Brain oscillations and the importance of waveform shape

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BIOMAG 2018

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“Even though it may be possible to analyze the complex forms of brain waves into a number of different sine-wave frequencies, this may lead only to what might be term a “Fourier fallacy”" - Jasper (1948)

1:29 AM - 15 Jul 2018

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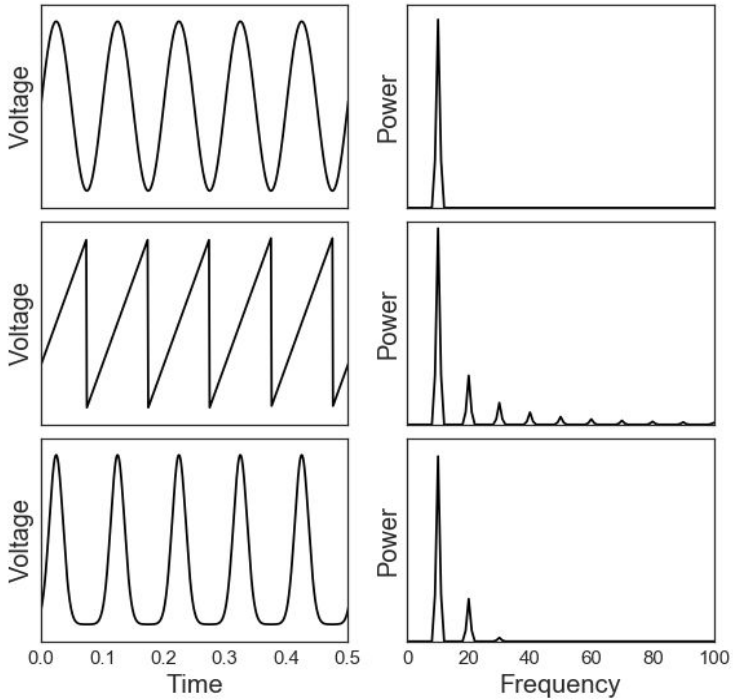
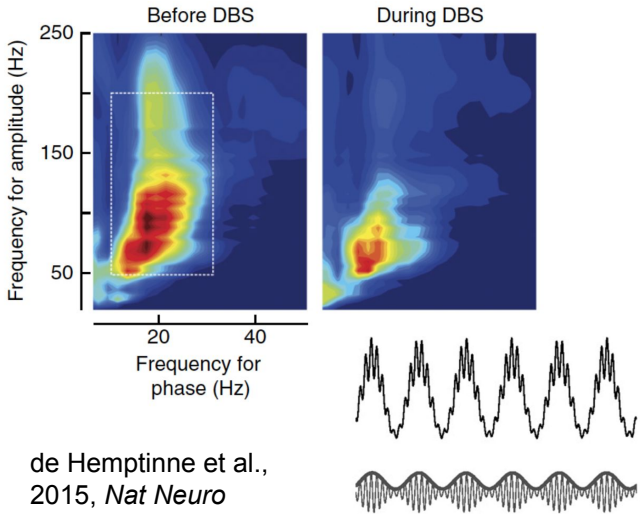


