re-referencing
why, how and when?

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what is a EEG reference

- Each measurement needs a reference (ref.).

- The ref. should (ideally) be neutral, i.e. without electrical activity.

- EEG studies use single/double mastoid, Cz, common average, etc. as the measurement ref.

- If a reference is not neutral, the EEG will be w.r.t to the ref. activity.

- BioSemi ActiveII uses a feed-back ref. system.

BioSemi ref.

- The open-loop feed-back system:
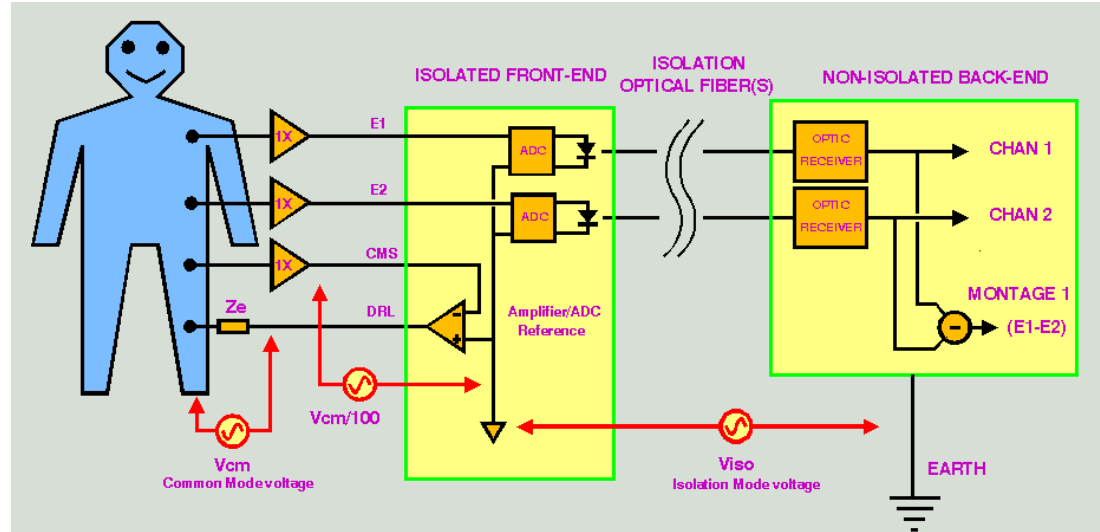
should we re-ref. during importing?

- EEGLAB strongly suggests to re-ref. to not lose data:

  - **We highly recommend that you choose a reference channel IF these are Biosemi data (e.g., a mastoid or other channel). Otherwise the data will lose 40dB of SNR!**

- But re-referencing essentially removes a channel or the common average:

