

The physiology and function of aperiodic neural activity

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Abstract: Perception, action, and cognition depend upon coordinated neural activity. This coordination operates within noisy, distributed neural networks, which themselves change with development, aging, and disease. Extensive field potential and EEG research shows that neural oscillations interact with neuronal spiking. This interaction has been proposed to be a mechanism for implementing dynamic coordination between brain regions, placing oscillations at the forefront of neuroscience research. Our work challenges our conception of what an oscillation even is. Beginning from basic theory and modeling, we show that traditional analyses conflate non-oscillatory, aperiodic activity with oscillations. To do this, we leverage neural modeling and a breadth of empirical data—spanning human iPSC-derived cortical organoids, animal electrophysiology, invasive human EEG, and large-scale data mining. We show that, while not all things that appear oscillatory are so, the physiological information we can extract from the local field potential and EEG may nevertheless be far richer than previously thought, including nonsinusoidality of oscillation waveform shape and the aperiodic signal.



Bio: Bradley Voytek is a Professor in the Department of Cognitive Science, the Halıcıoğlu Data Science Institute, and the Neurosciences Graduate Program at UC San Diego. He's an Alfred P. Sloan Neuroscience Research Fellow and a Kavli Fellow of the National Academies of Sciences, as well as a founding faculty member of the UC San Diego Halıcıoğlu Data Science Institute and the Undergraduate Data Science program. After his PhD at UC Berkeley, he joined Uber as their first data scientist—when it was a 10-person startup—where he helped build their data science strategy and team. His research lab combines large-scale data science and machine learning to study how brain regions communicate with one another, and how that communication changes with aging and disease. He is an advocate for promoting

science to the public and speaks extensively with students at all grade levels about the joys of scientific research and discovery. In addition to his academic publications, his outreach work has appeared in outlets ranging from Scientific American and NPR to the San Diego Comic-Con. He is currently writing a book with neuroscientist Ashley Juavinett regarding the powerful future of data science in neuroscience discovery, though his most important contribution to science is his book with fellow neuroscientist Tim Verstynen, "Do Zombies Dream of Undead Sheep?", by Princeton University Press.

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