Combining TMS with EEG

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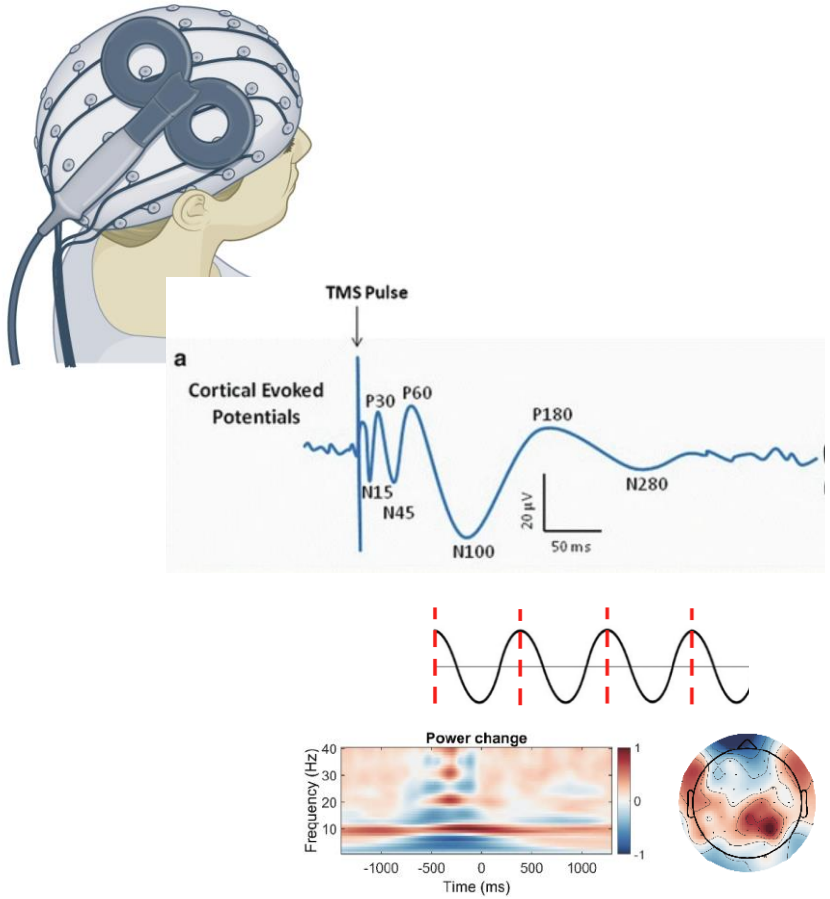
Why TMS-EEG?



- Both TMS and EEG have very high temporal resolution (1 ms); great for testing temporal-specific effects
- Single-pulse TMS + EEG: Modulate ERPs (TMS-evoked potentials; TEPs); directly measure cortical excitability and connectivity.
- Rhythmic TMS + EEG: Manipulate (entrain) neural oscillations at specific frequency band

The TMS-EEG setup

DuoMag XT-100 TMS

Brainsight 2 Neuronavigation system

TMS-compatible EEG system

TMS-compatible EEG caps

DC coupling recording and high sampling rate (> 5,000 Hz; 25,000 Hz by default); active electrodes are also recommended

- To avoid online filtering
- To prevent saturation and to capture TMS pulses and artefacts with fast recovery (< 10 ms)

