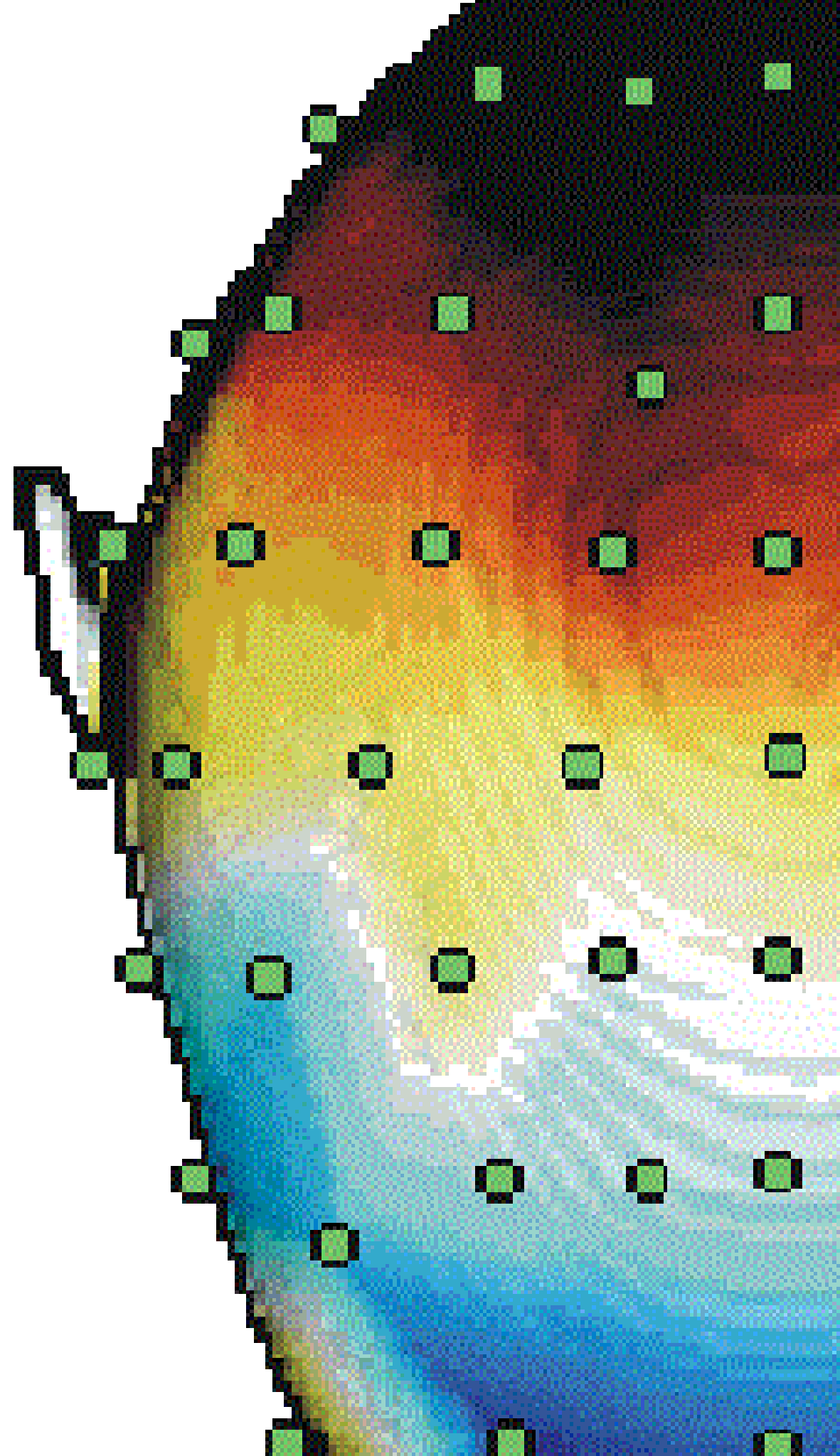Session 2:

Preprocessing EEG for MVPA

Daniel Bennett
UniSA, March 2016
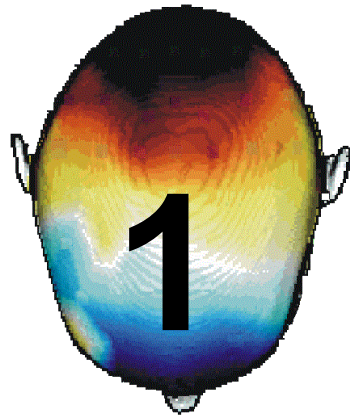
1 Why preprocess EEG data?

