: NEPR 208 (Spr)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Luke Brezovec, Xuehao Ding, Tucker Fisher, Gabriel Mel, Josh Melander, Christopher Minasi, Ethan Richman, Linnie Warton, John Wen

Postdoctoral Faculty Sponsor

Haggai Agmon

Doctoral Dissertation Advisor (AC)

Matthew Bauer, Tyler Benster, Feng Chen, Lydia Hamburg, Erin Kunz, Balint Kurgyis, Yi Liu, Benyamin Meschede-Krasa

Doctoral Dissertation Co-Advisor (AC)

Minseung Choi, John Kochalka

GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Neurosciences (Phd Program)

Publications

PUBLICATIONS

- **A high-performance speech neuroprosthesis.** *Nature*
Willett, F. R., Kunz, E. M., Fan, C., Avansino, D. T., Wilson, G. H., Choi, E. Y., Kamdar, F., Glasser, M. F., Hochberg, L. R., Druckmann, S., Shenoy, K. V., Henderson, J. M.
2023
- **Hypothalamic neurons that mirror aggression.** *Cell*
Yang, T., Bayless, D. W., Wei, Y., Landayan, D., Marcelo, I. M., Wang, Y., DeNardo, L. A., Luo, L., Druckmann, S., Shah, N. M.
2023
- **Unraveling the Entangled Brain: How Do We Go About It?** *Journal of cognitive neuroscience*
Druckmann, S., Rust, N. C.
2022: 1-4
- **Regional cytoarchitecture of the adult and developing mouse enteric nervous system.** *Current biology : CB*
Hamnett, R., Dershowitz, L. B., Sampathkumar, V., Wang, Z., Gomez-Frittelli, J., De Andrade, V., Kasthuri, N., Druckmann, S., Kaltschmidt, J. A.
2022
- **Towards a more general understanding of the algorithmic utility of recurrent connections.** *PLoS computational biology*
Larsen, B. W., Druckmann, S.
2022; 18 (6): e1010227
- **Transforming representations of movement from body- to world-centric space.** *Nature*
Lu, J., Behbahani, A. H., Hamburg, L., Westeinde, E. A., Dawson, P. M., Lyu, C., Maimon, G., Dickinson, M. H., Druckmann, S., Wilson, R. I.
1800
- **Modularity and robustness of frontal cortical networks.** *Cell*
Chen, G., Kang, B., Lindsey, J., Druckmann, S., Li, N.
2021
- **Targeted photostimulation uncovers circuit motifs supporting short-term memory.** *Nature neuroscience*
Daie, K., Svoboda, K., Druckmann, S.
2021

