Oscillations

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Contents

Cognition as brain rhythms

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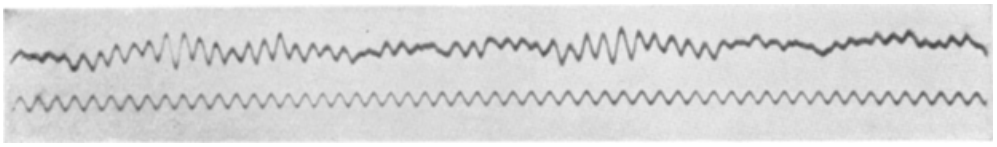
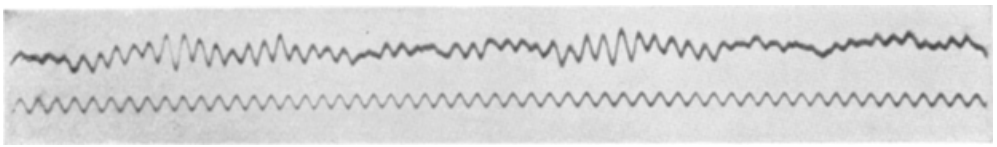
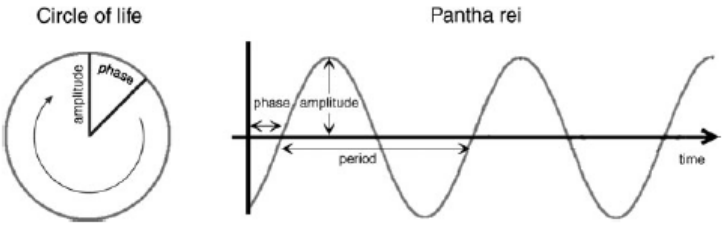


(Figure from Berger, 1929)

Cognition as brain rhythms

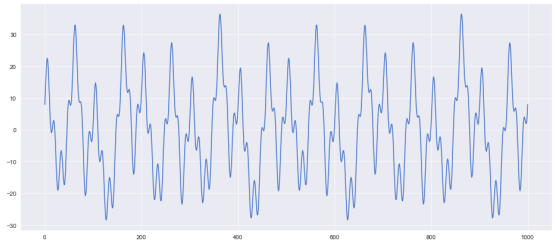


(Figure from Berger, 1929)



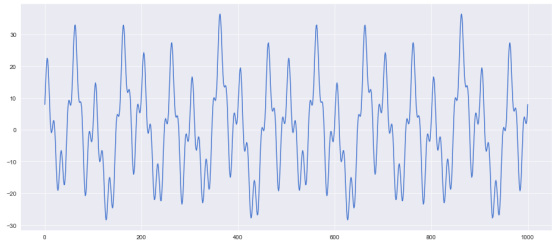
(Figure from Buzsáki, 2006)

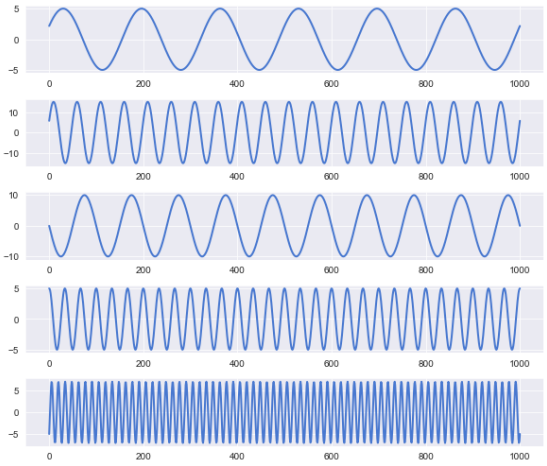
Sine waves



(Figure from https://github.com/lyndond/Analyzing_Neural_Time_Series/blob/master/chapter11.ipynb)

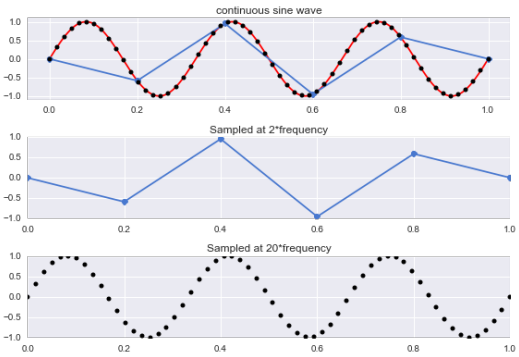
Sine waves





(Figure from https://github.com/lyndond/Analyzing_Neural_Time_Series/blob/master/chapter11.ipynb)