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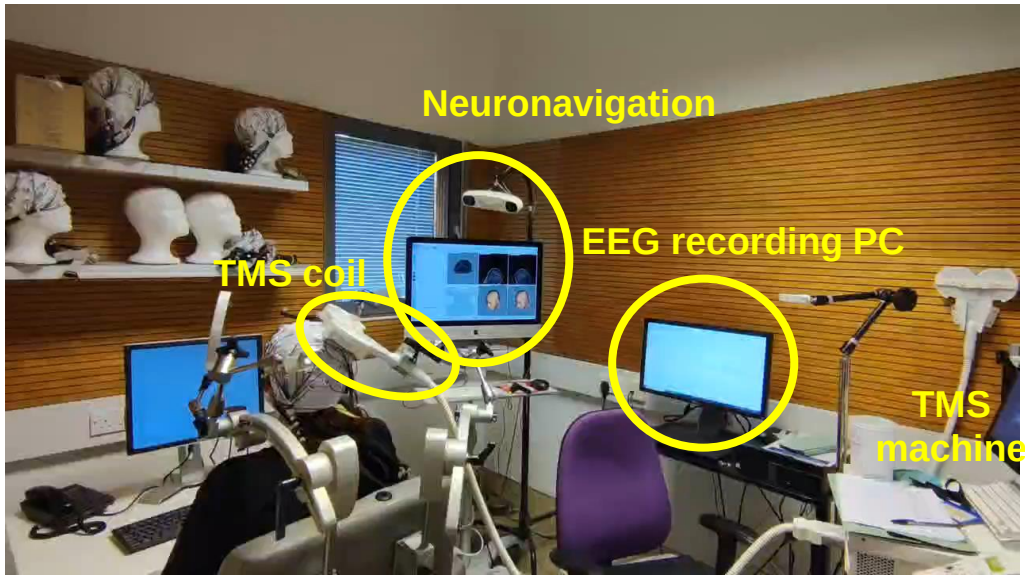
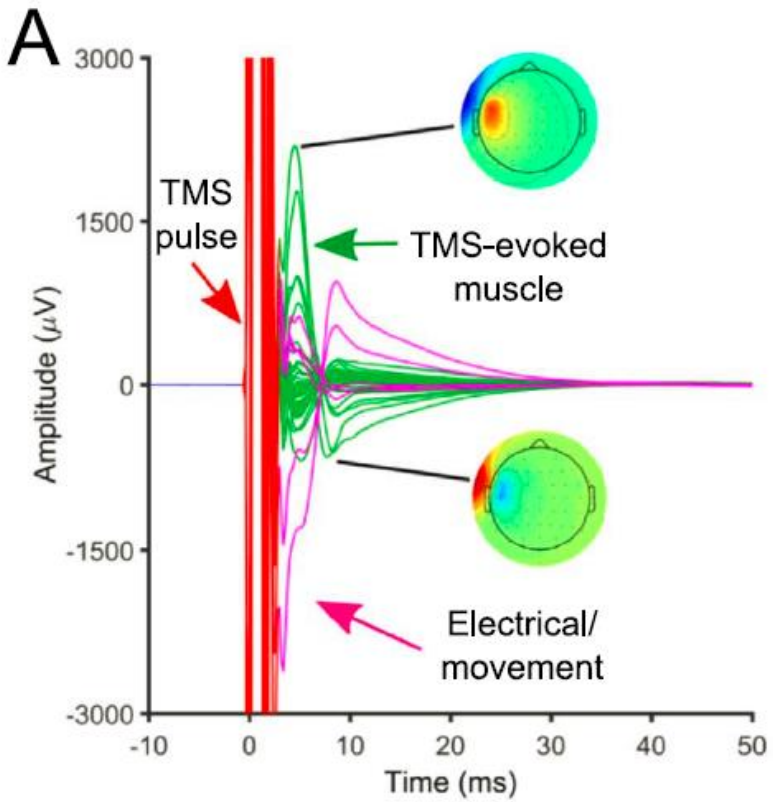