2 Preprocessing pipeline for MVPA

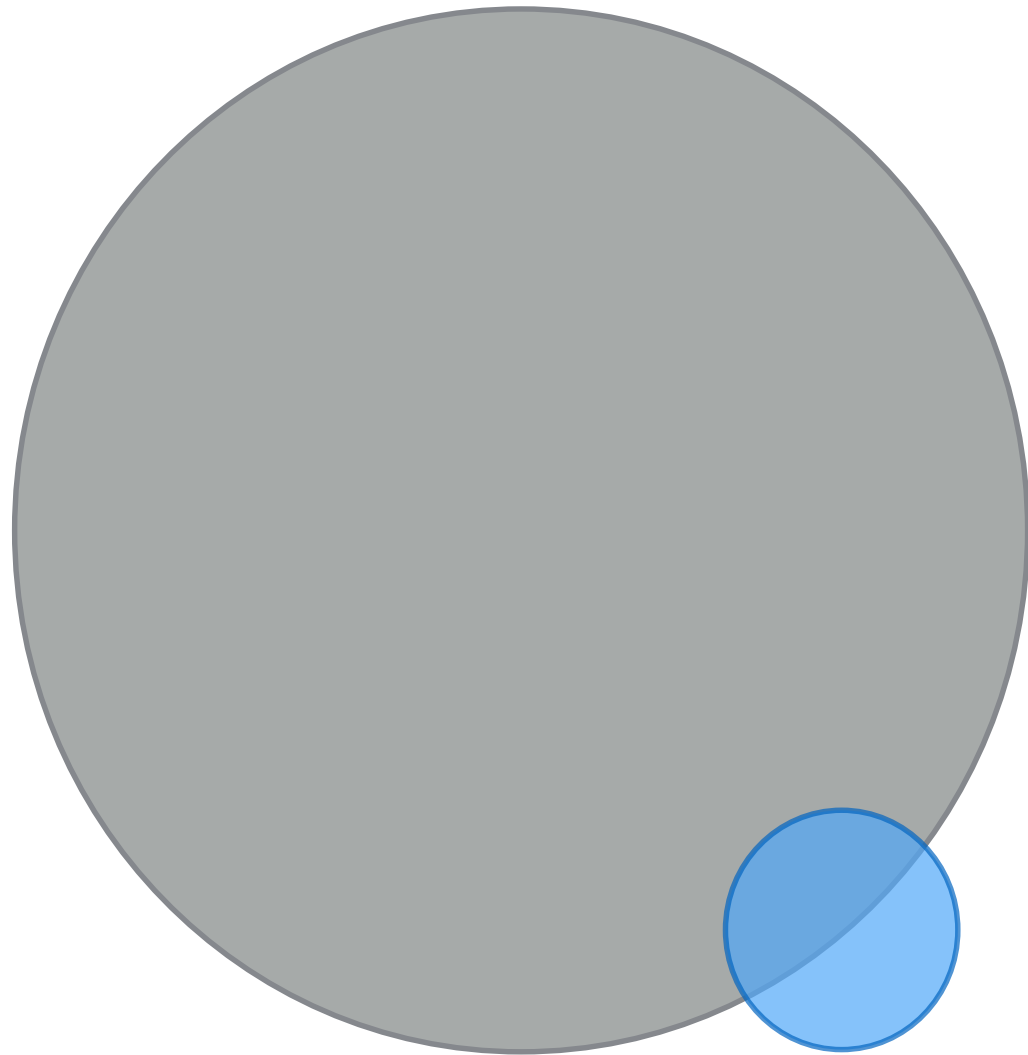3 Further resources

1 Why preprocess EEG data?

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3 Further resources

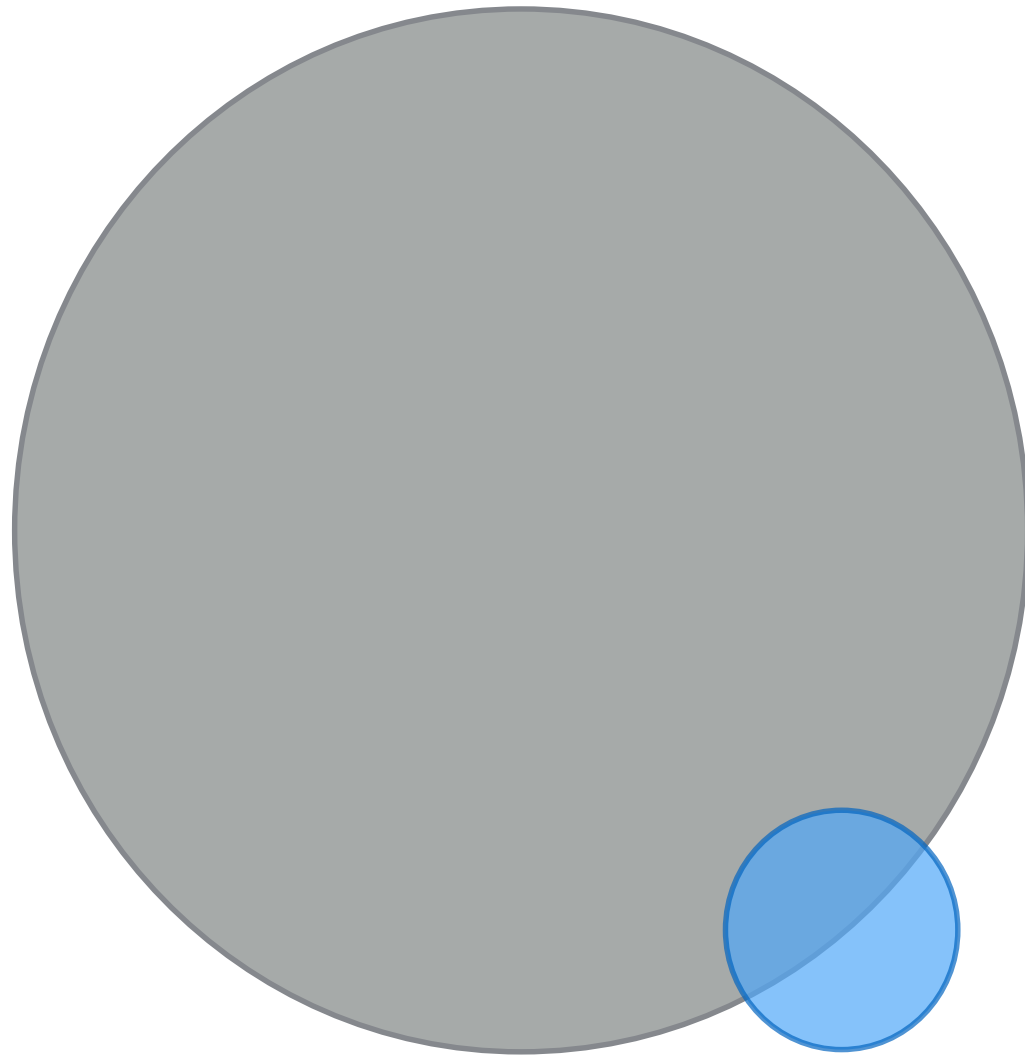**Things in the brain**

Things recorded by EEG

Things in the brain

Things recorded by EEG

This area represents all neural activity that is not captured by EEG.

Research specifically interested in this area should use another technique, and analyses of EEG data should be conducted in the understanding that inference is limited to the types of neural activity that EEG does reflect.
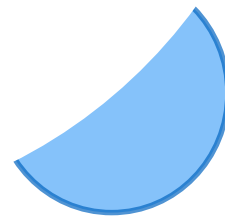
Things in the brain

Things recorded by EEG

Things in the brain
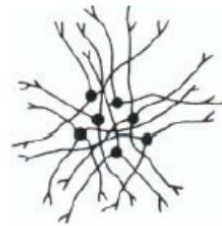
Things recorded by EEG

This area represents variance in the EEG signal which does not reflect neural activity.