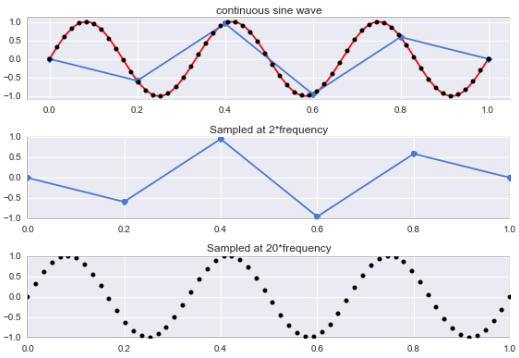
Sampling rate matters



(Figure from

https://github.com/lyndond/Analyzing_Neural_Time_Series/blob/master/chapter06.ipynb)

Sampling rate matters

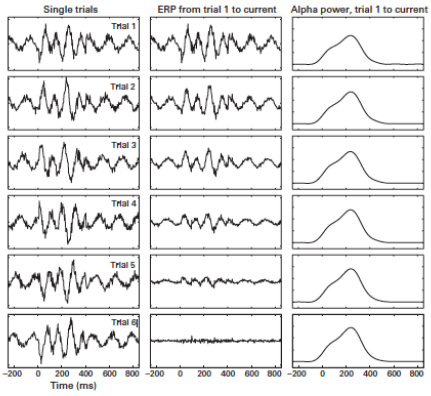


- **Nyquist frequency** is half of the temporal sampling rate.
- **Rayleigh frequency** is the spacing between discrete frequencies

(Figure from

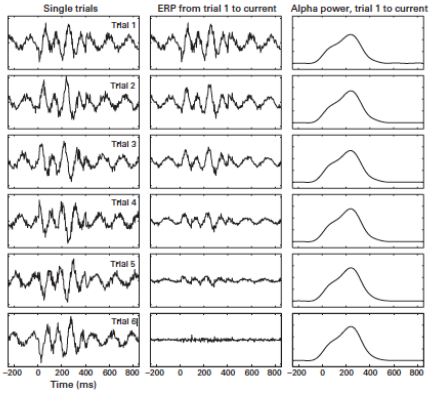
https://github.com/lyndond/Analyzing_Neural_Time_Series/blob/master/chapter06.ipynb)

Information in ERPs & Oscillations

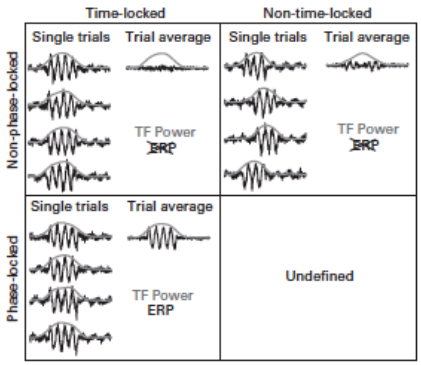


(Figure from Cohen, 2014)

Information in ERPs & Oscillations



(Figure from Cohen, 2014)



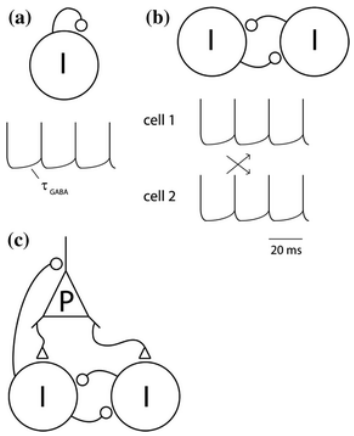
(Figure from Cohen, 2014)

Frequency bands

Name	Frequency range[1]
α (Alpha)	8 - 12 Hz
β (Beta)	14 - 30 Hz
γ (Gamma)	30 - 100 Hz
θ (Theta)	4 - 8 Hz
δ (Delta)	1 - 4 Hz

[1] As defined in Jensen et al., 2014

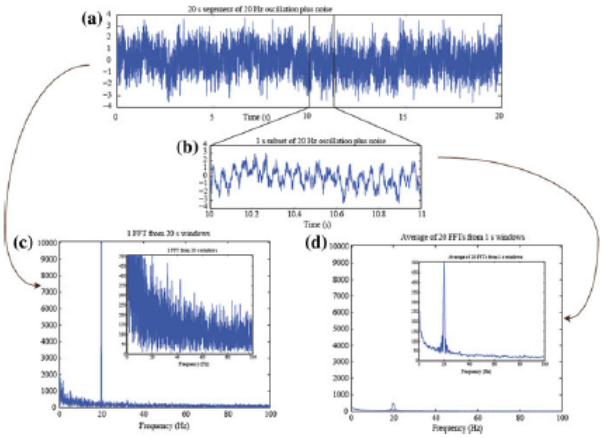
Physiological origin of oscillations



(Figure from Jensen et al., 2014)