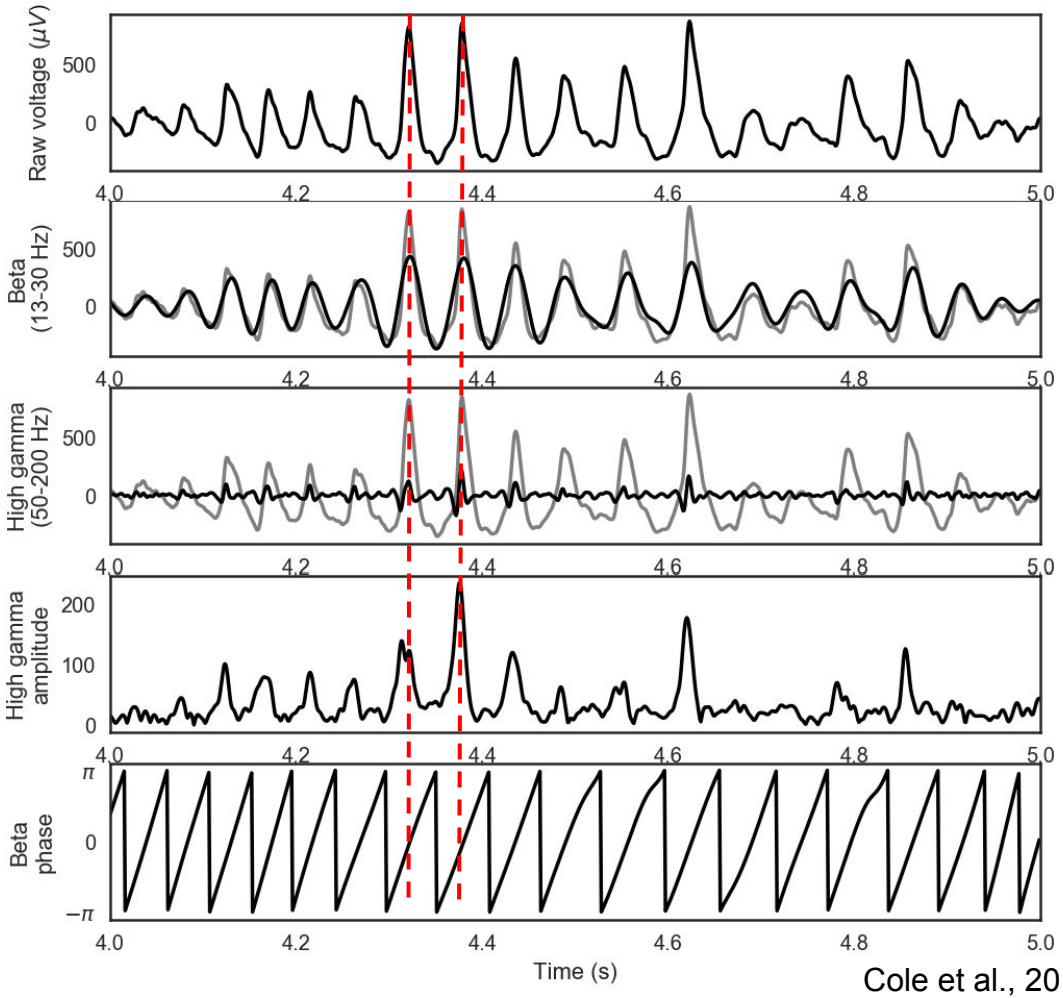


de Hemptinne et al., 2015, *Nat Neuro*

~~2 processes (beta, high gamma)~~

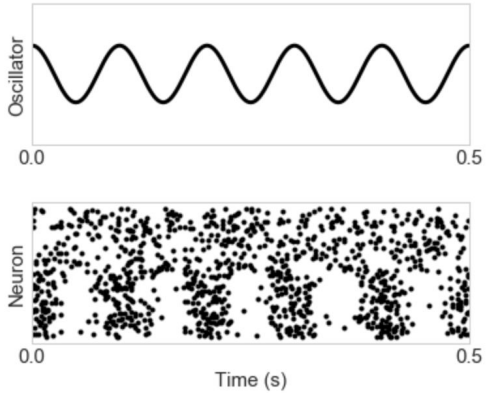
1 (nonsinusoidal) beta

Motor cortical ECoG, Parkinsonian

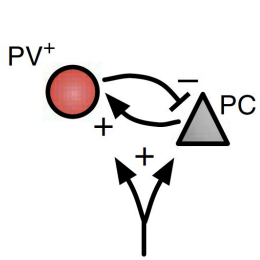


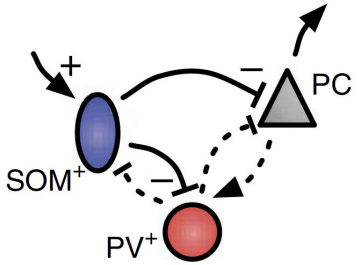
Cole et al., 2017

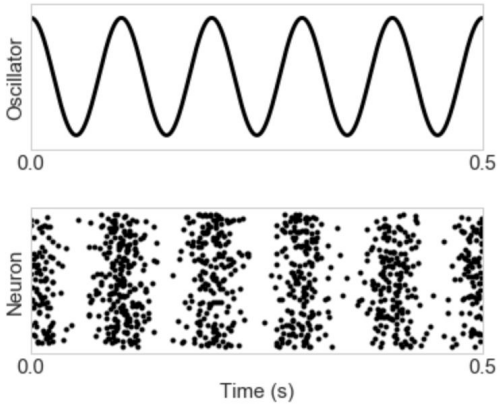
What might waveform shape reflect?