Many of these sources of variance are amenable to correction via preprocessing.
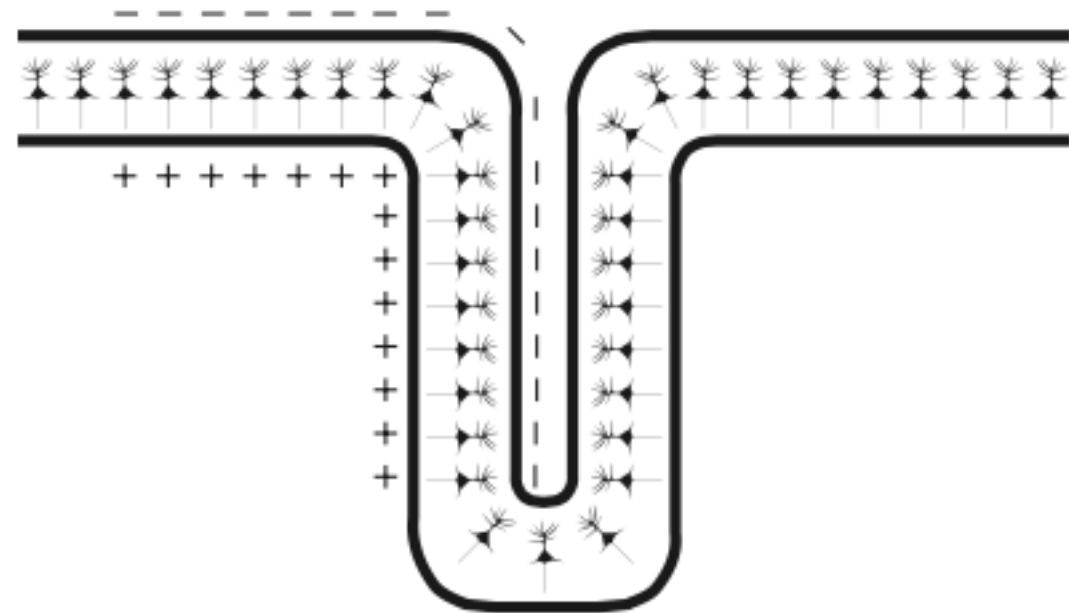
What does(n't) EEG record?

- Not single neurons.

- Not action potentials.

- Not all neurons.

- Not the whole cortex.

Glial Cells

Cortical Pyramidal Cells

What does(n't) EEG record?

- Not single neurons.

- Not action potentials.

- Not all neurons.

- Not the whole cortex.

