

# 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

- Award for Excellence in Graduate Teaching, Stanford University (2023)
- 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)

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

### Orals Chair

Kevin Feiglis

### Postdoctoral Faculty Sponsor

Taiga Abe, Haggai Agmon

### Doctoral Dissertation Advisor (AC)

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

### Doctoral Dissertation Co-Advisor (AC)

Minseung Choi, John Kochalka

## GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Neurosciences (Phd Program)

## Publications

---

### PUBLICATIONS

#### • Transforming a head direction signal into a goal-oriented steering command. *Nature*

Westeinde, E. A., Kellogg, E., Dawson, P. M., Lu, J., Hamburg, L., Midler, B., Druckmann, S., Wilson, R. I.  
2024

#### • Brain-wide neural activity underlying memory-guided movement. *Cell*

Chen, S., Liu, Y., Wang, Z. A., Colonell, J., Liu, L. D., Hou, H., Tien, N., Wang, T., Harris, T., Druckmann, S., Li, N., Svoboda, K.  
2024; 187 (3): 676

#### • Temporal scaling of motor cortical dynamics reveals hierarchical control of vocal production. *Nature neuroscience*

Banerjee, A., Chen, F., Druckmann, S., Long, M. A.  
2024

#### • Mapping the neural dynamics of locomotion across the *Drosophila* brain. *Current biology : CB*

Brezovec, B. E., Berger, A. B., Hao, Y. A., Chen, F., Druckmann, S., Clandinin, T. R.  
2024

#### • A high-performance speech neuroprosthesis *NATURE*

Willett, F. R., Kunz, E. M., Fan, C., Avansino, D. T., Wilson, G. H., Choi, E., Kamdar, F., Glasser, M. F., Hochberg, L. R., Druckmann, S., Shenoy, K. V., Henderson, J. M.  
2023

#### • 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*  
Kazemipour, 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., Apostolidis, 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**  
Kazemipour, 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**  
Kazemipour, 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