EEG Analysis support

Design EEG experiments

Create analysis pipeline

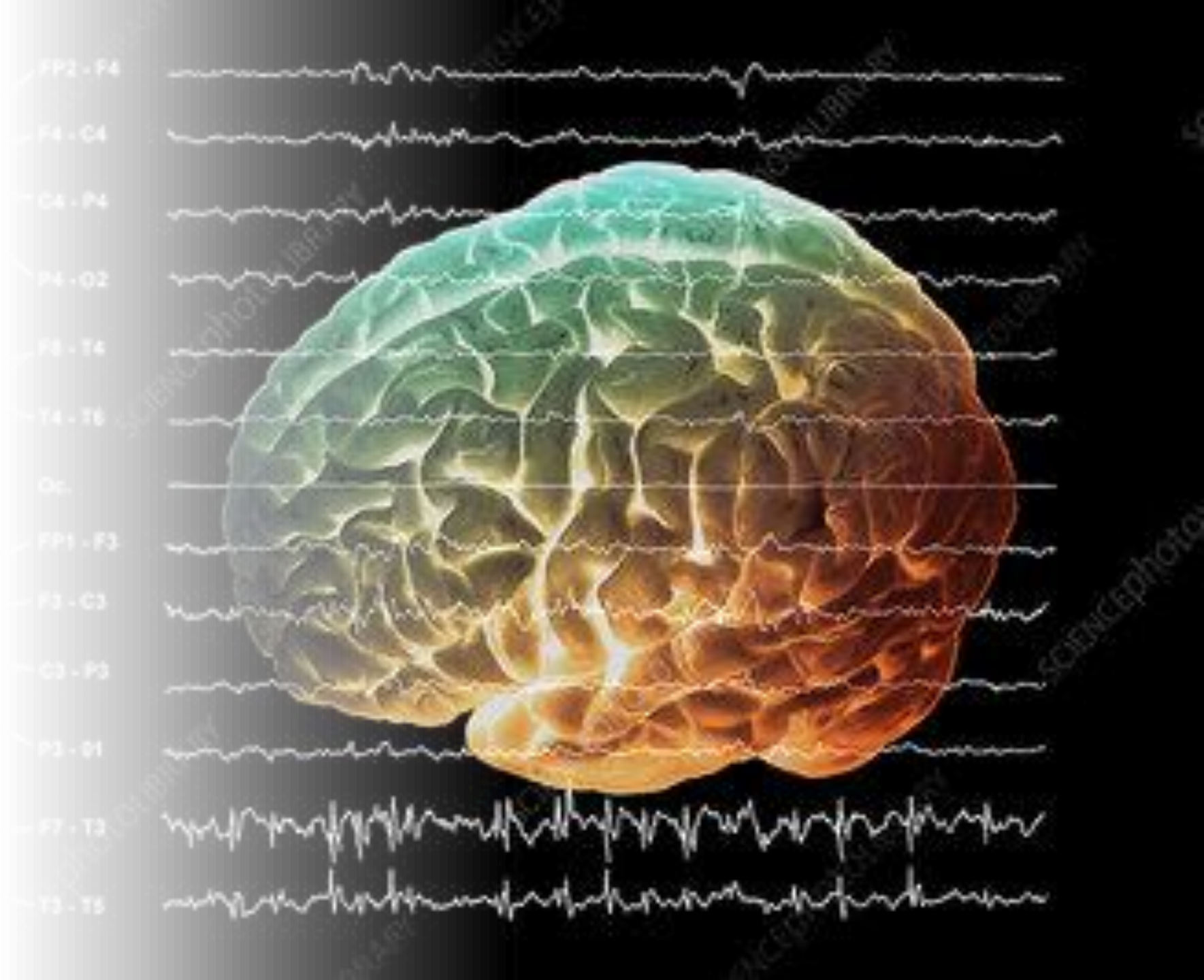
Get unstuck programming

Revisions

Project proposals

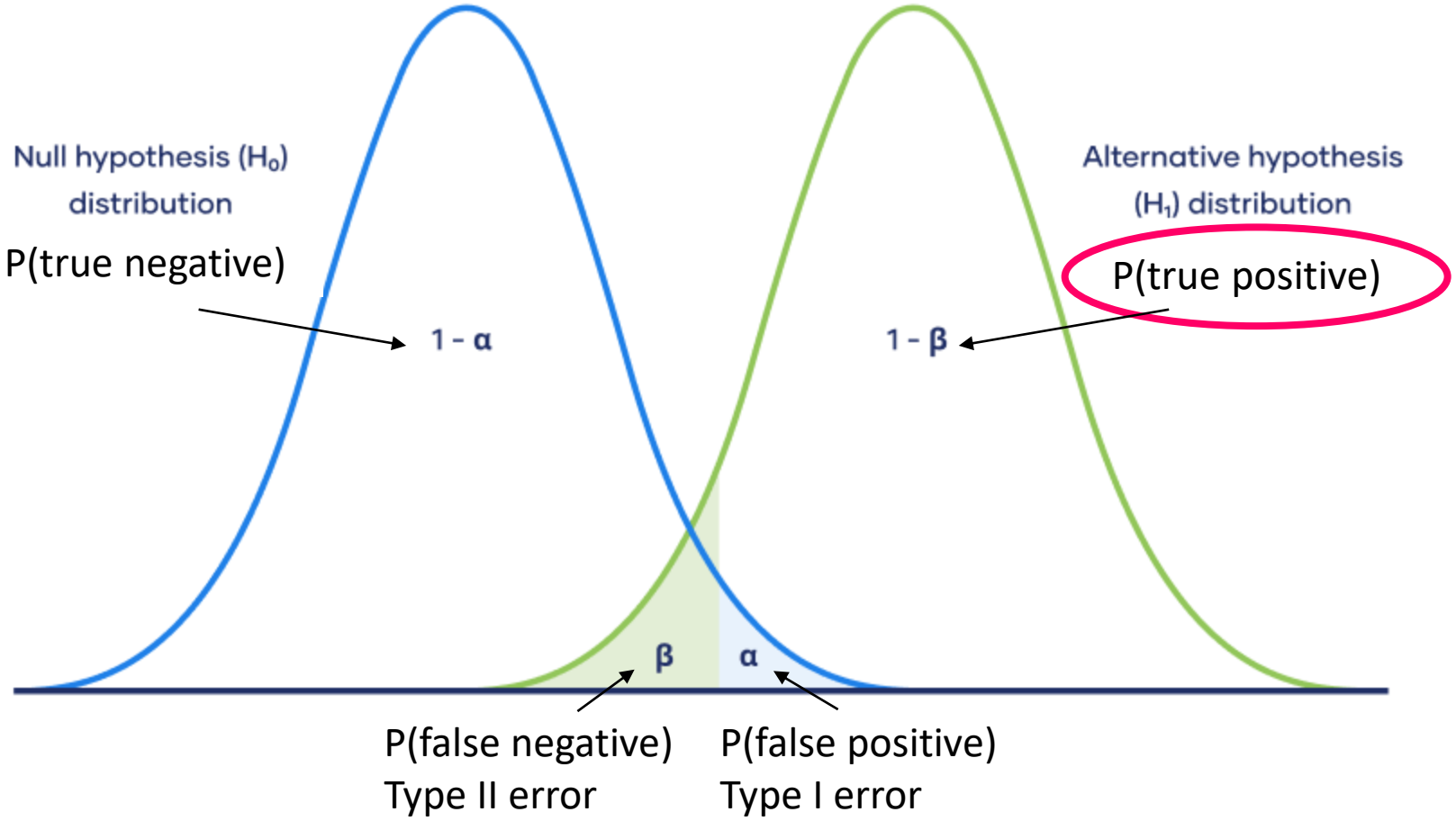
Find learning materials

Etc..