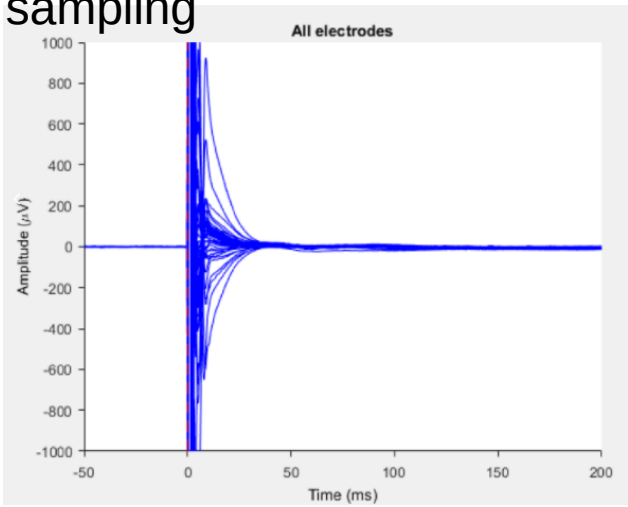
How to remove TMS-EEG artefacts

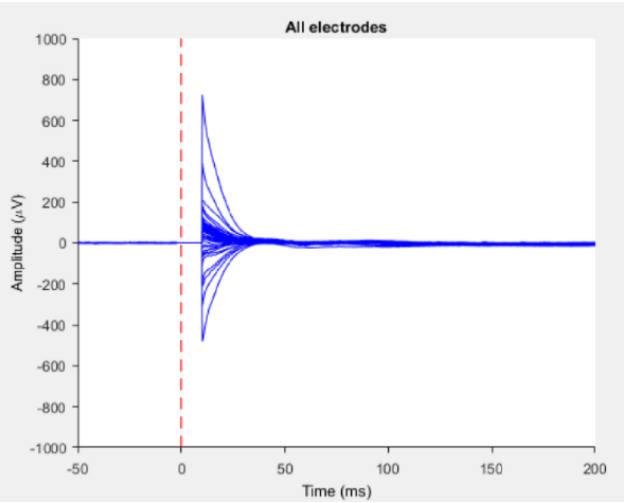
- 1. Remove the extremely large TMS pulse artefacts



Large TMS pulse artefact lasts ~5-8 ms (given the DC and very high sampling rate)

