Thomas Donoghue, PhD

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Languages: English (native), French (proficient), Spanish (intermediate)

Areas of Specialization

Cognitive Neuroscience - Electrophysiology - Periodic & Aperiodic Activity - Data Science

Education

2014 - 2020 **PhD, Cognitive Science - Advisor: Prof. Bradley Voytek**
University of California, San Diego, La Jolla, California, USA
Thesis: Measuring and Investigating Periodic and Aperiodic Neural Activity

2011 - 2014 **Bachelors of Arts and Sciences (BA&Sc) Honors Cognitive Science**
McGill University, Montreal, Quebec, Canada
Major: Cognitive Science. Minor: Philosophy. Graduated First Class Honors with Distinction

Research Experience

3/2021 - *present* **Postdoctoral Research Scientist - Advisor: Prof. Joshua Jacobs**
Columbia University, Department of Biomedical Engineering
Investigations of human electrophysiology, with intracranial recordings and single units.

10/2020 - 2/2021 **Postdoctoral Scholar - Advisor: Prof. Bradley Voytek**
UC San Diego, Department of Cognitive Science, Cognitive & Neural Dynamics Lab
Developing software tools for the analysis of electrophysiological recordings.

9/2014 - 9/2020 **Graduate Student Researcher - Advisor: Prof. Bradley Voytek**
UC San Diego, Department of Cognitive Science, Cognitive & Neural Dynamics Lab
Mechanisms of neural communication using human electrophysiological recordings.

5/2013 - 6/2014 **Research Assistant - Advisor: Prof. Sylvain Baillet**
Montreal Neurological Institute, Department of Neurology & Neurosurgery
Functional connectivity during sleep, using magnetoencephalography and polysomnography.

9/2012 - 9/2014 **Research Assistant - Advisor: Prof. Kris Onishi**
McGill University, Department of Psychology - McGill Infant Development Cluster (MIDC)
Psycholinguistics & Developmental Psychology: language perception & statistical learning.

Additional Training

2018 **Methods In Neuroscience at Dartmouth (MIND)**, *Dartmouth College,* Hanover, NH, USA
Short course.Topic: Narratives & Natural Contexts. Competitive application (~20% acceptance).

2017 **Neurohackweek,** *eScience Institute*, University of Washington, Seattle, WA, USA
Project-based course on neuro- & data science. Competitive application (~25% acceptance).

2016 **Advanced Scientific Programming in Python**, *G-Node & CINN*, Reading, England, UK
Short course on scientific programming. Competitive application (9.9% acceptance).

Preprints & Articles Currently Under Review

**Equal contribution. Underlined are research assistants under my direct supervision.*

preprint **Donoghue T***, Cao R*, Han CZ*, Holman C, Brandmeir NJ, Wang S, Jacobs J. Single neurons in the human medial temporal lobe flexibly shift representations across spatial and memory tasks. *bioRxiv.* DOI: 10.1101/2023.02.22.529437. LINK

preprint He W, **Donoghue T**, Sowman PF, Seymour RA, Brock J, Crain S, Voytek B, & Hillebrand A. Co-Increasing Neuronal Noise and Beta Power in the Developing Brain. *bioRxiv.* DOI: 10.1101/839258. LINK

Journal Articles (Peer Reviewed)

**Equal contribution. Underlined are research assistants under my direct supervision.*

2022 **Donoghue T,** Schaworonkow N & Voytek B. Methodological considerations for studying neural oscillations. *European Journal of Neuroscience, 55*(11-12), 3502-3527. DOI: 10.1111/ejn.15361. LINK
Project website: oscillationmethods.github.io

2022 **Donoghue T**, Voytek B, & Ellis S. Course Materials for Data Science in Practice. *Journal of Open Source Education, 5*(51), 121. DOI: 10.21105/jose.00121. LINK

2022 **Donoghue T** & Voytek B. Automated meta-analysis of the event-related potential (ERP) literature. *Scientific Reports, 12*(1). DOI: 10.1038/s41598-022-05939-9. LINK
Project website: erpscanr.github.io