More positive potential

$-\mu V$

S

$+\mu V$

P_1 Ω_1^- Ω_2^+ P_2
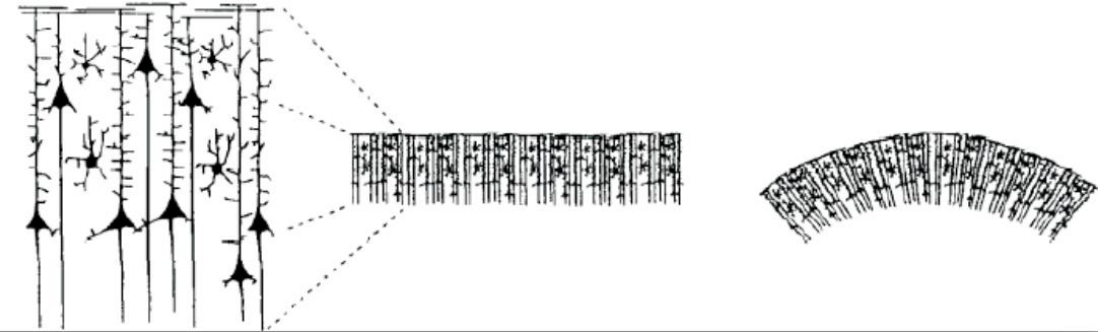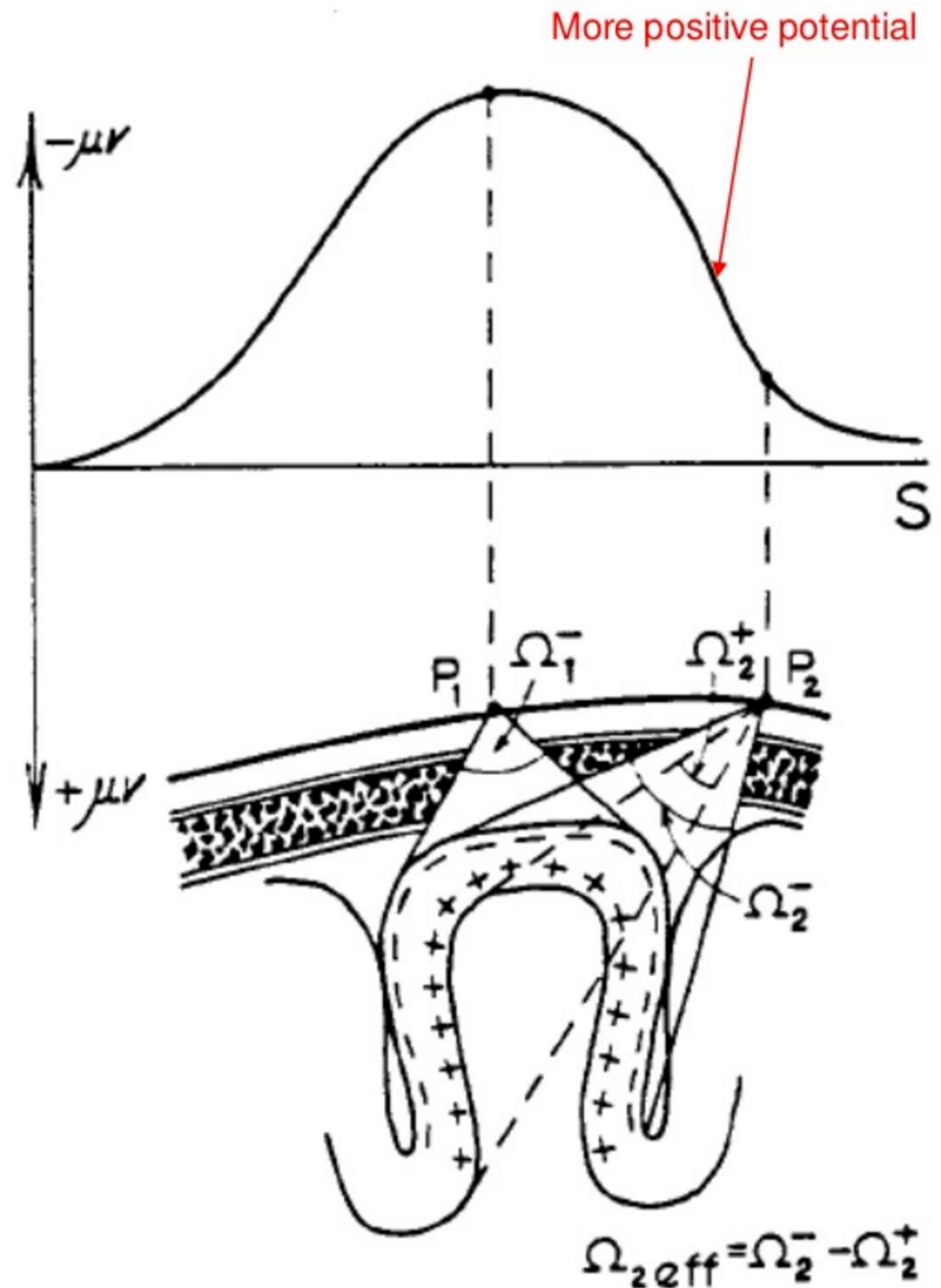
Ω_2^-

$\Omega_{2eff} = \Omega_2^- - \Omega_2^+$

What does(n't) EEG record?

- Not single neurons.

- Not action potentials

- Not all neurons.

- Not the whole cortex.

- Not subcortical structures.