Remove [-2, 10] ms from the TMS pulse artefact prior to down-sampling

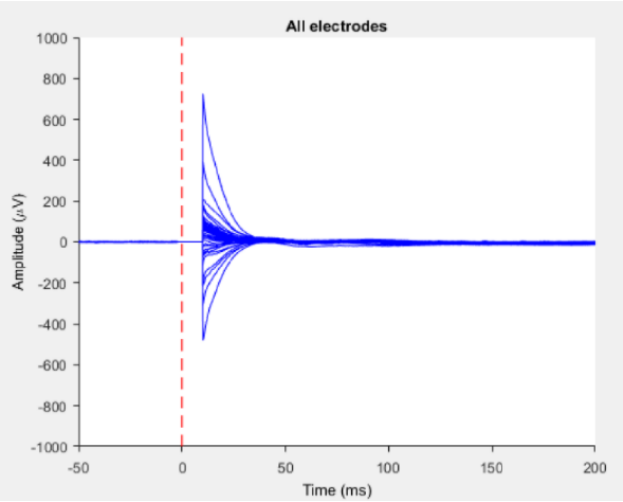




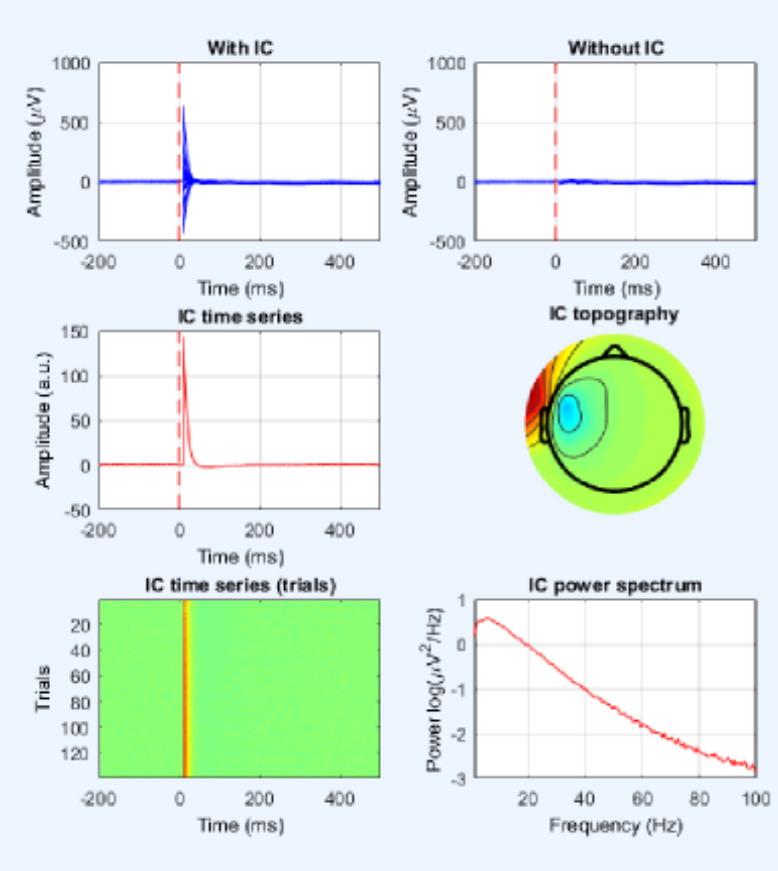
Rogasch et al., 2017, Neuroimage

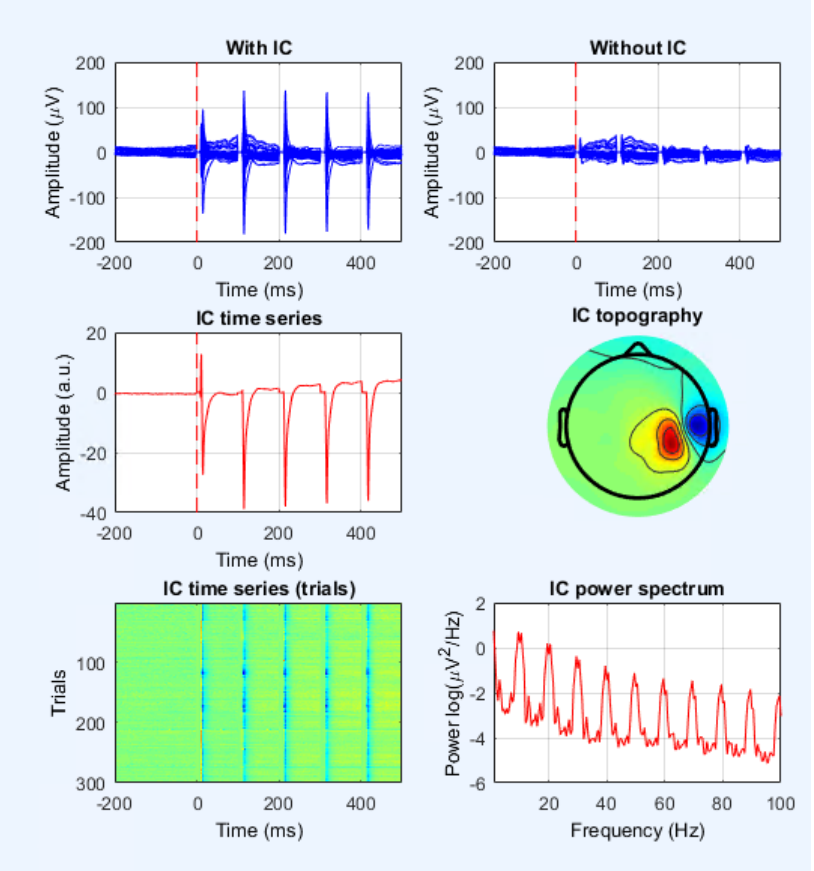
How to remove TMS-EEG artefacts

- 2. Remove the TMS-evoked muscle artefacts



Using ICA to just remove TMS-evoked muscle artefacts

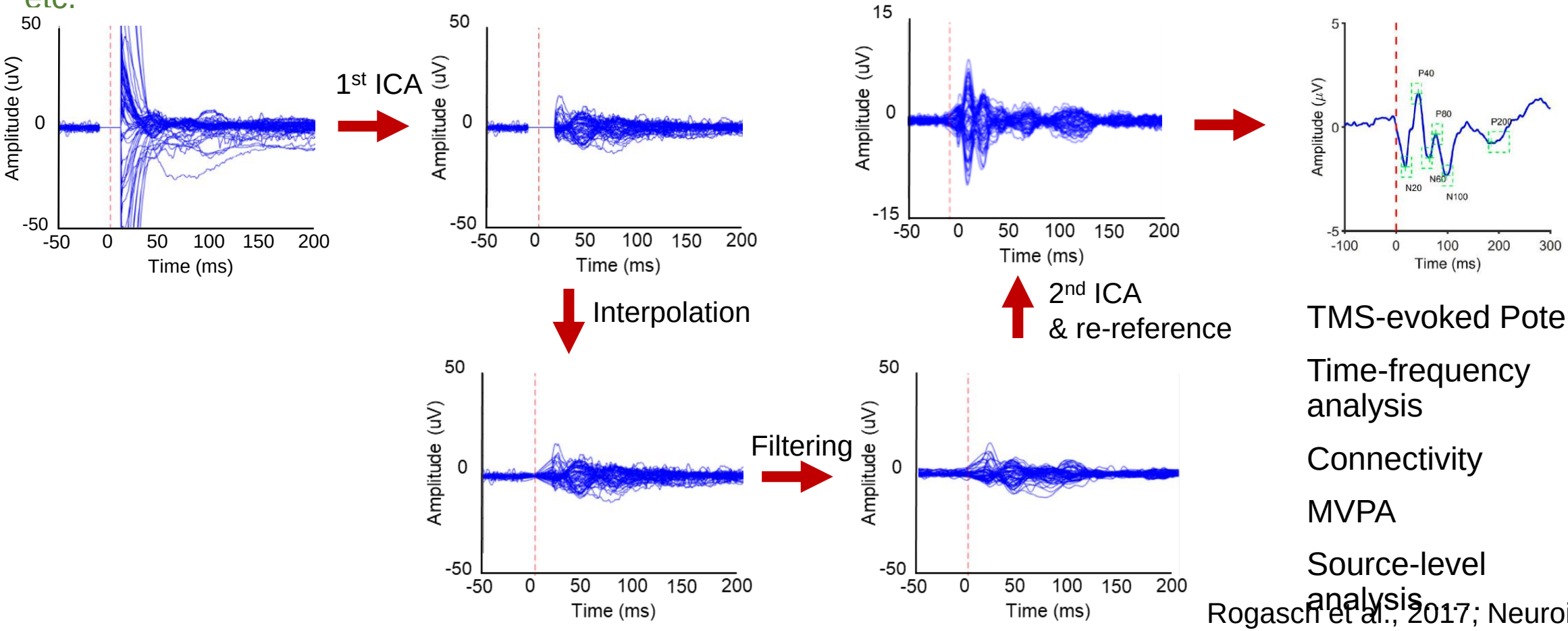




Rogasch et al., 2017, Neuroimage

How to remove TMS-EEG artefacts

- 1. Remove the extremely large TMS pulse artefacts