2022 Ostlund BD, **Donoghue T**, Anaya B, Gunther KE, Karalunas SL, Voytek B, Pérez-Edgar KE Spectral parameterization for studying neurodevelopment: How and why. *Developmental Cognitive Neuroscience, 54,*101073. DOI: 10.1016/j.dcn.2022.101073. LINK

2021 Waschke L, **Donoghue T**, Fiedler L, Smith S, Garrett DD, Voytek B & Oblesser J. Modality-specific tracking of attention and sensory statistics in the human electrophysiological spectral exponent. *eLife.* DOI: 10.7554/eLife.70068. LINK

2021 **Donoghue T**, Voytek B, & Ellis S. Teaching Creative and Practical Data Science at Scale. *Journal of Statistics and Data Science Education, 29*(sup1), S27-S39. DOI: 10.1080/10691898.2020.1860725. LINK

2020 **Donoghue T**, Haller M, Peterson EJ, Varma P, Sebastian P, Gao R, Noto T, Lara AH, Wallis JD, Knight RT, Shestyuk A & Voytek B. Parameterizing Neural Power Spectra into Periodic and Aperiodic Components. *Nature Neuroscience, 23.* DOI: 10.1038/s41593-020-00744-x. LINK
Media coverage: Quanta Magazine; reprinted in Wired

2020 **Donoghue T**, Dominguez J & Voytek B. Electrophysiological Band Ratio Measures Conflate Periodic and Aperiodic Activity. *eNeuro, 7*(6). DOI: 10.1523/eneuro.0192-20.2020. LINK

2019 Robertson MM, Furlong S, Voytek B, **Donoghue T**, Boettiger CA, & Sheridan MA. EEG Power Spectral Slope Differs by ADHD Status and Stimulant Medication Exposure in Early Childhood. *Journal of Neurophysiology, 122*(6). DOI: 10.1152/jn.00388.2019. LINK

2019 **Donoghue T**. LISC: A Python Package for Scientific Literature Collection and Analysis. *Journal of Open Source Software, 4*(41), 1674. DOI: 10.21105/joss.01674. LINK

2019 Cole S, **Donoghue T**, Gao R & Voytek B. NeuroDSP: A Package for Neural Digital Signal Processing. *Journal of Open Source Software, 4*(36), 1272. DOI: 10.21105/joss.01272. LINK

Book Chapters

upcoming **Donoghue T** & Watrous A. How can we differentiate narrow-band oscillations from aperiodic activity? In *Intracranial EEG for Cognitive Neuroscience*. Editor: Nikolai Axmacher, New York (USA): Springer Press. Preprint: *PsyArXiv*. DOI: 10.31234/osf.io/k6nhd. LINK

Conference Proceedings (Peer Reviewed Papers - Selected)

Underlined are research assistants under my direct supervision.

2019 **Donoghue T**, Gao R, Waschke L & Voytek B. A Simulation-Based Comparison of Methods for Analyzing Aperiodic Neural Activity. *Cognitive Computational Neuroscience*. LINK

2018 Fox W, **Donoghue T**. Confidence Levels in Scientific Writing: Automated Mining of Primary Literature and Press Releases. *Proceedings of the Cognitive Science Society*. LINK

2017 Gao R, **Donoghue T** & Voytek B. Automated Generation of Cognitive Ontology via Web Text-Mining. *Proceedings of the Cognitive Science Society*. LINK

Conference Presentations

12/2022 **Investigators Workshop Presenter:** Extracting neural signals from noise.
American Epilepsy Society Meeting, Nashville, TN, USA.
Award: funding provided for attendance to the conference

11/2022 **Short Talk:** Single neurons in the human medial temporal lobe engage in distinct aspects of different tasks. *Human Single Neuron Meeting*, Los Angeles, CA, USA.

11/2018 **NanoSymposium Presentation:** Parameterizing Neural Power Spectra
Society for Neuroscience Conference, San Diego, CA, USA.