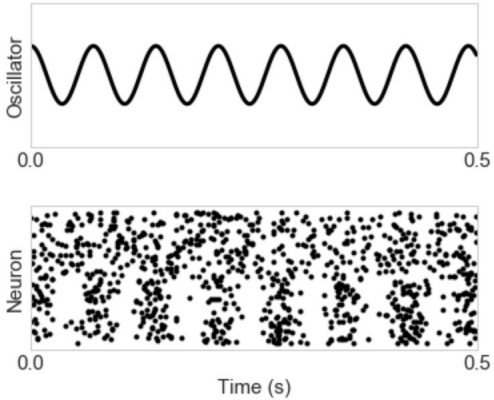


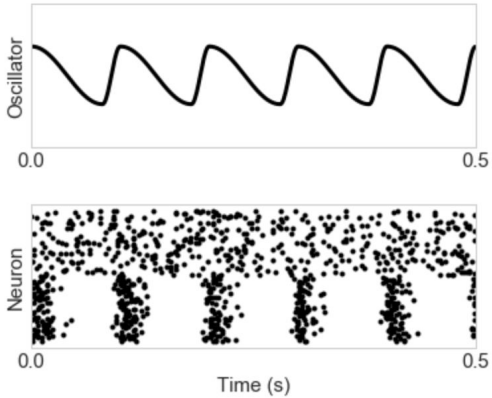
Womelsdorf et al., 2014



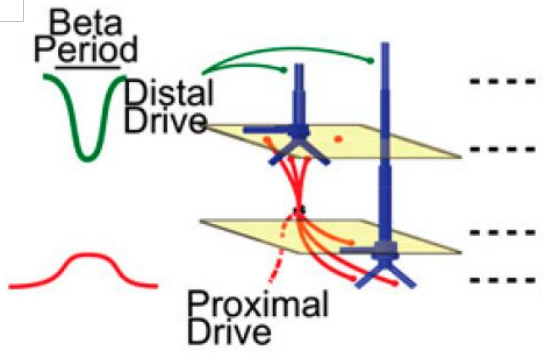


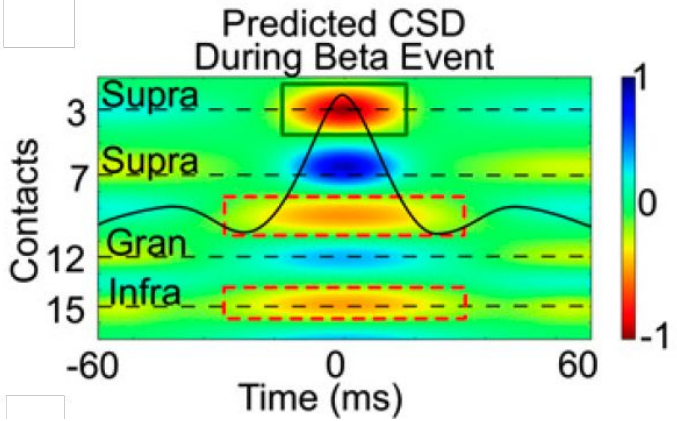


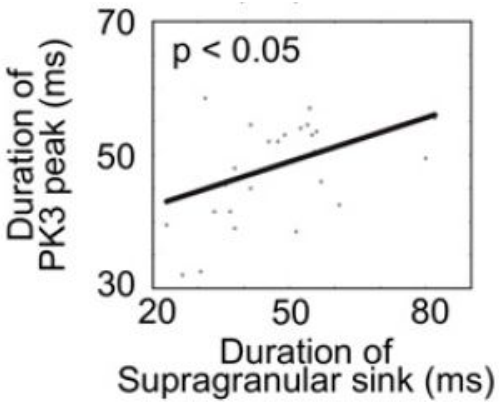




Sensorimotor beta sharpness ~ input synchrony

