

# Erik • Peterson

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## Experience

### 2018 ▶ Present • Research Scientist • Verstynen Lab, Carnegie Mellon, PA

- Developing biologically-inspired methods for cooperative AI.

### 2017 ▶ 2018 • Research Scientist • Kernel.co, Los Angeles CA

- Technical lead developing a *real-time* system for complex spatio-temporal voltage field shaping in deep brain stimulation. End result: a ~430,000X speed up compared to traditional approaches. This project combined deep neural networks with biophysically-augmented data, nonlinear systems analysis, & large-scale biological modelling.

### 2015 ▶ 2017 • Postdoctoral Fellow • Voytek Lab, U.C. San Diego

- Developed novel theoretical accounts, biophysical modeling approaches, to understand the role of neural oscillations in human cognition.
- Advised several projects approaching "big data" scale: machine-learning analysis of time-series data.

### 2014 ▶ 2015 • Postdoctoral Fellow • Wheeler Lab, University of Pittsburgh

- Theoretical and empirical analysis of human decision making.
- Machine learning analysis of high-dimensional (fMRI) data.

### 2006 ▶ 2012 • Graduate Research Assistant • Seger Lab, Colorado State University

- Completed PhD on human reinforcement learning, and category learning.
- Authored several (at the time) state-of-the-art libraries for machine learning analysis of fMRI data.

### 2004 ▶ 2006 • Research Assistant II • Biosearch Technologies, Novato CA

## Education

- **PhD** • Neuroscience • Colorado State University, Fort Collins, CO, 2012
- **PMS** • Psychology • Colorado State University, Fort Collins, CO, 2012
- **BS** • Chemistry & Biochemistry • California Polytechnic State University, San Luis Obispo, CA, 2004.

## Publications

- **Peterson EJ & Voytek B**, Homeostasis and oscillatory modulation. (2018). *In prep*
- **Peterson EJ & Voytek B**, Learning with discrete representations using continuous chaotic neural populations. (2018). *In prep*
- **Peterson EJ & Voytek B**, The trade-off between neural computation and oscillatory coordination, bioRxiv 309427, (2018). <https://doi.org/10.1101/309427>

- Matar Haller \*, Thomas Donoghue \*, **Erik Peterson** \*, Paroma Varma, Priyadarshini Sebastian, Richard Gao, Torben Noto, Robert T. Knight, Avgusta Shestyuk, Bradley Voytek, Parameterizing neural power spectra, *bioRxiv*, (2018). <https://doi.org/10.1101/299859>
- **Peterson EJ** & Voytek B, Alpha rhythmically alters gain by modulating excitatory-inhibitory background activity, *bioRxiv*, (2017). <https://doi.org/10.1101/185074>. *Under review: Neuron*
- Gao RD, **Peterson EJ**, Voytek B, Inferring synaptic excitation/inhibition balance from field potentials, *Neuroimage*. 2017 Sep;158:70-78 (2017)
- **Peterson EJ**, Burke QR, Campbell AM, Belger A, Voytek B, 1/f neural noise is a better predictor of schizophrenia than neural oscillations, *bioRxiv* <https://doi.org/10.1101/113449> (2017),
- Cole SR, **Peterson EJ**, van der Meij R, Hemptinne C, Starr PA, & Voytek B, Nonsinusoidal oscillations underlie pathological phase-amplitude coupling in the motor cortex in Parkinson's disease, *J Neurosci* (2017),
- **Peterson EJ**, Rosen BQ, Campbell AM, Belger A & Voytek B, 1/f neural noise is a better predictor of schizophrenia than neural oscillations, *bioRxiv* (2017) *Under review: Cerebral Cortex*
- Haller M, **Peterson EJ**, Varma P, Noto T, Knight RT, Shestyuk A, & Voytek B. Automated “spectrally fingerprinting” of electrophysiological oscillations, *In preparation* (2017).
- Voytek B, Postle BR, Watrous AJ, **Peterson EJ**, van der Meij R, Gao RD, Inferring neurophysiology and network-level dynamics from the human EEG, *Nature Neuroscience* (2016), *Accepted*.
- **Peterson EJ** and Voytek B, Balanced oscillatory coupling improves information flow, *bioRxiv* (2016).
- **Peterson EJ** and Seger CA, In model-based fMRI significant is less than specific., *bioArxiv* (2017).
- **Peterson EJ**, Seger CA and Anderson CA, Many Hats: Changes in the Striatal Bold Signal Across Stimulus, Preparation, Response and Feedback, *Journal of Neurophysiology* (2013), 110(7) 1689-1702.
- Seger CA and **Peterson EJ**, Categorization = Decision Making - Generalization, *Neurosci Biobehav Rev* (2013), 37(7), pp1187-1200
- Seger CA, Dennison CM, Lopez-Paniagua DL, **Peterson EJ**, and Roark AA, Dissociating Hippocampal and Basal Ganglia Contributions to Category Learning Using Stimulus Novelty and Subjective Judgments, *Neuroimage* (2011), 55(4), pp1739-53.
- Seger CA, **Peterson EJ**, Cincotta C, Lopez-Paniagua DL and Anderson C, Dissociating the Contributions of Independent Corticostriatal Systems to Visual Categorization Learning Through the Use of Reinforcement Learning Modeling and Granger Causality Modeling, *NeuroImage* (2010), 50(2) pp644-656.
- Bedoukian MA, Whitesell J, **Peterson EJ**, Clay C and Partin KM, The Stargazin C Terminus Encodes an Intrinsic and Transferable Membrane Sorting Signal, *J. Biol. Chem.* (2008), 283(3), pp1597-1600.