Not-reref'ed   *Ref'ed to Cz*   *Ref'ed to average*
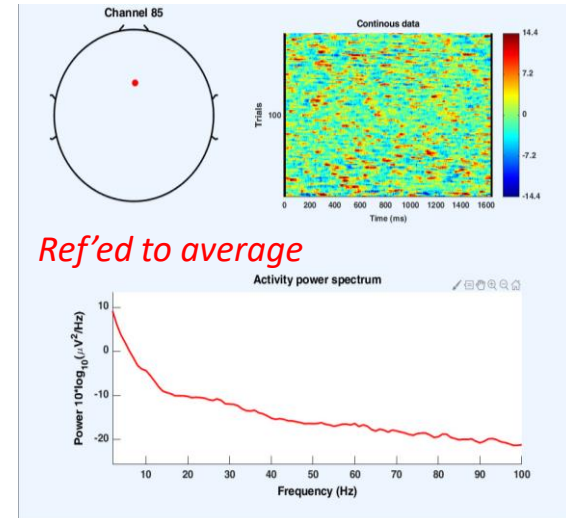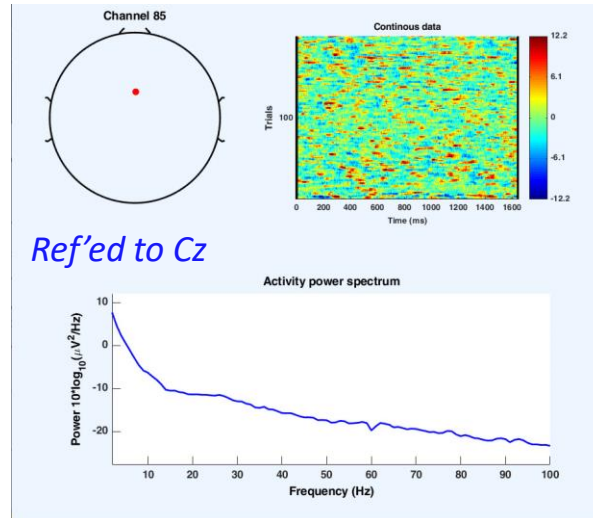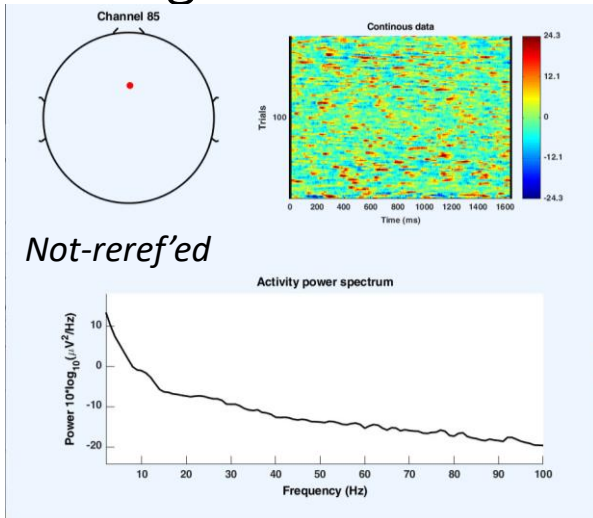