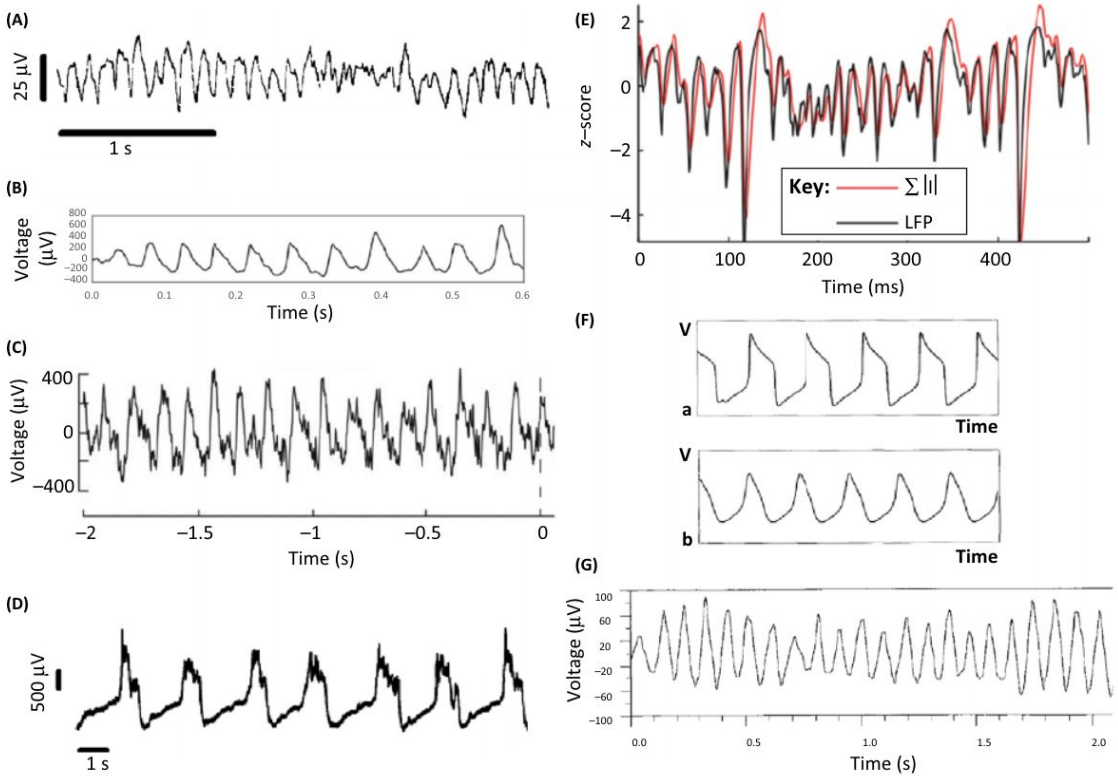






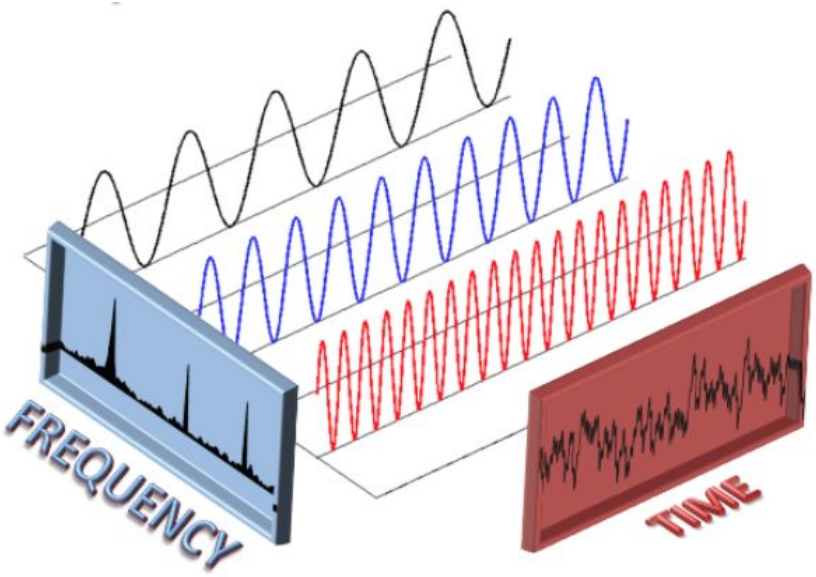
Sherman et al., 2016

Neural oscillation waveform shapes are diverse

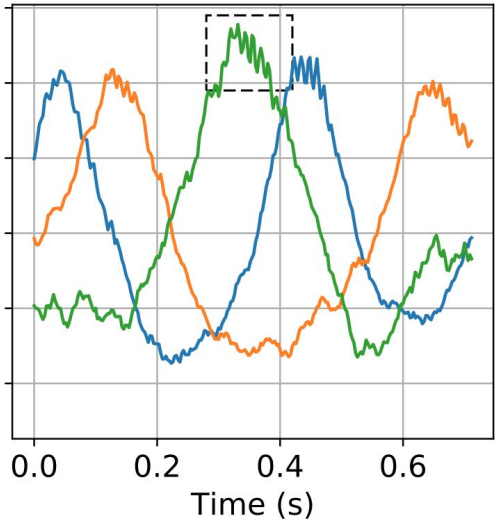


Cole & Voytek, 2017

How should we measure waveform shape?