1/2016 **Research Talk:** The Effect of Oscillatory Phase on Perception and Cognition
Temporal Dynamics of Learning Centre - All Hands Meeting, San Diego, CA, USA.

Interactive Workshops

3/2019 **New Methods for Analyzing Periodic Oscillations and Aperiodic 1/f in Electrophysiology**
Cognitive Neuroscience Society Conference, San Francisco, CA, USA.
Developed & lead an interactive workshop covering software tools for neural data analysis.

2013 - 2015 **Brainstorm Software for M/EEG Analyses**
Assisted with interactive workshops for the Brainstorm toolbox [3 workshops].

Research Presentations (Invited)

3/2022 - **Separating periodic and aperiodic activity to investigate physiology, cognition, & disease**
Cognitive Brown Bag, Center for Cognitive Neuroscience, Dartmouth University [in person - 3/2022]
Psychology Seminar Series, Psychology Department, University of Salzburg [virtual - 3/2022]

2020 - **Investigating Periodic & Aperiodic Neural Activity** (Guest Talks - University & Companies)
University: invited talks to group meetings & journal clubs (virtual) [8 talks up to 03/2022]
Company: Friday Talk Series, Beacon Biosignals (virtual) [10/2021]

11/2018 **Simulation-Driven Methods Development** (Seminar Talk - University)
Cognition at the Shore Talk Series, Department of Cognitive Science, UC San Diego

08/2018 **Fitting Oscillations & One-Over F and Other Things** (Invited Seminar - Company)
Interaxon, Toronto, Canada

Conference Abstracts & Posters (Selected)

Underlined are students or research assistants under my direct supervision.

2022 **Donoghue T**, Kleen JK, Voytek B, Jacobs J. Methodological considerations for examining spectral features in epilepsy. *American Epilepsy Society Meeting*, Nashville, TN, USA. LINK

2022 Maesta Pereira S*, **Donoghue T***, Qasim SE, Patel A, Azab H, Smith EH, Mathura R, Myers J, Anand A, Adkinson J, Davis TS, Shofty B, Kurth-Nelson Z, Rey HG, Rolston JD, Behrens TEJ, Botvinick M, Sheth SA, Jacobs J. Conjunctive encoding in human place and time cells. *Human Single Neuron Meeting,* Los Angeles, CA, USA. LINK
Also presented at: *Society for Neuroscience,* San Diego, CA, USA.

2022 **Donoghue T***, Cao R*, Han CZ*, Holman C, Brandmeir NJ, Wang S, Jacobs J. Single neurons in the human medial temporal lobe engage in distinct aspects of different tasks. *Human Single Neuron Meeting,* Los Angeles, CA, USA. LINK
Also presented at: *Society for Neuroscience,* San Diego, CA, USA.

2021 **Donoghue T**, Qasim SE, Patel A, Azab H, Smith EH, Mathura R, Myers J, Anand A, Atkinson J, Rey HG, Rolston JD, Behrens TEJ, Botvinich M, Sheth SA, Jacobs J. Human single neuron activity encodes future trajectories. *Society for Neuroscience*, Virtual.

2020 **Donoghue T** & Voytek B. Considerations for Detecting & Measuring Neural Oscillations. *LiveM/EEG (Cutting EEG)*, Virtual Conference. LINK

2019 Farnan T, **Donoghue T**, & Voytek B. Evaluating Spectral Estimation Methods for Time-Resolved Measurement of Aperiodic Activity. *Society for Neuroscience*, Chicago, IL, USA. LINK

2019 Zhang F, **Donoghue T**, & Voytek B. Comparing the Effects of Pre-Stimulus Periodic and Aperiodic Activity on Post-Stimulus Event Related Potentials. *Society for Neuroscience*, Chicago, IL, USA. LINK

2019 Waschke L, **Donoghue T**, Smith S, Voytek B & Obleser J. Tracking of 1/f Stimulus Characteristics in the Human EEG. *Society for Neuroscience*, Chicago, IL, USA.