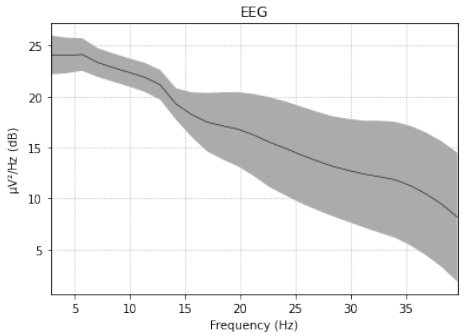
Quantifying brain waves

Power spectrum density

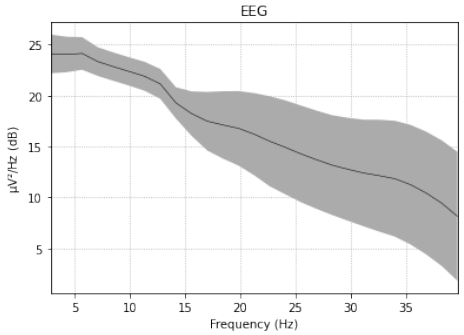


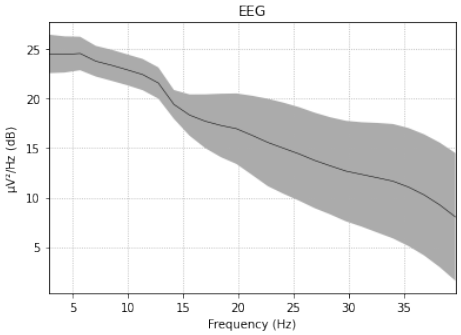
(Figure from Jensen et al., 2014)

Power spectrum density

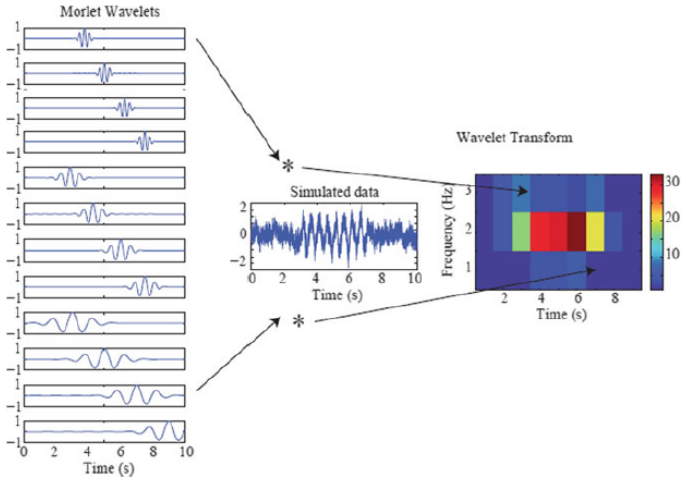


Power spectrum density





Wavelets



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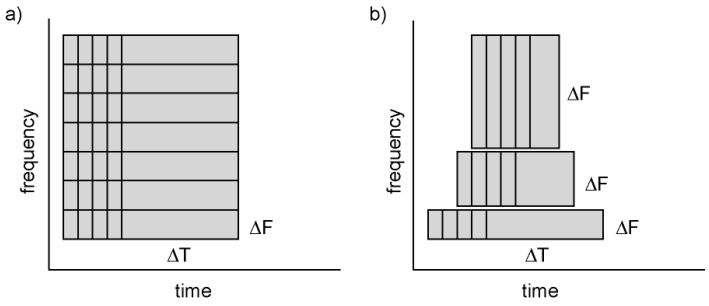
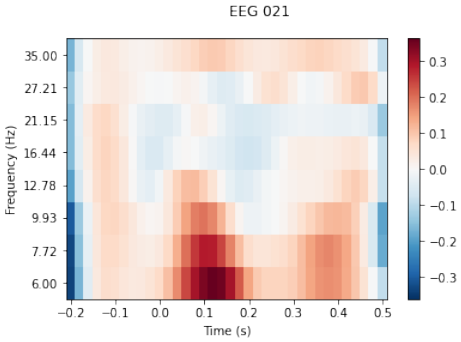
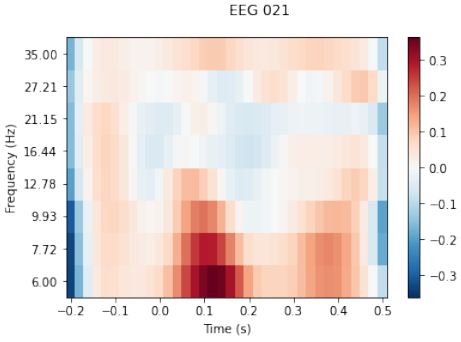