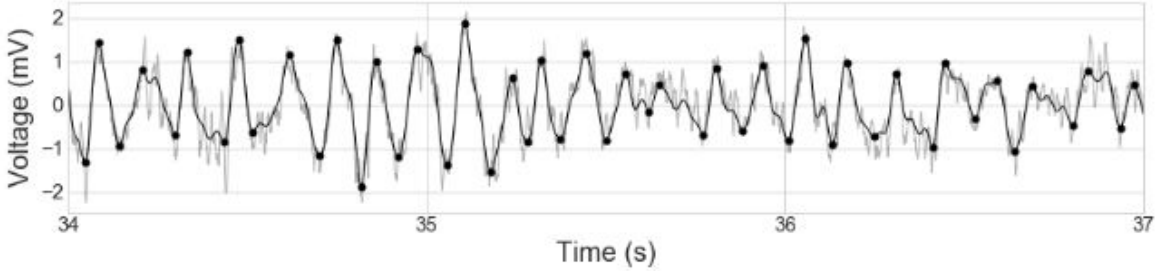


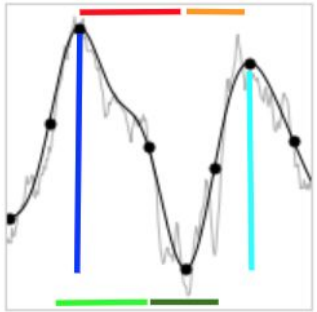
www.bsic.it



α-convolutional sparse coding
Jas et al., 2017

Cycle-by-cycle analysis



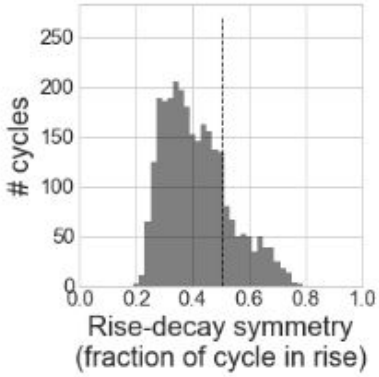


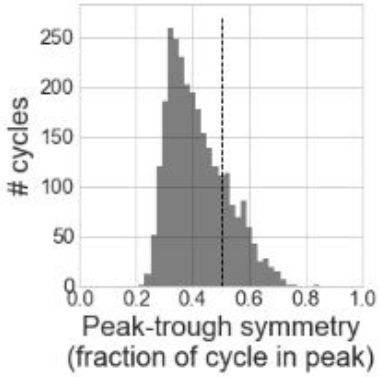
Amplitude = (| + |) / 2

Period = — + —

Rise-decay symmetry = — /(— + —)

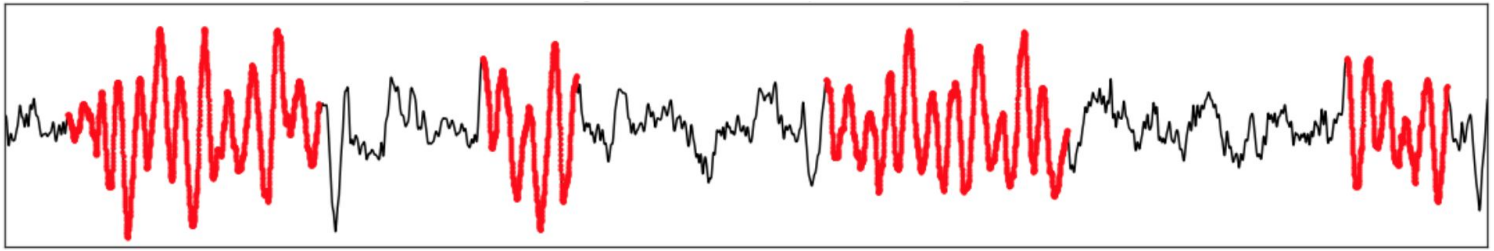
Peak-trough symmetry = — /(— + —)