How to increase the power of your EEG analyses

Power

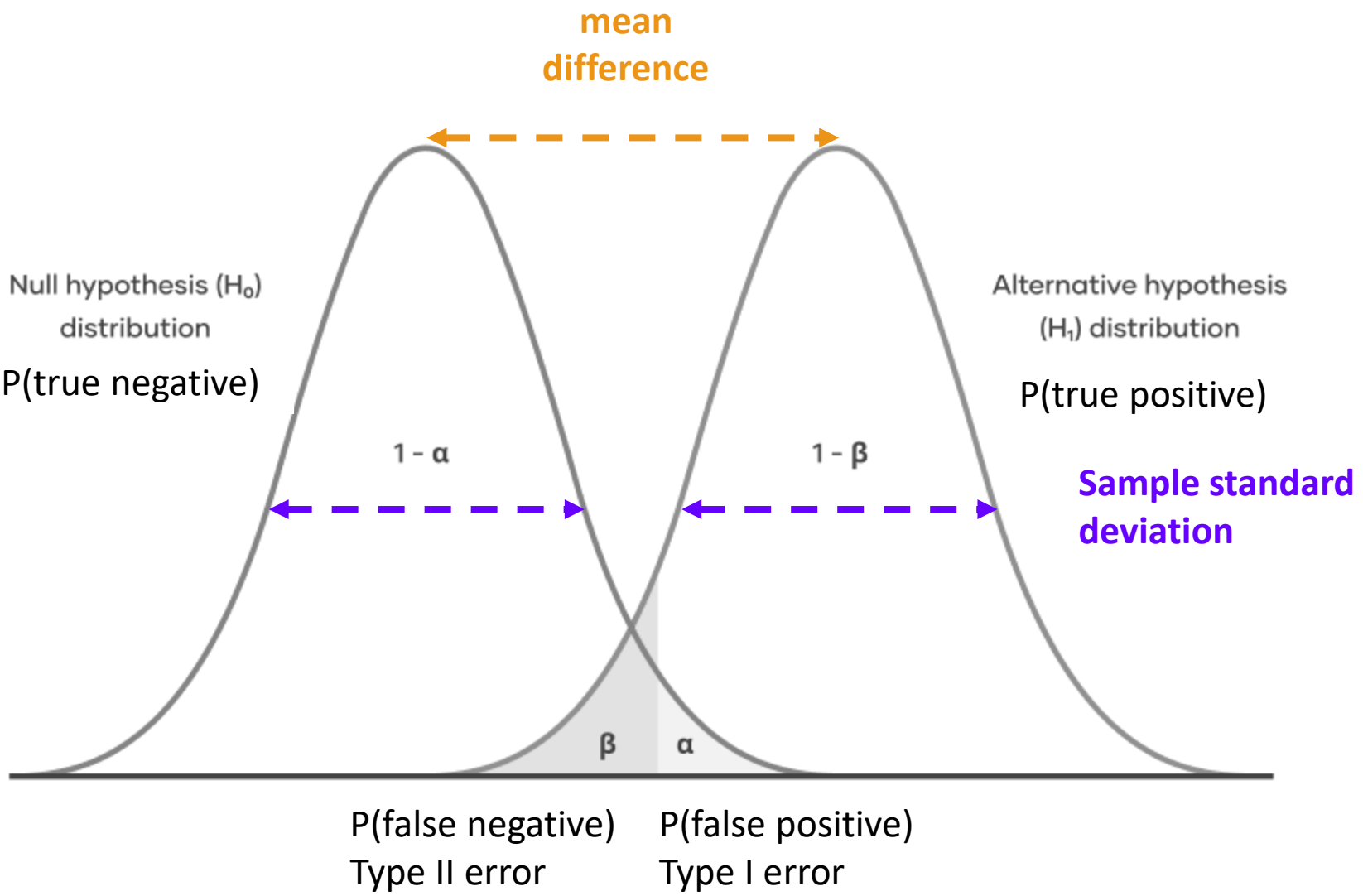

Null hypothesis (H_0) distribution
P(true negative)
1 - α
Alternative hypothesis (H_1) distribution
P(true positive)
1 - β
β
α
P(false negative)
Type II error
P(false positive)
Type I error

Increasing power

Use directional tests where appropriate

Increase mean difference