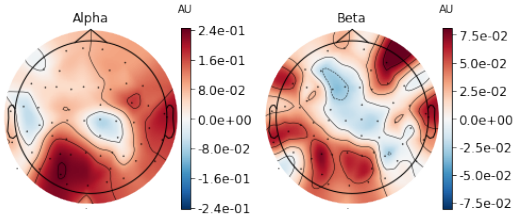
(Figure from http://www.fieldtriptoolbox.org/tutorial/timefrequencyanalysis/)

Wavelets



Wavelets





Hilbert transform

Hilbert transform

- Band pass filter for the frequency bands of interest

Hilbert transform

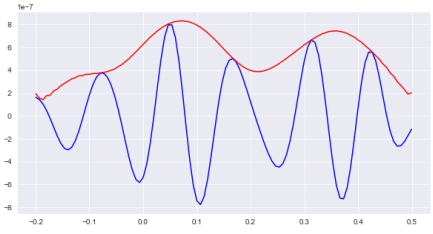
- Band pass filter for the frequency bands of interest
- Apply Hilbert transform

Hilbert transform

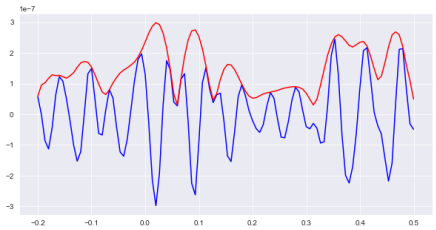
- Band pass filter for the frequency bands of interest
- Apply Hilbert transform
- Extract amplitute/power and/or phase

Hilbert transform

α

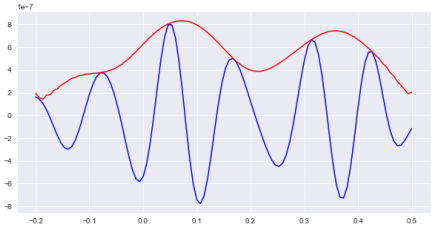


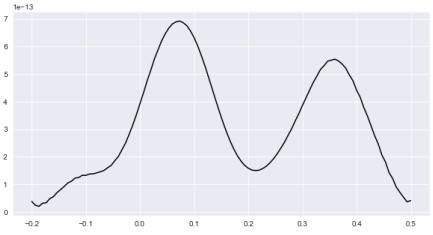
β



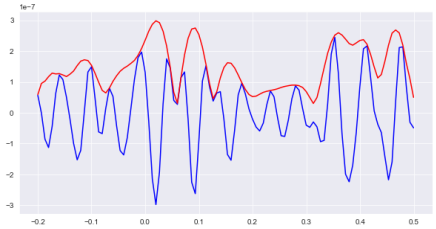
Hilbert transform

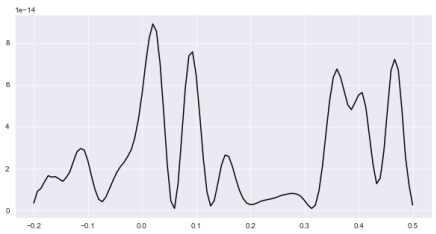
α





β

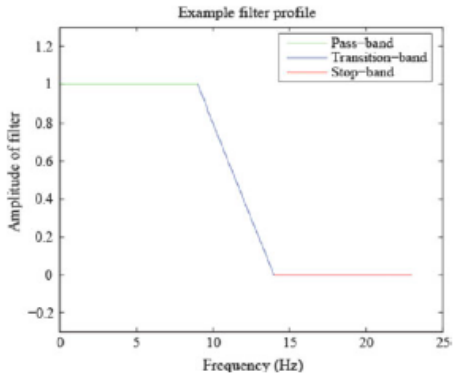




Frequency bands

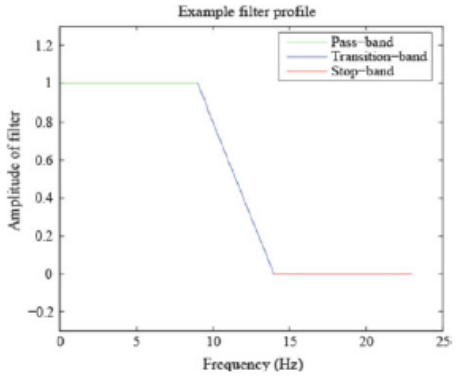
Name	Frequency range	Function
α (Alpha)	8-12 Hz	Inhibition Attention Inter-regional communication
β (Beta)	14 - 30	Sensory motor
γ (Gamma)	30 - 100 Hz	Information processing Feedforward-drive
θ (Theta)	4 -8 Hz	Error processing Inter-regional communication
δ (Delta)	1 - 4 Hz	Excitability of a network