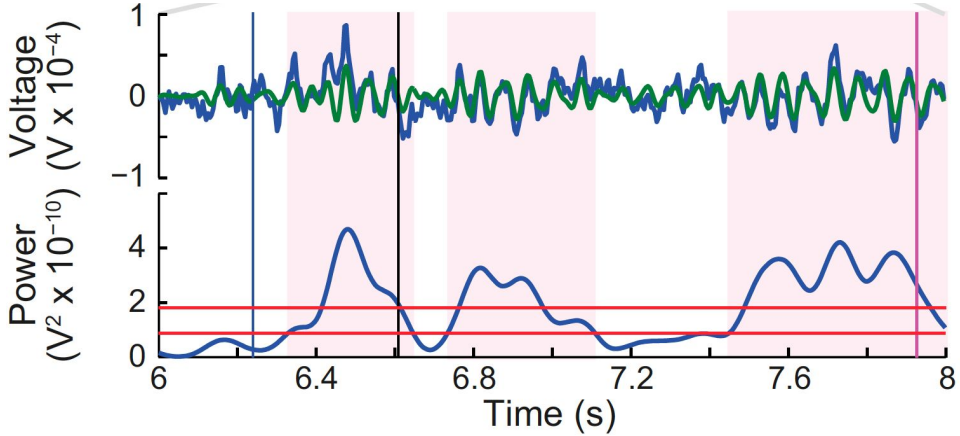




Cole & Voytek, 2018

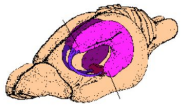
Burst detection





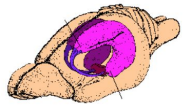
Feingold et al., 2015

What might waveform shape reflect?