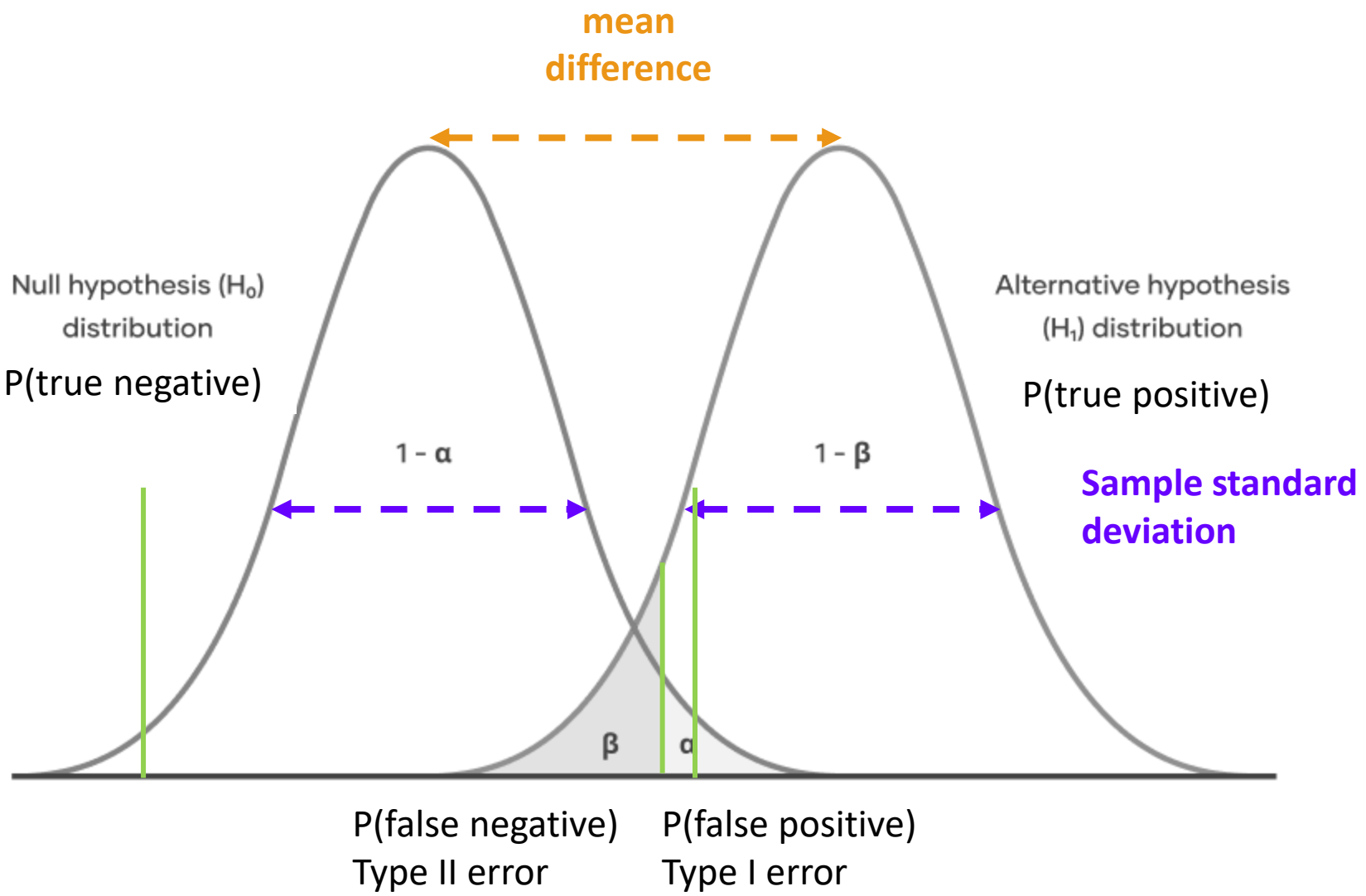
Reduce sample standard deviation



Use directional tests

Two-tailed testing with a directional question loses the logical connection between the research hypothesis and its statistical hypothesis.

A directional test moves the Type I error rate to one tail, lowering the critical value, and the number of observations needed to achieve the same statistical power.

