FACULTY OF PSYCHOLOGY
AND EDUCATIONAL SCIENCES

PSYCHOLOGY – DEPT. OF DATA ANALYSIS

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PARAMETRIZATION OF POWER SPECTRA

TO BETTER UNDERSTAND COGNITIVE PROCESSES

0 My PhD research is part of the GOA-BOF project "Brain Interactions and Neural Dynamics (BIND)", which investigates memory and cognitive control using neuroimaging data.

Oscillations

1
- Neural oscillatory activity play an important role during maintaining and processing information on different scales
- a proposed mechanism for human flexibility (memory, attention) and cognitive control (Verguts, 2017)
- "when oscillations do exist, they often manifest as "bumps" on top of the 1/f slope in the power spectrum" (He, 2014)
- Non-oscillatory, 1/f-like activity in the background carries physiological information too (Voytek, 2015)
- oscillatory content of the signal may change during a cognitive task or resting state

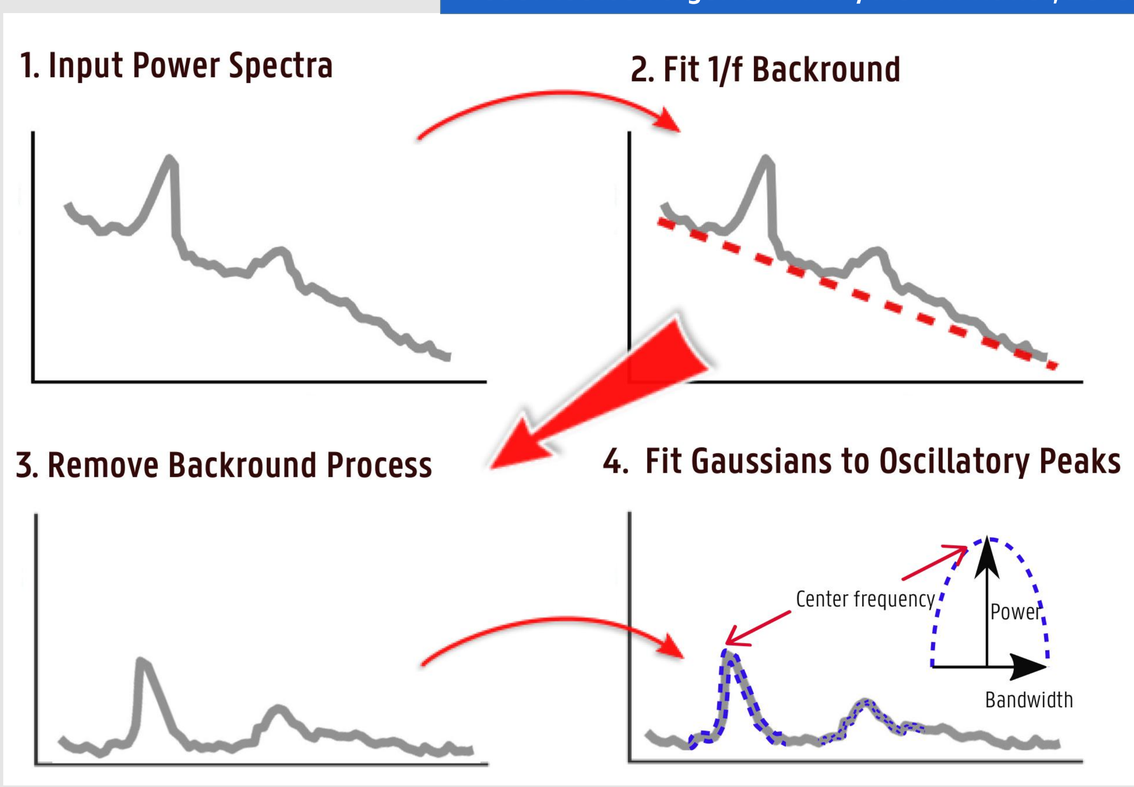
Possible pitfalls

2
- standard: comparison of mean alpha-band power between conditions
- nonzero power in a narrow frequency band is not necessarily a sign of oscillating activity there
- a priori definition of canonical bands not consistent across studies
- information about 1/f component is put aside