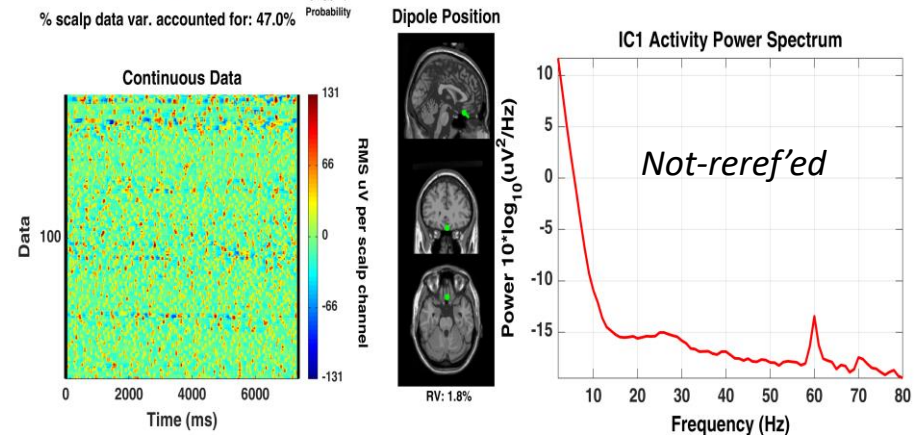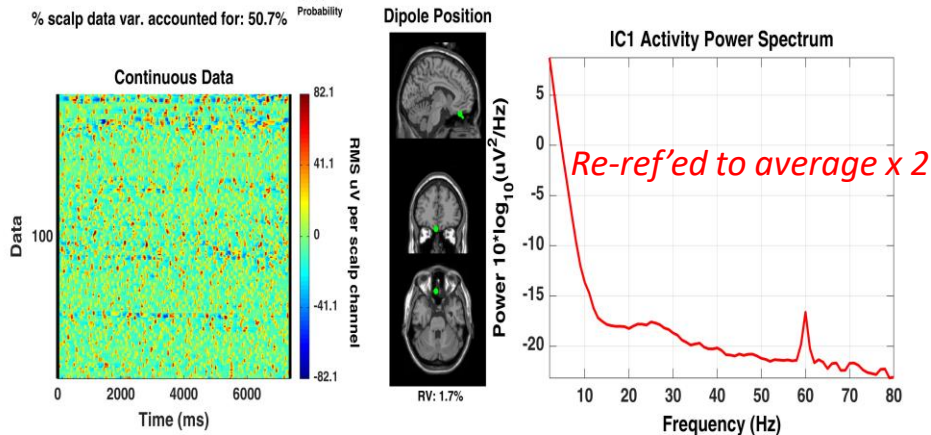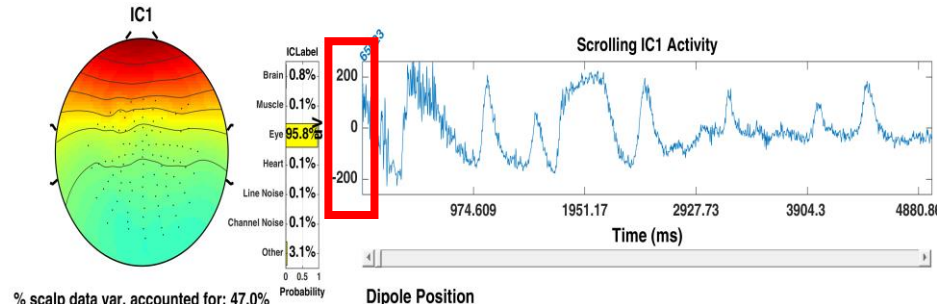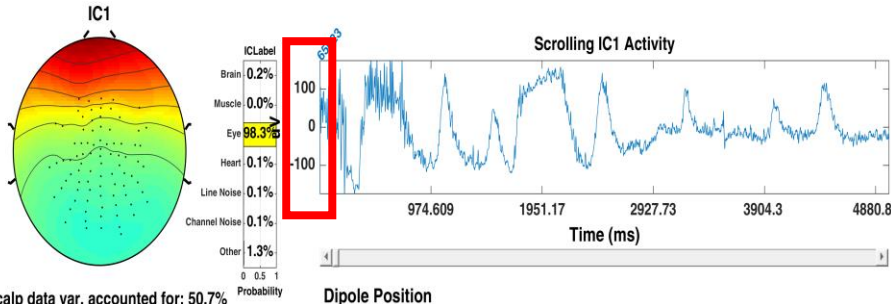
should we re-ref. during importing?