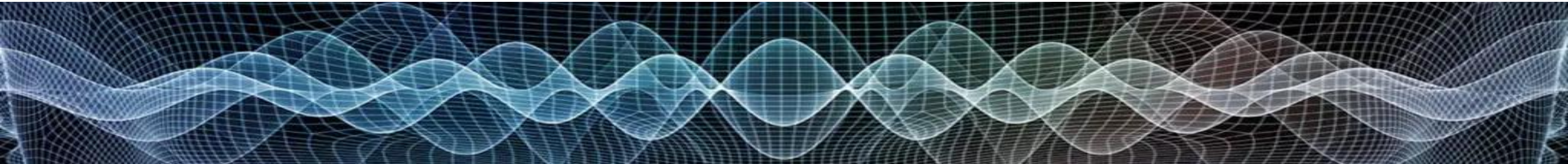


Cho & Abe, 2013; Lakens, 2022

Increase the mean difference

Use a more extreme manipulation or comparison.

Blocked instead of randomized conditions.
Be careful! Use short blocks and randomize block order to account for non-stationarity of the EEG over time.

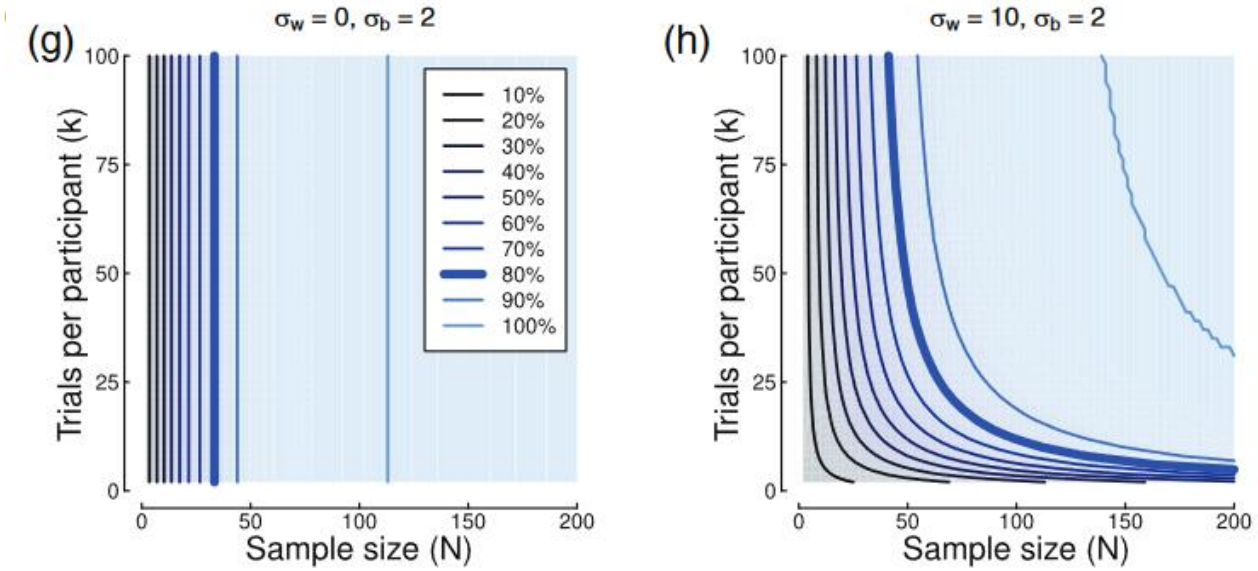


Reduce the standard deviation of the sample

Increase sample size

Increase measurement precision by trial count

Increase measurement precision by reducing measurement error



https://shiny.york.ac.uk/powercontours/

Baker et al., 2021; Brysbaert & Stevens, 2018

Sources of measurement error

Recording noise, artefacts etc.

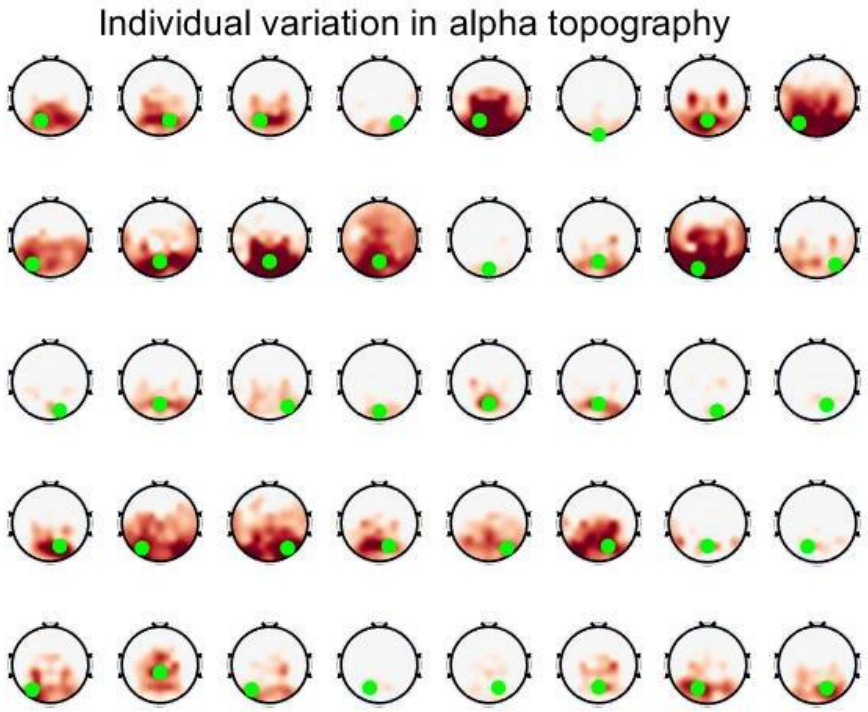
Mixing of sources at the electrodes

Mixing of activity in time (e.g. overlapping ERP's, artefacts)