2019 **Donoghue T**, Gao R, Waschke L & Voytek B. A Simulation-Based Comparison of Methods for Analyzing Aperiodic *Neural* Activity. *Cognitive Computational Neuroscience,* Berlin, Germany. LINK

2019 Dominguez J, **Donoghue T**, & Voytek B. Electrophysiological Frequency Band-Ratio Measures Conflate Changes in Periodic and Aperiodic Features. *Cognitive Neuroscience Society*, San Francisco, CA, USA. LINK

2018 Mdanda L, **Donoghue T**, & Voytek B. Parameterization of Periodic and Aperiodic Human Electrophysiology Reveals Greater Between- Than Within-Subject Variability. *Society for Neuroscience*, San Diego, CA, USA. LINK

2018 **Donoghue T**, Sebastian P, & Voytek B. Topographical Analysis of Electrophysiological 1/f and Oscillations Reveals Patterns of Spatial Variation. *International Conference on Biomagnetism*, Philadelphia, PA , USA. LINK

2018 **Donoghue T**, Sebastian P, Noto T, Haxby S & Voytek B. Integrating Human Electrophysiology, Gene Expression and Functional Data. *Neuroinformatics*, Montreal, QC, Canada. LINK

2018 Fox W, **Donoghue T**. Confidence Levels in Scientific Writing: Automated Mining of Primary Literature and Press Releases. *Cognitive Science*, Madison, WI, USA. LINK

2018 **Donoghue T** & Voytek B. Alpha Power and 1/f Slope Provide Independent Decoding of Visual Spatial Attention. *Cognitive Neuroscience Society*, Boston, MA, USA. LINK

2018 Gao R, **Donoghue T** & Voytek B. Defining Cognition: Automated Generation of Cognitive Ontology by Text-Mining Literature. *Cognitive Neuroscience Society*, Boston, MA, USA.

2017 Waschke L, **Donoghue T,** Obleser J & Voytek B. Attention-Modulated Tracking of 1/f Stimulus Characteristics in Human EEG. *Signals & Noise in the Auditory Pathway*, Lübeck, Germany.

2017 **Donoghue T** & Voytek B. Assessing approaches for estimating the electrophysiological 1/f background spectrum. *Society for Neuroscience*, Washington DC, USA. LINK

2017 **Donoghue T** & Voytek B. Automated meta-analysis of event-related potentials and their correlates by text-mining. *Cognitive Neuroscience Society*, San Francisco, CA, USA. LINK
Award: graduate student award winning poster including a 500$ travel award

2016 **Donoghue T**, Fox W, Kim A, & Voytek B. The relation of oscillatory-phase to visual perception depends on attention & location of stimuli. *Society for Neuroscience*, San Diego, CA. LINK

2016 Sebastian P, **Donoghue T**, Noto T, Haxby S, & Voytek B. Data mining to generate novel hypotheses for the genetic underpinnings and functional roles of cortical oscillations. *Society for Neuroscience*, San Diego, CA, USA. LINK

2016 **Donoghue T**, Sebastian P, & Voytek B. Automated Analysis of Resting State Cortical Oscillatory Characteristics using Magnetoencephalography. *International Conference on Biomagnetism*, Seoul, South Korea. LINK

2015 Gougelet R, **Donoghue T,** Piper M, Althoff A, Urbach TP, & Voytek B. Influencing Visual Target Detection with Oscillatory Phase-Specific Stimulus Presentation. *Society for Neuroscience*, Chicago, IL, USA. LINK

Honors & Awards

2022 **Trainee Professional Development Award, Society for Neuroscience (SfN)**
Merit based award for SfN conference registration and travel funds (1000$).

2017 - 2019 **Travel Awards, UC San Diego, Graduate Student Association (GSA)**
Travel awards for conferences, from the GSA (2X) and from departmental funds.

1/2016 **Small Grants Award, Temporal Dynamics of Learning Centre (TDLC)**
2,200$ USD funding for an EEG project on the temporal dynamics of perceptual learning.