Filters



(Figure from Jensen et al., 2014)

Filters




```
epochs_30.filter(0, 30)

Setting up low-pass filter at 30 Hz

FIR filter parameters
---------------------
Designing a one-pass, zero-phase, non-causal lowpass filter:
- Windowed time-domain design (firwin) method
- Hamming window with 0.0194 passband ripple and 53 dB stopband attenuation
- Upper passband edge: 30.00 Hz
- Upper transition bandwidth: 7.50 Hz (-6 dB cutoff frequency: 33.75 Hz)
- Filter length: 67 samples (0.446 sec)
```

(Figure from Jensen et al., 2014)

Gating by inhibition

Gating by inhibition

frontiers in
HUMAN NEUROSCIENCE

HYPOTHESIS AND THEORY ARTICLE
published: 04 November 2010
doi: 10.3389/fnhum.2010.00186

Shaping functional architecture by oscillatory alpha activity: gating by inhibition

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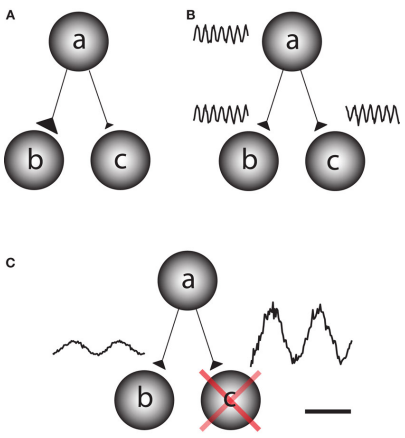
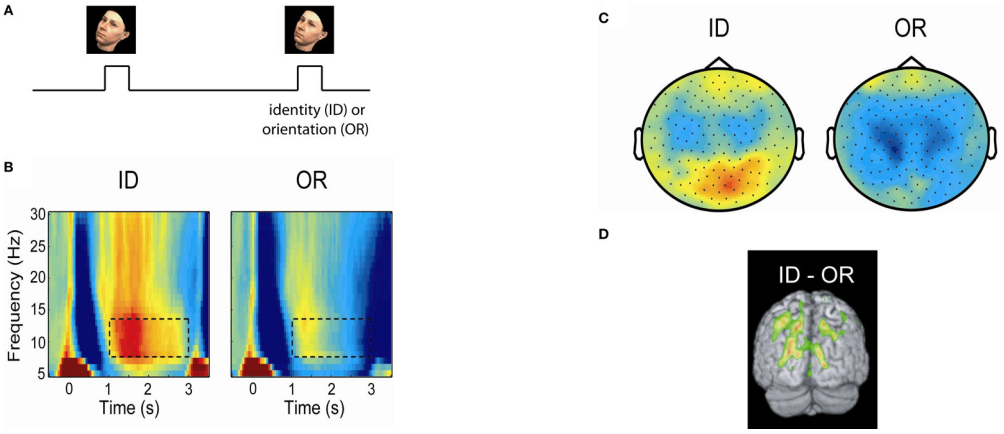
Donders Institute for Brain, Cognition and Behavior, Radboud University, Nijmegen, Netherlands

Gating information



(Figure from Jensen & Mazaheri, 2010)

Gating information



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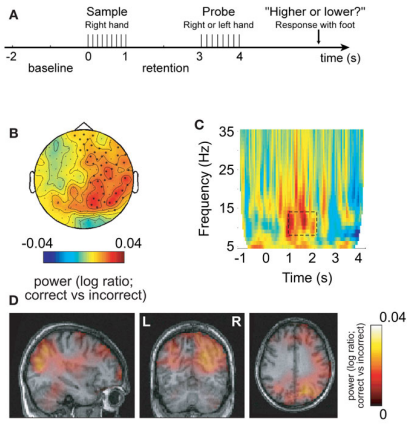
Gating information



(Figure from Jensen & Mazaheri, 2010)

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