Temporal correlations (time-on-task)

Individual differences (even in within pp designs)

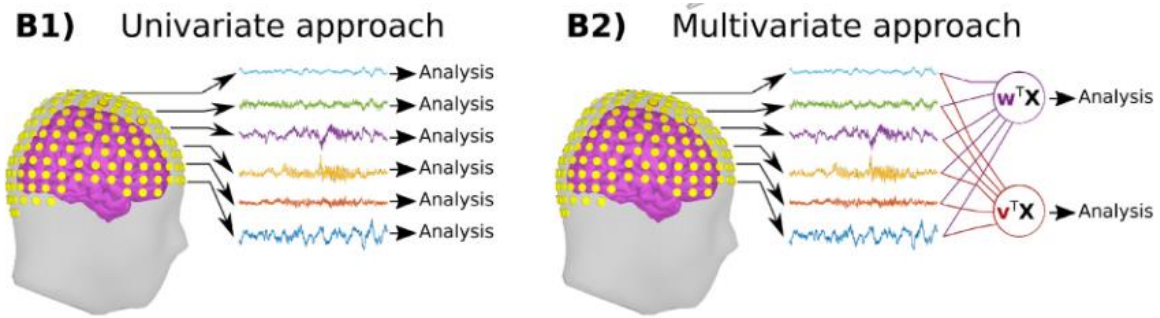
Idiosyncratic mixing of sources



Relevant and irrelevant sources of activity are mixed at the sensor level.

Different for each participant.

Generalized eigen-decomposition

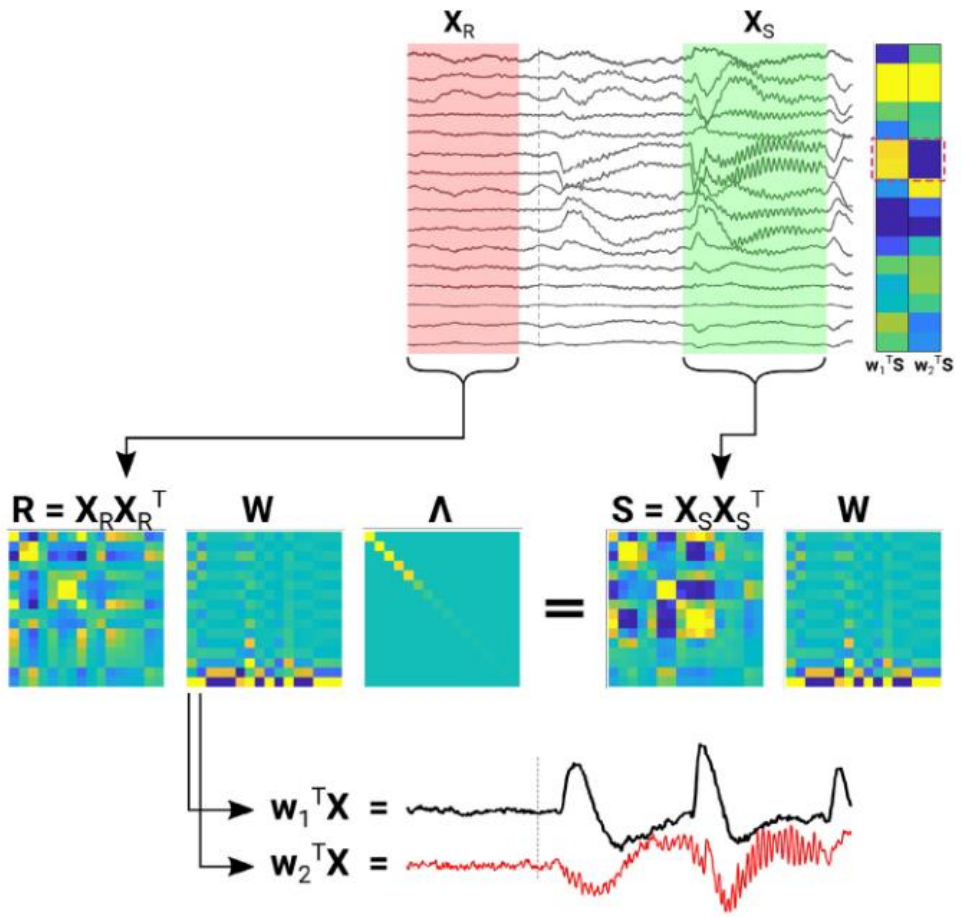


GED creates an individualized spatial filter (weights) isolates a pattern that may be mixed or have low signal-to-noise quality in individual electrodes.

The component can then be analyzed instead of a set of electrodes.

Cohen, 2022

Generalized eigen-decomposition



GED maximizes a contrast between two features.

Experimental vs. control condition. Prestimulus period vs. poststimulus period; Trial-average vs. single-trial data; Narrowband filtered vs. unfiltered data.

The GED finds a weighting of the data channels that maximizes a signal-to-noise ratio (SNR) that can be thought of as $\mathbf{S/R}$. Interchannel covariance patterns that are common between $\mathbf{S}$ and $\mathbf{R}$ are ignored.

No more picking channels, best filter created per individual ánd less researcher degrees of freedom.