- **Decoding spoken English from intracortical electrode arrays in dorsal precentral gyrus.** *Journal of neural engineering*
Wilson, G. H., Stavisky, S. D., Willett, F. R., Avansino, D. T., Kelemen, J. N., Hochberg, L. R., Henderson, J. M., Druckmann, S., Shenoy, K. V.
2020; 17 (6): 066007
- **Approaches to inferring multi-regional interactions from simultaneous population recordings: Inferring multi-regional interactions from simultaneous population recordings.** *Current opinion in neurobiology*
Kang, B., Druckmann, S.
2020; 65: 108–19
- **A comparison of neuronal population dynamics measured with calcium imaging and electrophysiology.** *PLoS computational biology*
Wei, Z. n., Lin, B. J., Chen, T. W., Daie, K. n., Svoboda, K. n., Druckmann, S. n.
2020; 16 (9): e1008198
- **Neural ensemble dynamics in dorsal motor cortex during speech in people with paralysis.** *eLife*
Stavisky, S. D., Willett, F. R., Wilson, G. H., Murphy, B. A., Rezaii, P., Avansino, D. T., Memberg, W. D., Miller, J. P., Kirsch, R. F., Hochberg, L. R., Ajiboye, A. B., Druckmann, S., Shenoy, et al
2019; 8
- **Kilohertz frame-rate two-photon tomography.** *Nature methods*
Kazempour, A., Novak, O., Flickinger, D., Marvin, J. S., Abdelfattah, A. S., King, J., Borden, P. M., Kim, J. J., Al-Abdullatif, S. H., Deal, P. E., Miller, E. W., Schreiter, E. R., Druckmann, et al
2019; 16 (8): 778–86
- **An orderly single-trial organization of population dynamics in premotor cortex predicts behavioral variability.** *Nature communications*
Wei, Z., Inagaki, H., Li, N., Svoboda, K., Druckmann, S.
2019; 10 (1): 216
- **Single-Cell Reconstruction of Emerging Population Activity in an Entire Developing Circuit.** *Cell*
Wan, Y. n., Wei, Z. n., Looger, L. L., Koyama, M. n., Druckmann, S. n., Keller, P. J.
2019
- **Active dendritic integration and mixed neocortical network representations during an adaptive sensing behavior.** *Nature neuroscience*
Ranganathan, G. N., Apostolides, P. F., Harnett, M. T., Xu, N., Druckmann, S., Magee, J. C.
2018
- **Schaffer Collateral Inputs to CA1 Excitatory and Inhibitory Neurons Follow Different Connectivity Rules** *JOURNAL OF NEUROSCIENCE*
Kwon, O., Feng, L., Druckmann, S., Kim, J.
2018; 38 (22): 5140–52
- **Nonlinear Dimensionality Reduction Via Polynomial Principal Component Analysis**
Kazempour, A., Druckmann, S., IEEE
IEEE.2018: 1336–40
- **central brain.** *Science (New York, N.Y.)*
Kim, S. S., Rouault, H., Druckmann, S., Jayaraman, V.
2017; 356 (6340): 849-853
- **Angular velocity integration in a fly heading circuit** *ELIFE*
Turner-Evans, D., Wegener, S., Rouault, H., Franconville, R., Wolff, T., Seelig, J. D., Druckmann, S., Jayaraman, V.
2017; 6
- **Maintenance of persistent activity in a frontal thalamocortical loop** *NATURE*
Guo, Z. V., Inagaki, H. K., Daie, K., Druckmann, S., Gerfen, C. R., Svoboda, K.
2017; 545 (7653): 181-?
- **Multiplicative Updates for Optimization Problems with Dynamics**
Kazempour, A., Babadi, B., Wu, M., Podgorski, K., Druckmann, S., Matthews, M. B.
IEEE COMPUTER SOC.2017: 2025–29
- **Robust neuronal dynamics in premotor cortex during motor planning** *NATURE*

Li, N., Daie, K., Svoboda, K., Druckmann, S.
2016; 532 (7600): 459-?

- **Dynamical feature extraction at the sensory periphery guides chemotaxis** *ELIFE*
Schulze, A., Gomez-Marin, A., Rajendran, V. G., Lott, G., Musy, M., Ahammad, P., Deogade, A., Sharpe, J., Riedl, J., Jarriault, D., Trautman, E. T., Werner, C., Venkadesan, et al
2015; 4
- **From a meso- to micro-scale connectome: array tomography and mGRASP** *FRONTIERS IN NEUROANATOMY*
Rah, J., Feng, L., Druckmann, S., Lee, H., Kim, J.
2015; 9
- **Structured Synaptic Connectivity between Hippocampal Regions** *NEURON*
Druckmann, S., Feng, L., Lee, B., Yook, C., Zhao, T., Magee, J. C., Kim, J.
2014; 81 (3): 629-640
- **Mapping mammalian synaptic connectivity** *CELLULAR AND MOLECULAR LIFE SCIENCES*
Yook, C., Druckmann, S., Kim, J.
2013; 70 (24): 4747-4757
- **A Hierarchical Structure of Cortical Interneuron Electrical Diversity Revealed by Automated Statistical Analysis** *CEREBRAL CORTEX*
Druckmann, S., Hill, S., Schuermann, F., Markram, H., Segev, I.
2013; 23 (12): 2994-3006
- **Neuronal Circuits Underlying Persistent Representations Despite Time Varying Activity** *CURRENT BIOLOGY*
Druckmann, S., Chklovskii, D. B.
2012; 22 (22): 2095-2103
- **Effective Stimuli for Constructing Reliable Neuron Models** *PLOS COMPUTATIONAL BIOLOGY*
Druckmann, S., Berger, T. K., Schuermann, F., Hill, S., Markram, H., Segev, I.
2011; 7 (8)
- **Evaluating automated parameter constraining procedures of neuron models by experimental and surrogate data** *BIOLOGICAL CYBERNETICS*
Druckmann, S., Berger, T. K., Hill, S., Schuermann, F., Markram, H., Segev, I.
2008; 99 (4-5): 371-379