#### Biochemistry and Nanotechnology

- Johansson HE, Johansson MK, Wong AC, Armstrong ES, **Peterson EJ**, Grant RE, Roy MA, Reddington MV and Cook RM, BTI1, an Azoreductase with pH Dependent Substrate Specificity, *Applied Environmental Microbiology* (2012), under review.
- Cheung CL, Rubinstein AI, **Peterson EJ**, Chatterji A, Sabirianov RF, Mei W, Lin T, Johnson JE and DeYoreo JJ, Steric and Electrostatic Complementarity in the Assembly of Two-Dimensional Virus Arrays, *Langmuir* (2010), 26 (5), pp3498–3505.
- Wong MK, Armstrong ES, **Peterson EJ**, Grant RE, Cook RM, and Johnanssen HJ, The BIT1 Azoreductase Colormetric and Fluorometric Reporter System, presented at Experimental Biology 2009, New Orleans, April 2009.

- Sowers BA, **Peterson EJ**, Grant RE, Lin WY, Dick DJ and Cook RM, Optimization of Probe Performance in Real-Time PCR through an Understanding of Synthesis Impurities, presented at Quantitative PCR, San Diego (CA) March, 2005.
- **Peterson EJ**, Weeks BL, De Yoreo JJ, and Schwartz PV, Effect of Environmental Conditions on Dip Pen Nanolithography of Mercaptohexadecanoic Acid, *J. Phys. Chem B* (2004), 108 (39), pp15206-15210.