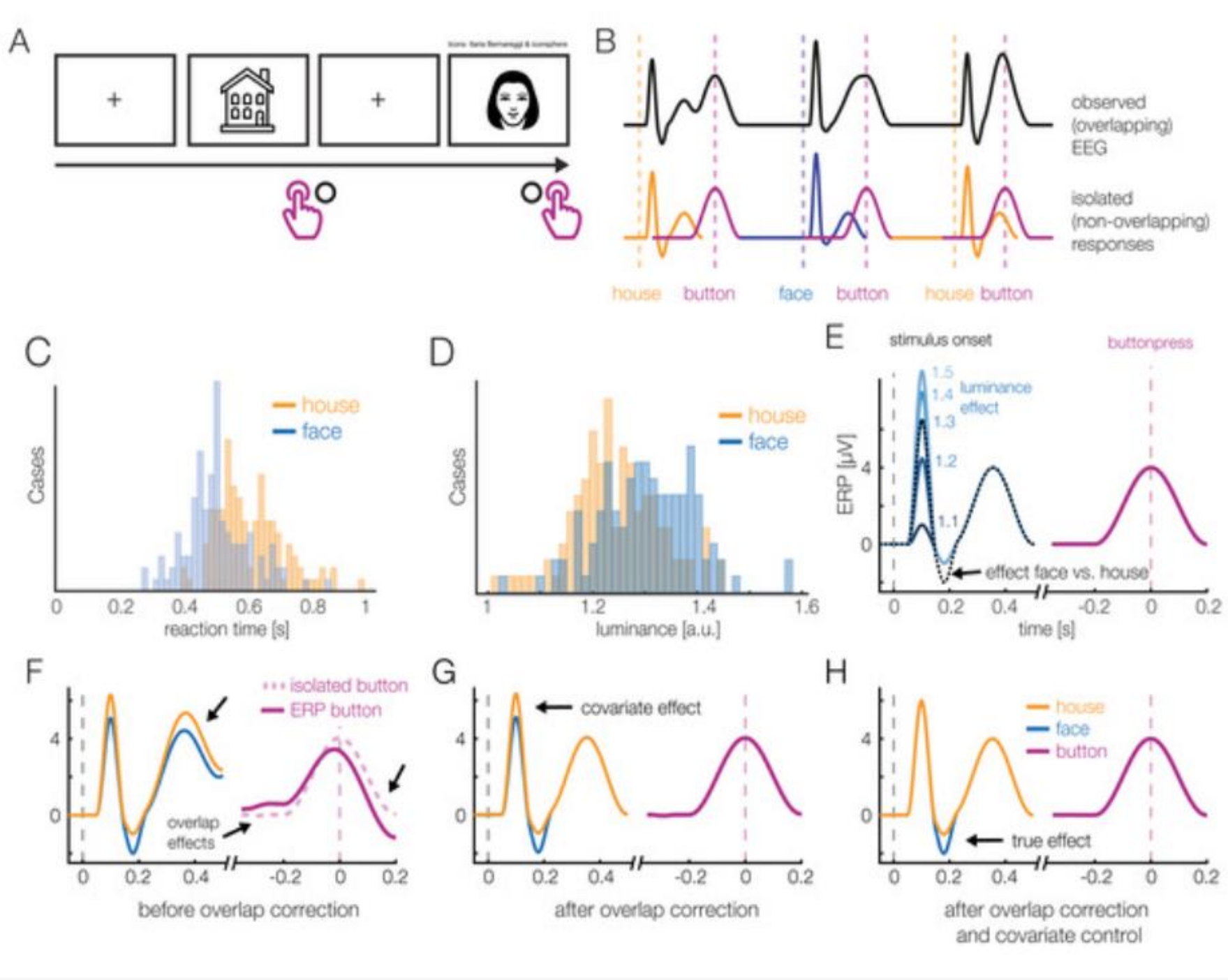
Parra, 2005; Cohen, 2022

Overlap

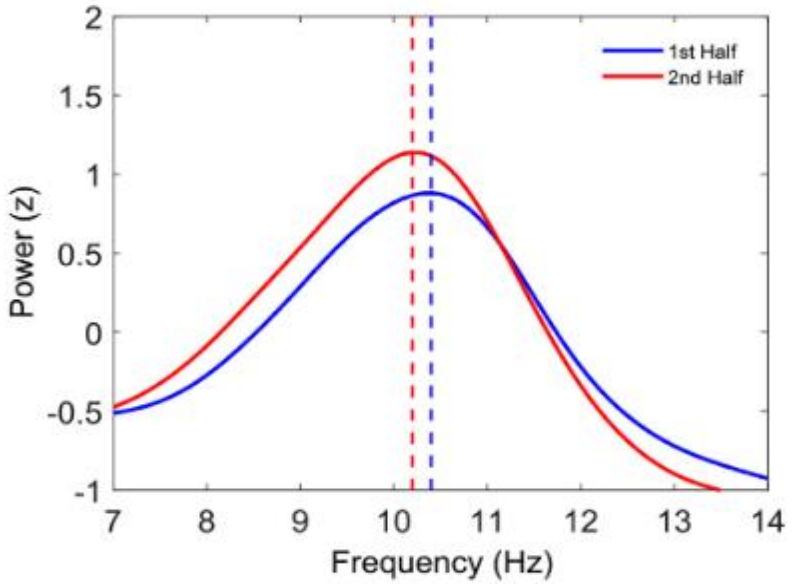
"Unfold" toolbox
Regression-based. Deconvolution of overlapping ERP's.

Modelling of effects of covariates on recorded potentials.

Ehinger & Dimigen (2019)



Temporal correlations (time-on-task)



A correlation between two measures arises when both measures systematically change over time.