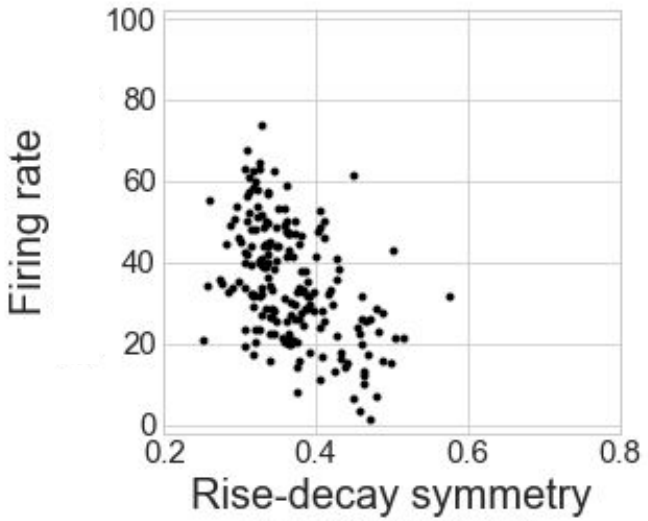
Data: CRCNS hc3,
Mizuseki et al., 2014

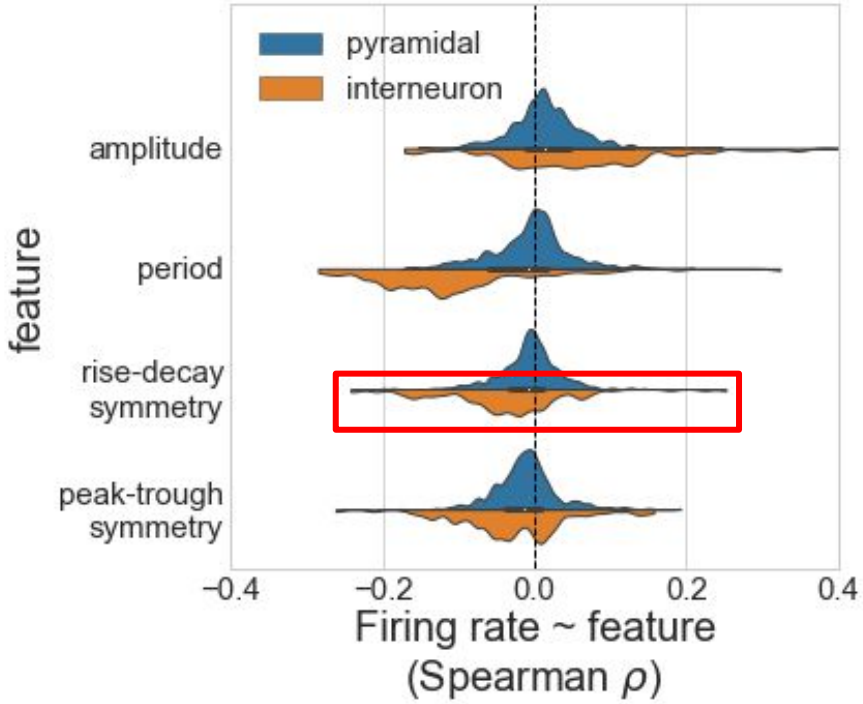
Waveform shape ~ local spiking pattern



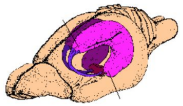
Data: CRCNS hc3,
Mizuseki et al., 2014

Waveform shape ~ firing rate



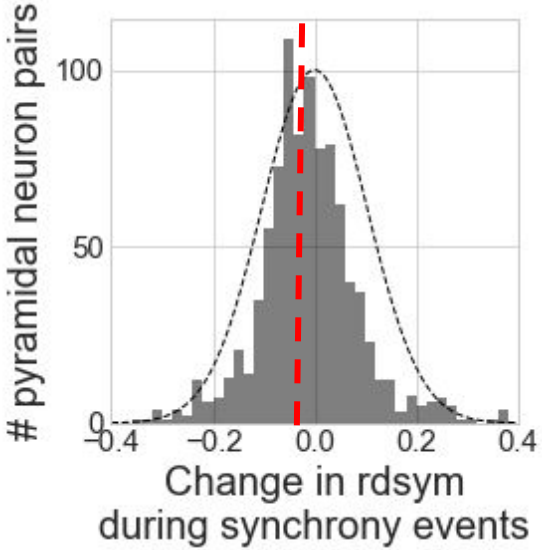


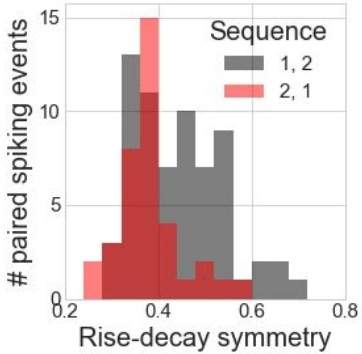
Cole & Voytek, in prep

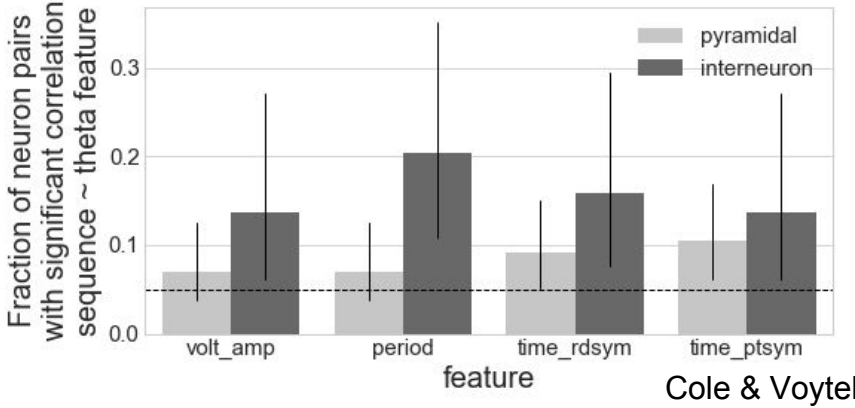


Data: CRCNS hc3,
Mizuseki et al., 2014

Waveform shape ~ synchrony and sequence

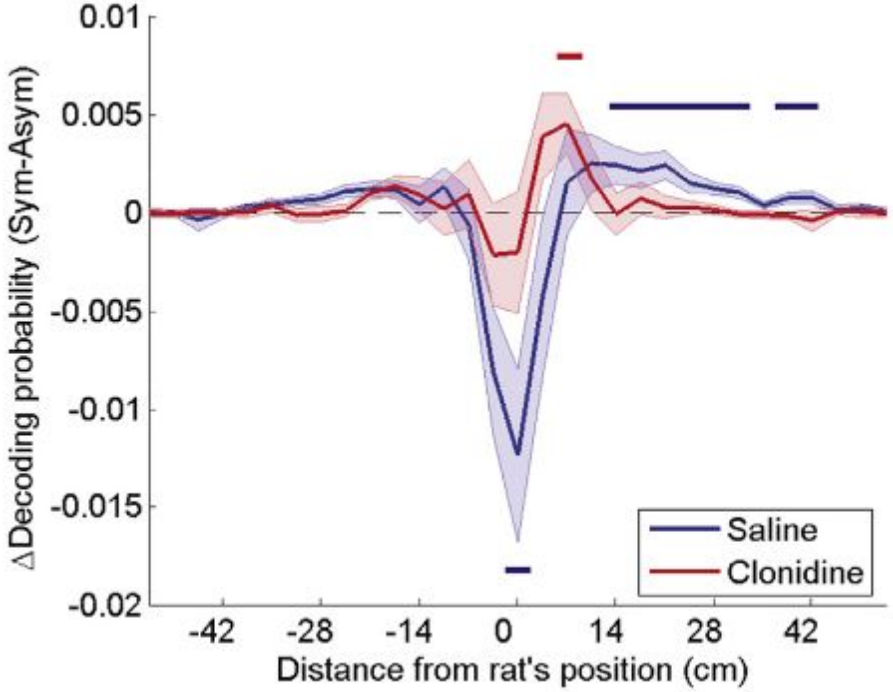






Cole & Voytek, in prep

Hippocampal theta asymmetry ~ representation



Amemiya & Redish, 2018

Summary

- Neural oscillations have diverse waveforms