- 2. Remove the TMS-evoked muscle artefacts [1st ICA]
- 3. Remove other artefacts (eye-blink, eye-movement, electrode artefacts..) using filtering, 2nd ICA etc.



TMS-evoked Potentials

Time-frequency analysis

Connectivity

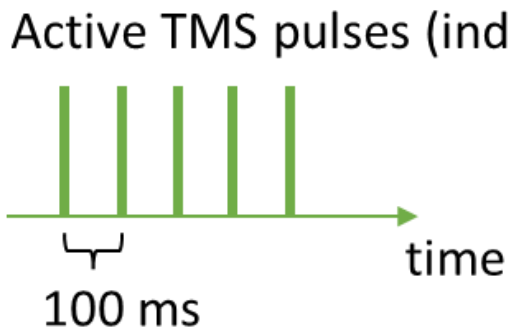
MVPA

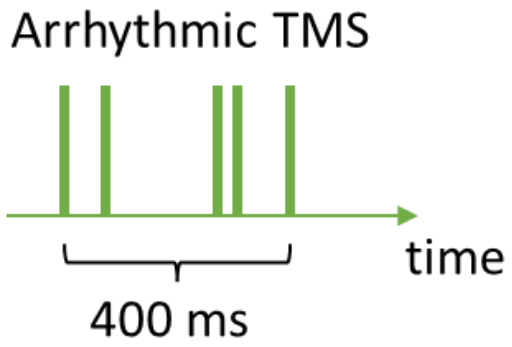
Source-level analysis

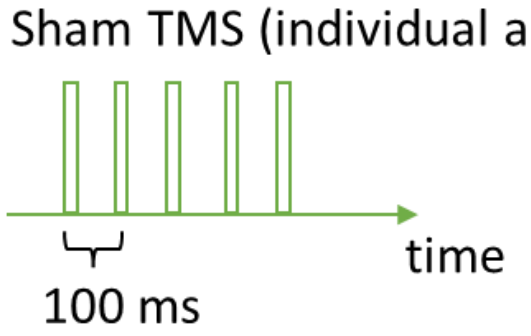
Rogasch et al., 2017; Neuroimage

Demo!

- Matlab
- EEGLAB
- TESA(TMS-EEG signal analysis)







https://nigelrogasch.gitbook.io/tesa-user-manual