## Posters

- **Peterson EJ** & Voytek B, The tradeoff between oscillatory coordination and neural computation, presented at Society for Neuroscience (SFN), Washington DC, 2017.
- **Peterson EJ** & Voytek B, Gain control across cortical layers can be mediated by balanced oscillatory coupling, presented at Society for Neuroscience (SFN), San Diego, CA 2016.
- Haxby S & **Peterson EJ**, Learning with discrete representations using continuous chaotic neural populations, presented at Society for Neuroscience (SFN), San Diego, CA 2016.
- Gao R, **Peterson EJ**, & Voytek V, Spiking correlates and temporal variability of oscillatory frequency modulation, presented at Society for Neuroscience (SFN), San Diego, CA 2016.
- Rosen BQ, **Peterson EJ**, Campbell AM, Belger A & Voytek B, Spectral 1/f noise differences account for apparent oscillatory band-specific effects in Schizophrenia, presented at Society for Neuroscience (SFN), San Diego, CA 2016.
- L. Izhikevich L, **Peterson EJ** and Voytek B, Neural oscillatory power is not Gaussian distributed across time, presented at Society for Neuroscience (SFN), San Diego, CA 2016.
- **Peterson EJ** & Wheeler MW, The diversity of distributed decisions, presented at Society for Neuroscience (SFN), San Diego, CA 2015.
- **Peterson EJ** & Voytek B. Spike-field coupling does not imply spike-spike coupling, presented at Society for Neuroscience (SFN), San Diego, CA 2015.
- Noto T, Gao R, **Peterson EJ**, Voytek B. Neural network properties can be inferred from electrophysiological power spectral geometry, presented at Society for Neuroscience (SFN), San Diego, CA 2015.
- Cole SR, **Peterson EJ**, de Hemptinne C, Starr PA, Voytek B. Deep brain stimulation increases motor cortical 1/f noise and decouples high gamma amplitude from beta phase, presented at Society for Neuroscience (SFN), San Diego, CA 2015.
- **Peterson EJ** & Seger CS, A precise problem in model-based fMRI?, presented at Cognitive Neuroscience Society Meeting (CNS), San Francisco, CA, May 2013.
- **Peterson EJ** & Seger CS, Evidence for generalizable reward representations in the basal ganglia examined using fMRI and reinforcement learning, International Meeting of the Basal Ganglia Society 11, Eilat, Israel, March 2013.
- **Peterson EJ** & Wheeler M, Looking everywhere for the right model of perceptual decision making, Computational Neuroscience Poster Session, Center for the Neural Basis of Cognition, Pittsburgh, PA, January 2013.
- **Peterson EJ** & Seger CA, Many Hats: Using fMRI to Characterize the Roles and Reward Sensitivity of the Striatum Across Stimulus, Response and Feedback., International Meeting of the Basal Ganglia Society 10, Long Branch, NJ, 2010.
- **Peterson EJ** and Seger, CA, Reward-level dependent activity preceding and following response selection: an fMRI study, presented at SFN2009, Chicago, IL, Fall 2009.
- **Peterson EJ** and Seger, CA, To Do the Right Thing: Temporal Difference Learning As Tool to Dissect the Role of Feedback in the Striatum, presented at Cognitive Neuroscience Society Meeting (CNS), San

## Software

- **fakespikes**: Model spiking as a statistical process, in Python.
- **pacpy**: Calculate phase-amplitude coupling in Python (and Matlab).
- **chinoise**: Create simple LFP simulations, with  $1/F^{\chi}$  noise.
- **danalysis**: A very basic library for studying recurrence matrices.
- **pacological**: Spiking simulations of good and bad PAC.
- **syncological**: A detailed look at the synchronization and coding fidelity of gamma oscillations.
- **bw**: Toy simulations to try and better interpret peak bandwidth in power spectra.
- **kdf**: A language agnostic key-value interface for hdf5.
- **rl**: A python library for fitting reinforcement learning models to behavioral data
- **modelmodel**: analyze and simulate (model-based) fMRI in python
- **fmrilearn**: a set of helper functions to analyze fMRI data in scikit-learn
- **roi**: A specialized module for doing parametric ROI analyses of fMRI data.
- **ds**: A python module for dynamical systems analysis. It's for learning not for real work.
- **accumulate**: Compare decision making theories based on information accumulation across every possible 2 choice trial (of length L).
- **bigstats**: A python library for calculating statistics, incrementally.
- **similarity**: Some similarity measures for perceptual categories.
- **simplepsychtoolbox**: A set of simple functions for doing common tasks with Psychtoolbox.
- **artificialGrammar**: Create and analyze artificial grammars
- **seq**: First, second and third order effects in behavioral (or other) data.

## Awards

- 2010 Editor's Choice Award, Systems Neuroscience Section NeuroImage (see Seger et al (2010).)
- 2003 Undergraduate Summer Research Fellowship, Lawrence Livermore National, Laboratory Livermore CA.

## Professional Activities

- *Summer 2014*: Summer school in Theoretical Neuroscience, University of Waterloo

## Teaching

- *Fall 2011, Spring 2012*: Teaching assistantship - taught two upper-division laboratories - Sense and Perception (PSY 457) and the neuroanatomy section of Cognitive Neuroscience (PSY 459).

## Invited public talks

- *Build your own brainwaves*, Nerd Nite, Los Angeles, Feb 2018.
- *Conflicted data science*, Open San Diego, San Diego, Feb, 2016.
- *The electronic dance club brain*, Nerd Nite, San Diego, Oct 2016.
- *In theory you're paying attention*, Ignite, San Diego, Nov 2016.
- *Science ambassador*, Science Hack Day, San Francisco, Oct, 2014.