3/2014 **Owens Scholar Award, Johns Hopkins University** (*declined*)
18 000$ USD additional funding over 3 years offered with admission to Johns Hopkins.

11/2013 **Samuel de Champlain Quebec Program for International Collaboration**
Funds provided by my research supervisor (Dr. Baillet) for travel to NeuroSpin in France.

Academic Activities: Reviewing

**Includes article co-reviewed with a research supervisor. #Includes code review.*

Journal Articles (Ad-Hoc Reviewer)

The American Journal of Psychiatry (1X); Behavior Research Methods (1X); Biological Psychology (1X); Clinical Neurophysiology (1X); Developmental Cognitive Neuroscience (1X); eLife (1X); eNeuro (1X); European Journal of Neuroscience (1X); F1000 Research (1X); Human Brain Mapping (*1X); Journal of Neurophysiology (*1X); Journal of Neural Engineering (1X); Journal of Neuroscience (1X); Journal of Open Source Education (#3X); Journal of Open Source Software (#4X); Mindfulness (1X); Neurobiology of Aging (*2X); Neurobiology of Disease (1X); NeuroImage (4X); Open Journal of Signal Processing (1X); SoftwareX (1X); PLoS Computational Biology (3X); PLoS Biology (1X); Psychophysiology (1X); ReScienceC (#1X);

Conference Proceedings

Affective Computing & Intelligent Interaction (ACII 2019: 1 paper); Cognitive Computational Neuroscience (CCN 2019: 6 papers);

Books

Columbia Press (1X);

Research Mentorship

Students under my direct mentorship. Awards are where I supervised the application and project.

PhD Students:

Mohamed Ameen	11/2022 - current	
Sandra Maesta Pereira	09/2021 - *current*	
Zhixian (Claire) Han	09/2021 - *current*	

Masters Student Research Assistants:

Tyler Farnan	01/2019 - 03/2021	

Undergraduate Research Assistants:

Fenglin (Allen) Zhang	01/2019 - 03/2021	
Julio Dominguez	06/2018 - 01/2020	TRELS Scholarship
Luyanda Mdanda	10/2016 - 01/2020	HDSI Undergrad Fellowship
Meyhaa Buvanesh	04/2019 - 06/2019	
Lakshmi Menon	04/2019 - 09/2019	
Fiona Cisternas	01/2019 - 06/2019	HDSI Undergrad Fellowship
Priyadarshini Sebastian	10/2015 - 06/2018	FISP Trainee Award
Aeri Kim	10/2015 - 12/2016	
Will Fox	06/2015 - 06/2018	

Computational Skills & Contributions

Languages Fluent in **Python**, **shell** scripting (bash) & **git**, intermediate in **Matlab** and **R**.

Packages **specparam** (formerly 'fooof'): Spectral Parameterization (Github - PYPI - Documentation)
Lead Developer - Python package for parameterizing neural power spectra.

neurodsp: Neuro Digital Signal Processing (Github - PYPI - Documentation)
Co-Developer - Python package for analyze neural electrophysiological recordings.

lisc: Literature Scanner (Github - PYPI - Documentation)
Lead Developer **-** Python package for collecting and analyzing the scientific literature.

spiketools: Analysis of spiking data (Github - PYPI - Documentation)
Lead Developer - Python package for analyzing single-unit neural data.

Github Code & open-source contributions are available on my Github profile and indexed here.
Example contributed projects: bycycle, spikeinterface, pynwb, nwbwidgets.

Resource Contributions

The following are open source / open access resources that I have created and made public.

SigViz: animated signal visualizers for exploring signal processing (Github - Website)
This resources includes novel animations to explain signals and topics such as filtering.

OpenLists: open lists of open resources (Github - Website)
This collection curates open resources, including open-access data & open-source tools.

StructuredScience: templates & resources for organizing scientific projects (Github - Website)
This resource curates templates for creating organized and standardized project structures.

Science Outreach

2022 - **Mentoring: Student Mentor for High-School Summer Internship**
Mentor for the Brainyac program, offering intensive summer internships to young students.