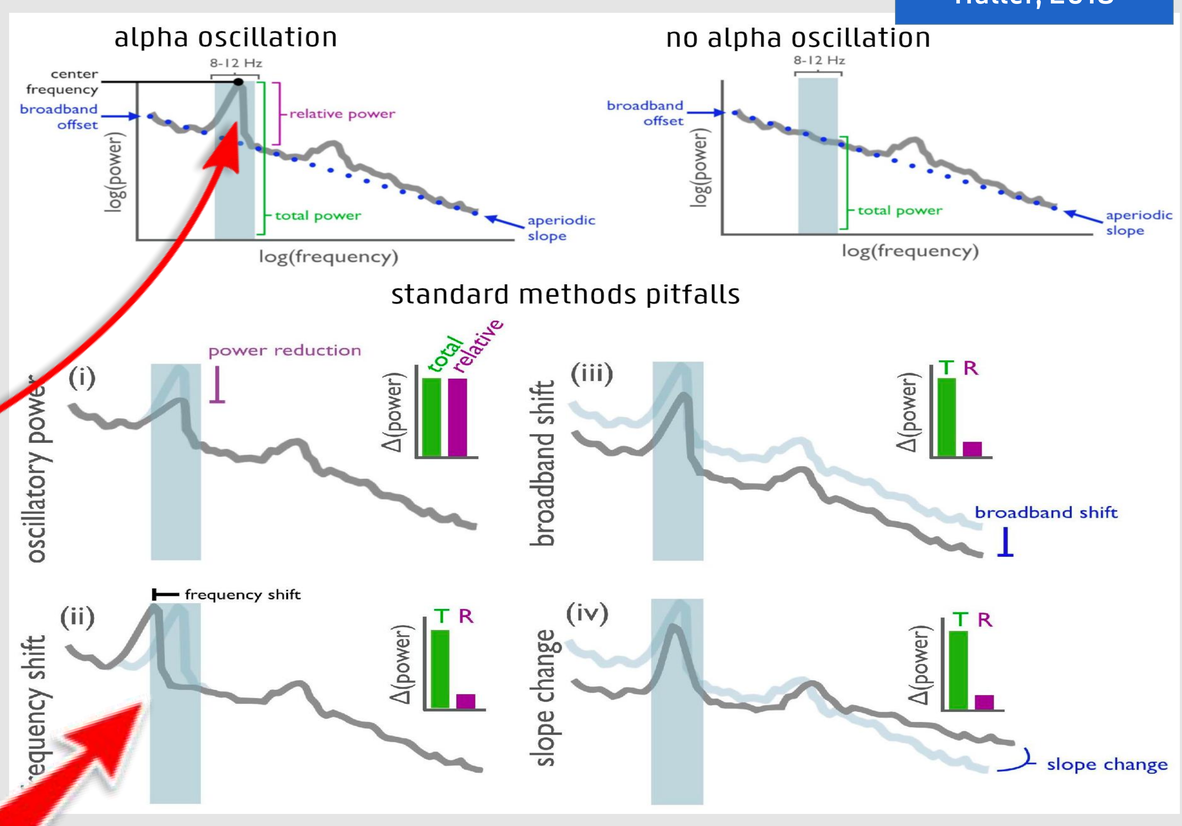
Parametrizing spectra

3
- data-driven approach built on standard Fourier analysis
- model of the power spectrum as a combination of additive distinct functional processes (aperiodic and periodic)
- an aperiodic 'background' component, reflecting 1/f like characteristics, modeled with an exponential fit, oscillatory components as Gaussians

fooof toolbox algorithm in Python in Haller, 2018



Haller, 2018



PROJECT

- Investigate the oscillatory dynamics during processes underlying cognitive flexibility
- Estimation of different spectral components in the signal. combine existing methods & improve them
- Learn more about the regional distribution of neurophysiological activity

Idea 1: compare localisations of oscillatory components in reconstructed sources and intracranial recordings during resting state

- datasets: Frauscher, 2018 (106 patients, 1772 channels, 60 s closed eyes activity from healthy brain regions) and Liu, 2017 (19 participants, sources extracted to match those regions)
- quantify the effect of solving the inverse problem
- validate a parametrical approach to a signal by reproducing results about topographical distributions of oscillations.
- code as a toolbox in Python

Idea 2: modeling alpha power changes and frequency shifts in attentional and cognitive control processes

- alpha oscillations in the EEG as a reliable marker of attention allocation (Janssens, 2017)
- collaborate between BIND group members
- inter- and intra-individual variability in alpha peak frequency
- take into account non-stationarity of the signal (single bursts)

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