Not-reref'ed
Ref'ed to Cz
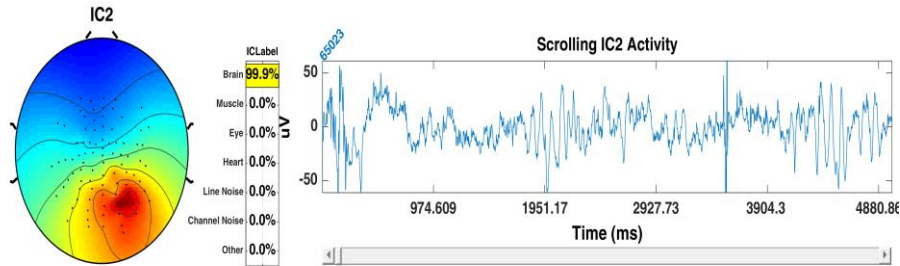Ref'ed to average

Activity power spectrum
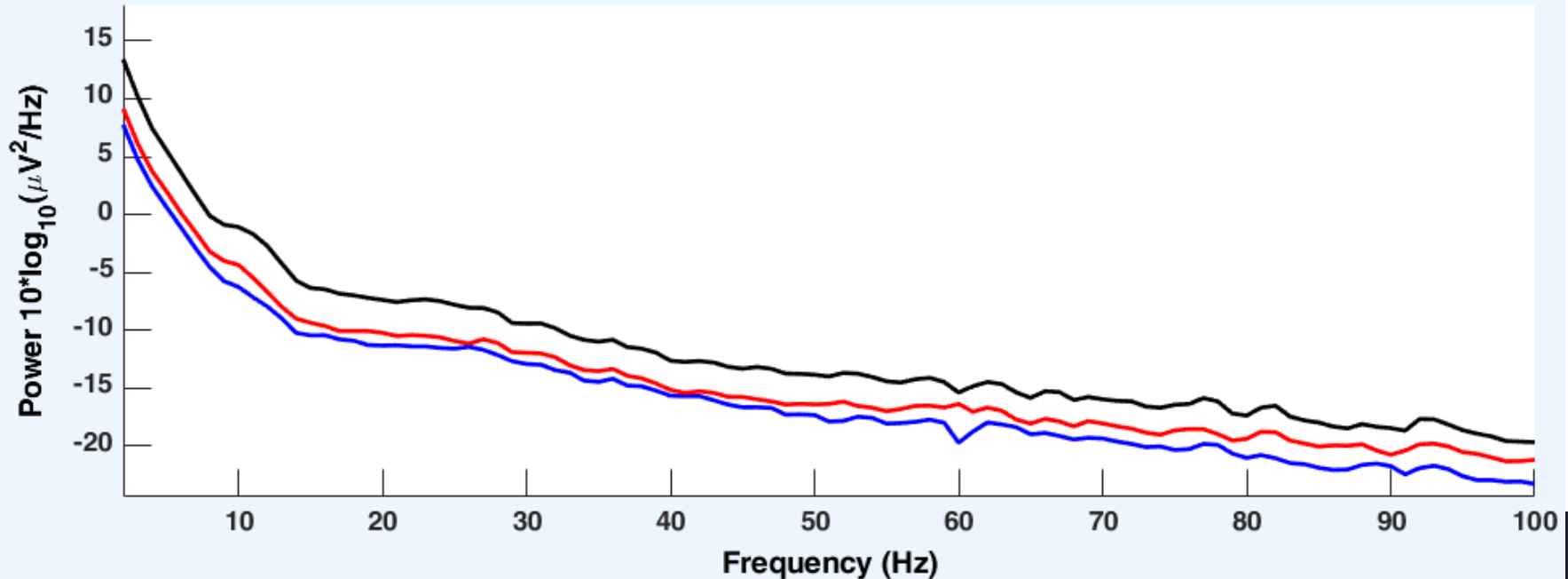
what happens to ICA with re-ref. (1)
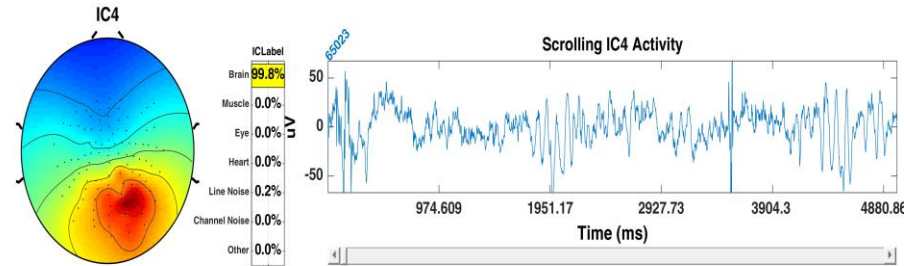
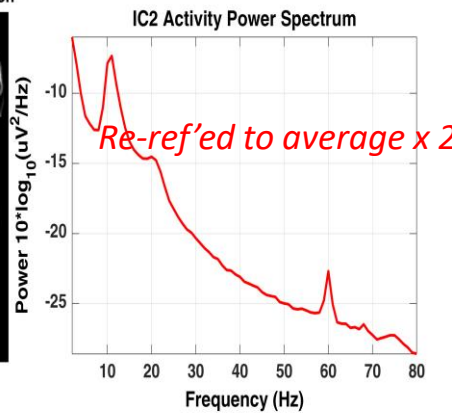- Common-mode signals may have decreased amplitudes:
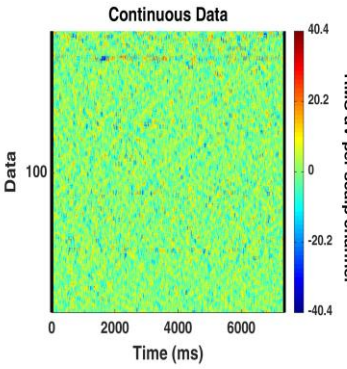

Re-ref'ed to average x 2

Not-reref'ed

what happens to ICA with re-ref. (2)

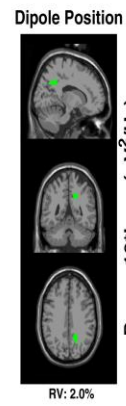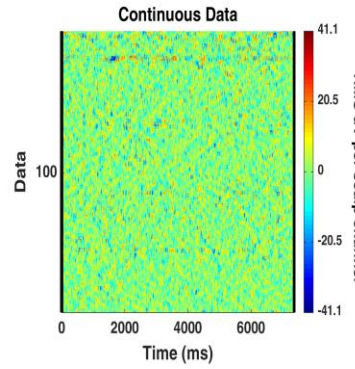- Local activity would not be likely affected, but:

Re-ref'ed to average x 2

Not-reref'ed
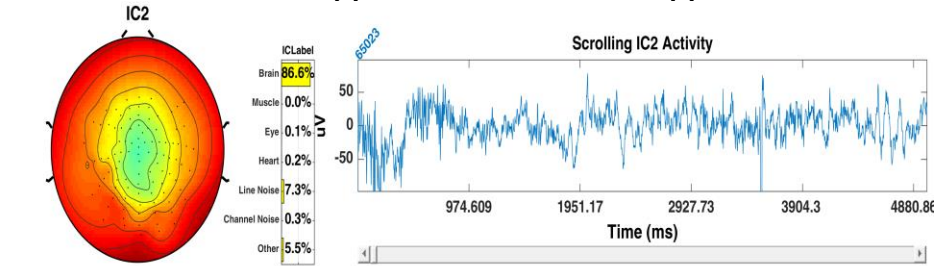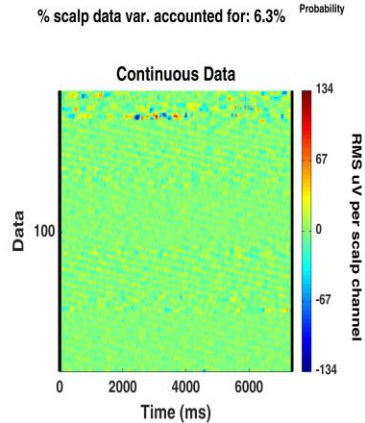
UCF
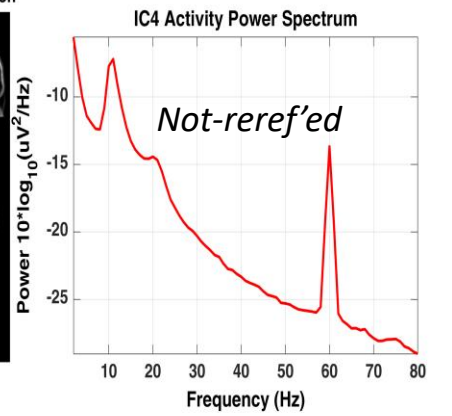
what happens to ICA with re-ref. (3)

- ICA may not pick up less strong non/cortical common-mode signals:
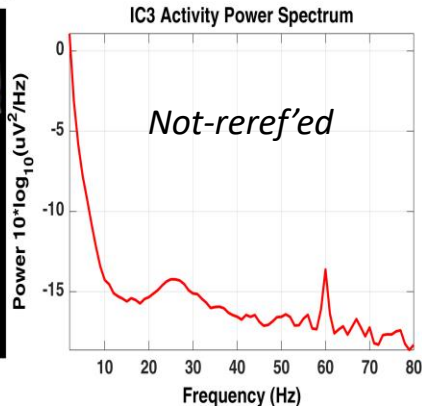 - These ICs are not present in the ICA results with x2 average re-referencing
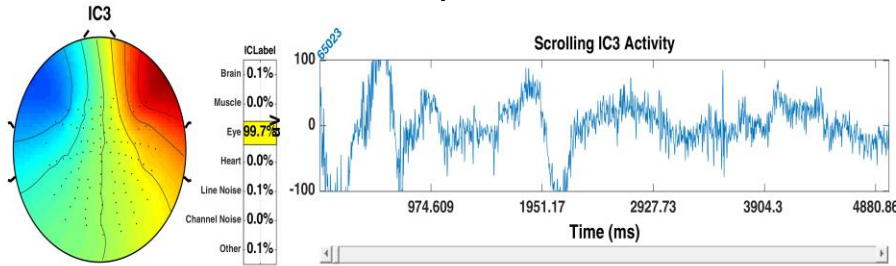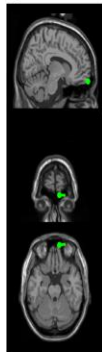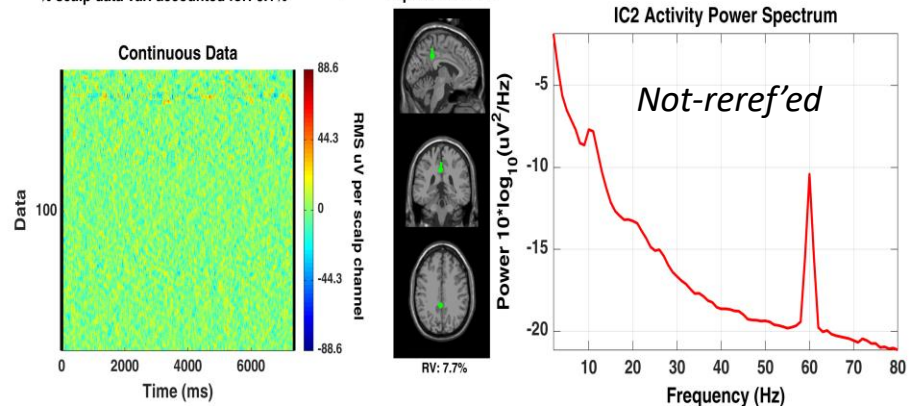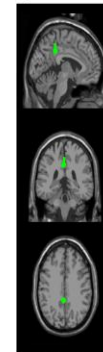
any solution?

1- Do not re-reference!

2- Re-reference after ICA 🥴

3- Use a less aggressive re-referencing approach.

UCF

alternative re-referencing

REST: Reference Electrode Standardization Technique

Impact of the reference choice on scalp EEG connectivity estimation

Federico Chella[1,2], Vittorio Pizzella[1,2], Filippo Zappasodi[1,2] and Laura Marzetti[1,2]

Thank you