2020 - **Mentoring: Project Guidance & Assistance with Grad School Applications**
Organizations include: Cientifico Latino, neuromatch

2018 - **Public Workshops & Presentations**
10/2018: Data Wrangling & Web Scraping: 2 hr workshop with SCALE-SD. *Materials* - *Media*

2013 - **Volunteer Tutoring & School Presenter**
Tutoring, presentations, science fair judging, and miscellaneous volunteering.
Organizations include: Brain Awareness**,** San Diego Science Fair**,** San Diego Refugee Tutoring

1/2014 - 1/2017 **Science Writer / Editor / Podcast Host, Useful Science Organization** (usefulscience.org)
Writing clear, concise and useful summaries of scientific research for a general audience.

Training in Teaching

Formal training in teaching and related topics.

2018 **Introduction to College Teaching**, Teaching & Learning Commons, UC San Diego
Semester long course on evidence-based teaching in university contexts.

2017 **Equity, Diversity, and Inclusion in Postsecondary Education**, UC San Diego Extension
Course on best practices for inclusive & equitable teaching in university contexts (10 hrs).

Teaching Experience

2018 **Instructor-of-Record**, Department of Cognitive Science, UC San Diego
COGS 18: Introduction to Python (30 hours lecture + coding labs; 200 undergrad students)
Developed & taught a course teaching introductory Python programming. Materials: LINK

2017 - 2020 **Instructor (3X)**, Clubes de Ciencia Mexico
Clubes de Ciencia is a non-profit organization promoting science education across Mexico.
1 week, hands-on research focused courses (25 hours of instruction; 12-18 students / year)
- *CdeCMx Challenge: Soluciones cientificas a problemas emergentes* (online, Aug. 2020)
- *Inteligencia Biologica & Artificial: Amigos o Enemigos?* (Ensenada, Mexico, Aug. 2019)
- *Bots on the Brain: Cognitive Science & Bio-Inspired Robotics* (Monterrey, Mexico, Aug. 2017)

2015 - 2017 **Instructor (3X)**, Academic Connections, UC San Diego
Academic Connections offers university-level courses to advanced high school students.
Co-developed & taught a course introducing cognitive science. Materials: LINK
Introduction to Cognitive Science (75 hours of instruction; 16-24 students / year)
Ratings: Course {4.71, 4.80, 4.59}/5; Instructor: {4.86, 4.92, 4.92}/5; Years: {2015, 2016, 2017}.

2015 - 2018 **Teaching Assistant (7X),** Department of Cognitive Science, UC San Diego
COGS 108: Data Science in Practice (Winter '18, Prof. Bradley Voytek, TA Evals: 4.31/5)
COGS 108: Data Science in Practice (Spring '17, Prof. Bradley Voytek, TA Evals: 4.32/5)
COGS 107B: Systems Neuroscience (Winter '17, Prof. Douglas Nitz, TA Evals: 4.60/5)
COGS 17: Neurobiology of Cognition (Winter '16, Dr. Christine Johnson, TA Evals: 4.58/5)
COGS 9: Introduction to Data Science (Fall '15, Prof. Bradley Voytek, TA Evals: 4.34/5)
COGS 3: Introduction to Computing (Spring '15, Prof. Bradley Voytek, TA Evals: 4.54/5)
Awarded *Excellence in Teaching* Award from the UCSD Cognitive Science Dept.
COGS 107B: Systems Neuroscience (Winter '15: Prof. Douglas Nitz, TA Evals: 4.69/5)
Awarded *Outstanding Teaching* Award from the UCSD Cognitive Science Dept.

Educational Materials

Openly available educational materials that I have created and/or contributed to.

Introductory Python, openly available online course
Materials for learning introductory programming in Python (Website - Source).

Data Science in Practice, openly available online course
Materials for learning introductory data science in Python (Website - Source).

Tutorials, openly available tutorial materials online course
Python Boot Camp: Open materials for a graduate student bootcamp. LINK
Electrophysiology Tutorials: Materials for getting started with M/EEG analyses. LINK