- Require alternative analysis approaches
- Rodent hippocampal theta waveform ~ CA1 neuronal firing patterns

voytekresearch

Acknowledgements

Voytek lab

- Richard Gao
- Tammy Tran
- **Tom Donoghue**
- Roemer van der Meij
- Erik Peterson

1:30pm

“Large-scale topographical analysis of oscillations and 1/f background reveals patterns of spatial variation within and between subjects”

UC San Diego

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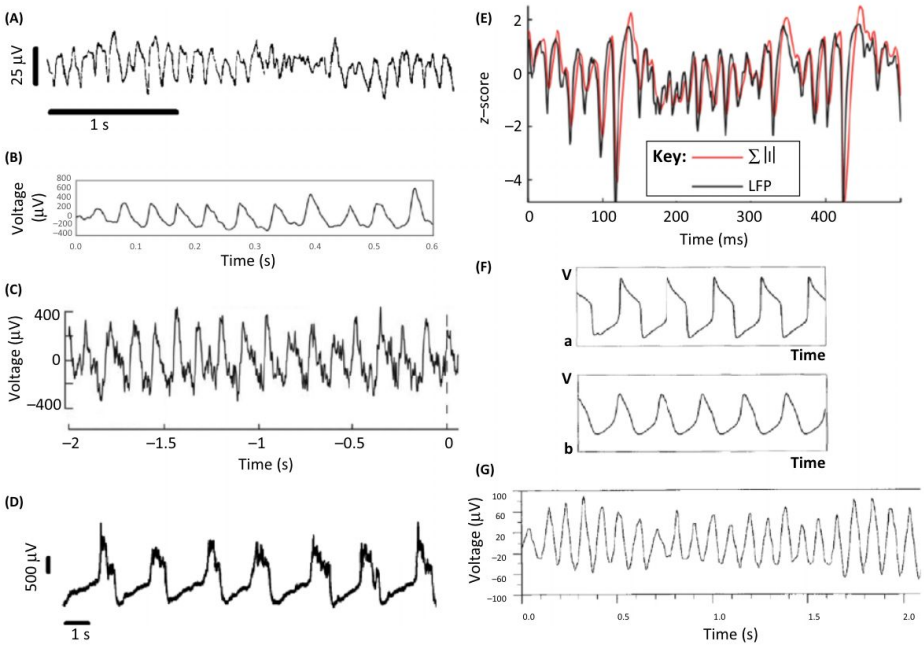
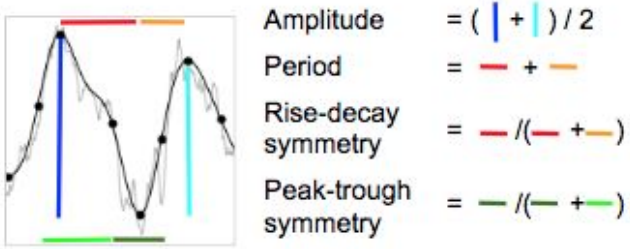
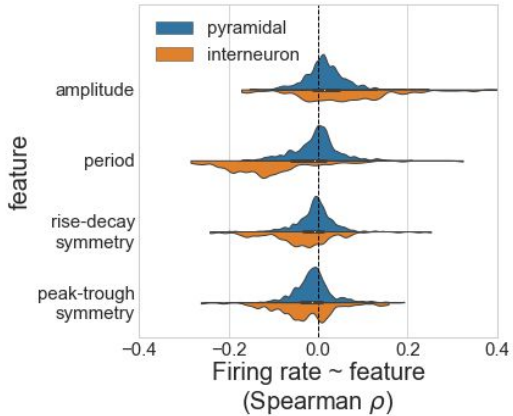
Information in waveform shape







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