Control for time-on-task

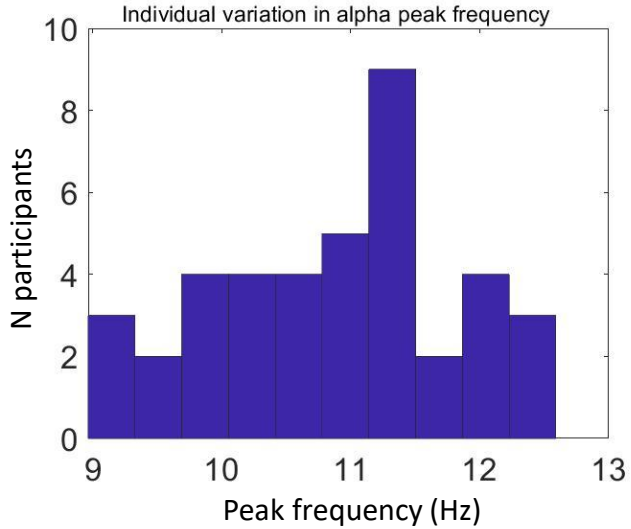
Include time-on-task/trial order as an additional variable.

Regress out the effect of trial order on the M/EEG and behavioural measures.

Assess the brain-behaviour relationship over only short timescales.

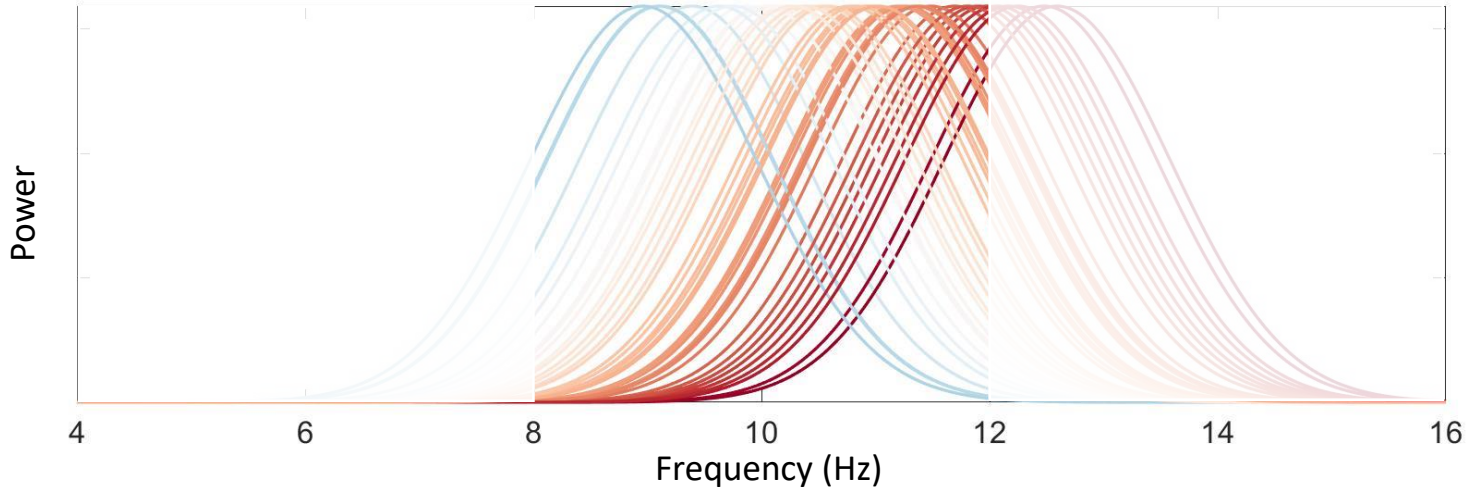
London et al. (2022); Benwell et al. (2019)

Individual differences



??

Using a fixed and limited ~~alpha~~ ~~frequency~~ ~~band~~ might bias results against certain subjects and conditions.



London et al. (2022)

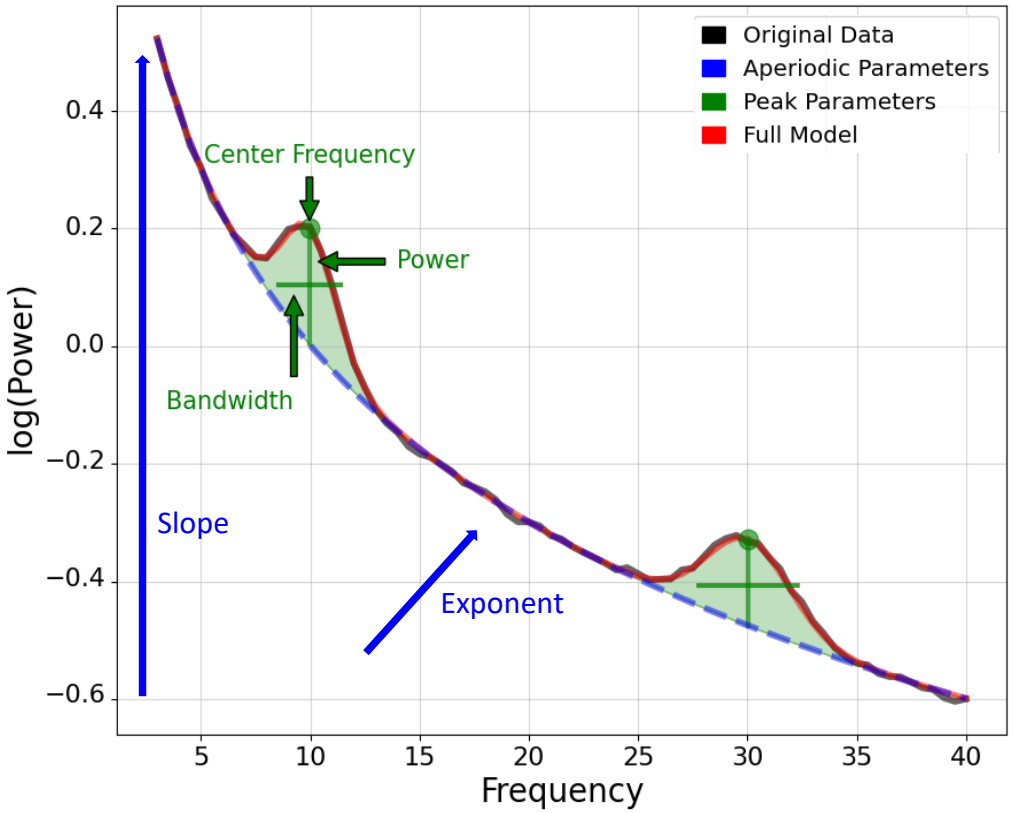
FOOOF toolbox

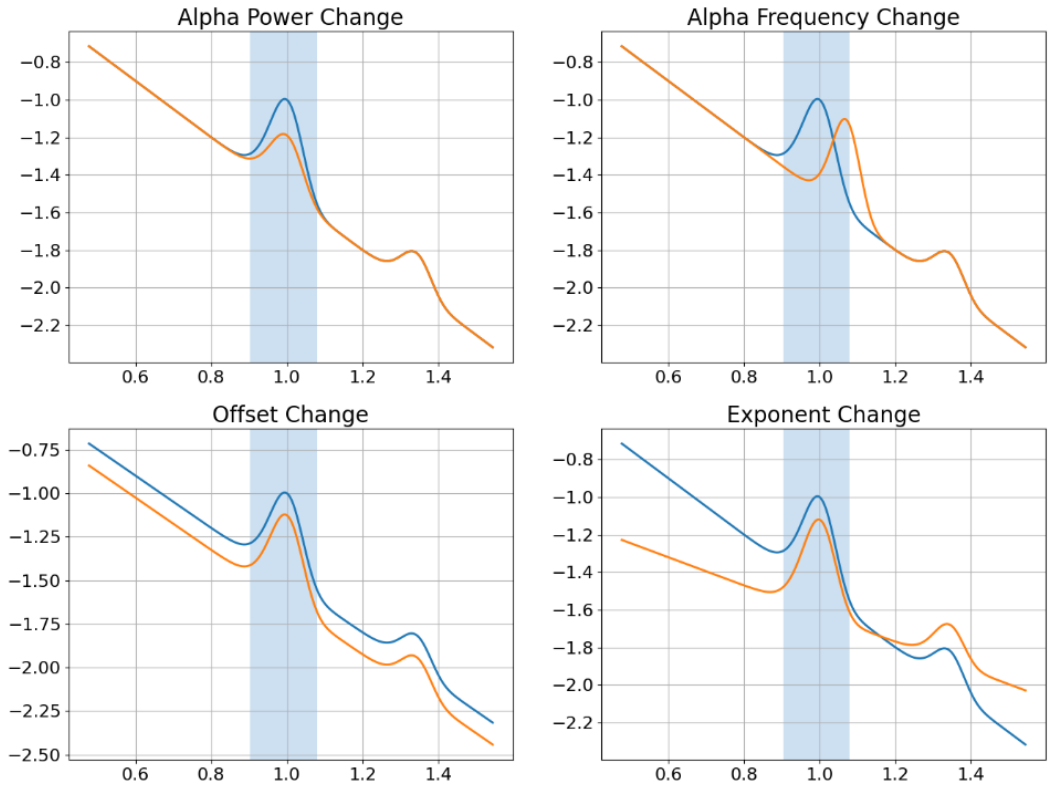
Models the periodic and aperiodic component of the power spectrum separately.

Extracts individual peak parameters (frequency, power).

Donoghue et al., 2020

FOOOF Toolbox





Donoghue et al., 2020

Resources

Papers:

Baker et al. (2021). Power contours: Optimising sample size and precision in experimental psychology and human neuroscience.

Brysbaert M., & Stevens M. (2018). Power analysis and effect size in mixed effects models: A tutorial.

Lakens, D. (2022). Sample size justification.

Tools:

FOOOF – Donoghue et al. (2020). Parameterizing neural power spectra into periodic and aperiodic components.

Unfold – Ehinger & Dimigen (2019). Unfold: an integrated toolbox for overlap correction, non-linear modeling, and regression-based EEG analysis.

GED – Cohen (2022). A tutorial on generalized eigendecomposition for denoising, contrast enhancement, and dimension reduction in multichannel electrophysiology.

Video:

Tutorial video (also by Mike Cohen): GED for spatial filtering and dimensionality reduction.

Newsletter:

"How to power your EEG experiment": https://github.com/raquellondon/TheEegNewsletter/wiki/003%23-The-EEG-Newsletter#how-to-power-your-eeg-experiment

"How to power your EEG experiment – part 2": https://github.com/raquellondon/TheEegNewsletter/wiki/004%23-The-EEG-Newsletter#how-to-power-your-eeg-experiment---part-2

"How to power your EEG experiment – part 3": https://theeegnewsletter.substack.com/p/the-eeg-newsletter-9

Come to the EEG Seminar!

Friday 12-May, 13:00, Leslokaal 1.2

Anne Keitel, Christian Keitel, Noor Seijdel

Neural entrainment and frequency tagging