- Various non-brain things.
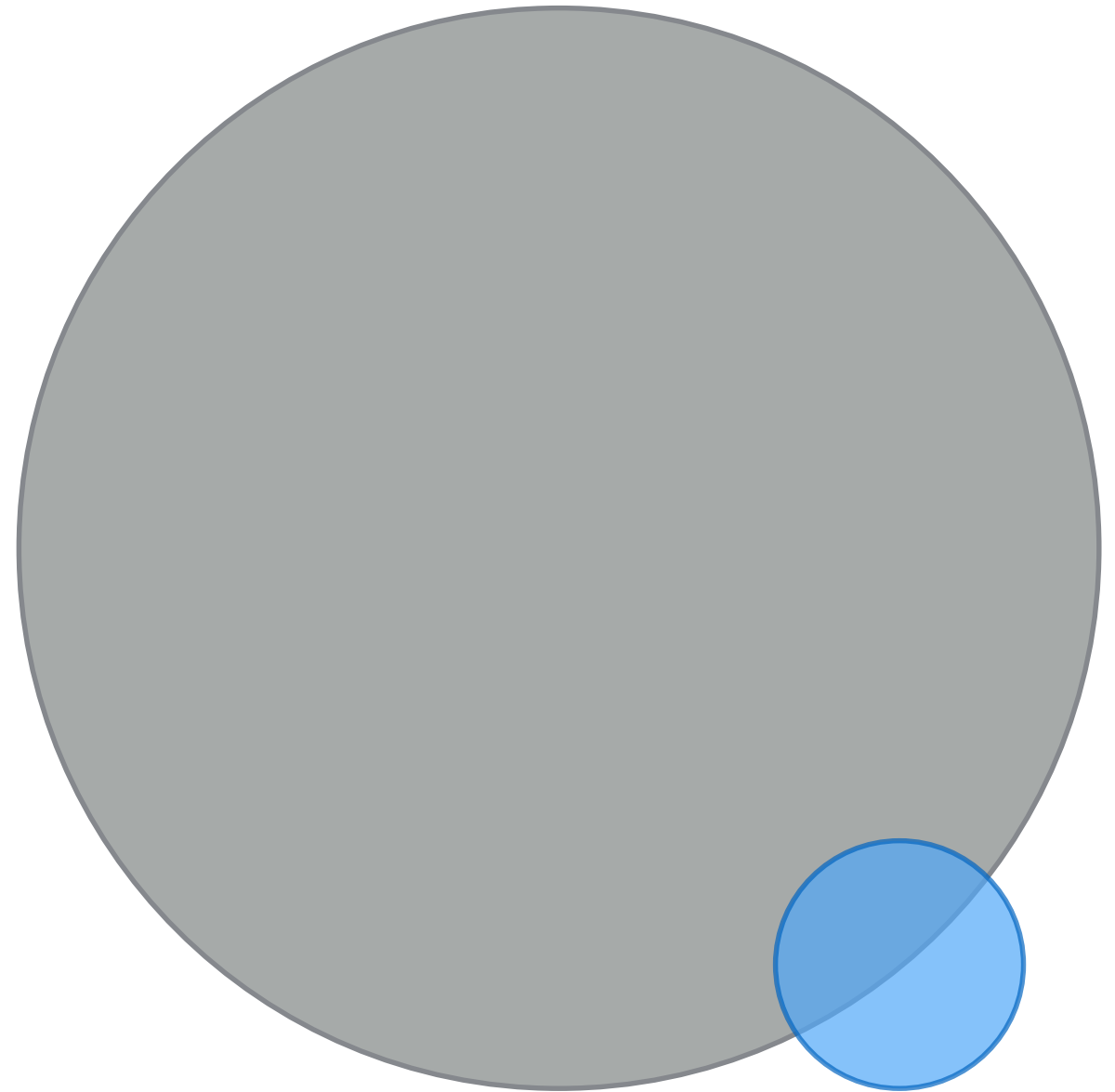
Things in the brain
Things recorded by EEG

1 Why preprocess EEG data?

2 Preprocessing pipeline for MVPA

3 Further resources

A standard preprocessing pipeline:
Stage 1

Load the raw datafile and convert it to an eeglab structure

Recode triggers using a user-created script

If any electrodes were swapped during recording, swap them back in the data structure

Splits runs and save them as separate files (if desired)

Delete irrelevant channels

Apply high-pass, low-pass, and notch filters.

Re-reference all data

Epoch the data

Baseline correct the epochs

First Manual Removal of Bad Epochs
[remove all muscle, skin potential and other artefacts, but leave in eye blinks]

Rereferencing

Electrical potentials are only defined with respect to a reference (acting as a "zero level").

Reference site should be affected by global voltage changes that affect other electrodes.

Reference site should not be (more) affected by any other signal.

There are a range of commonly used reference sites. We typically use the mastoid bones.

Other options include Cz, average reference, nose, earlobes.

A standard preprocessing pipeline:
Stage 1

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Epoch the data

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First Manual Removal of Bad Epochs
[remove all muscle, skin potential and other artefacts, but leave in eye blinks]

Baseline Correction

EEG recordings are subject to a drift component. As the conductive properties of skin, gel, and electrodes change over the course of a recording session, the 'baseline' voltage at each electrode changes.

Baseline correction removes this component by 're-zeroing' at the start of each epoch. Baseline period should be chosen based on intended analyses.
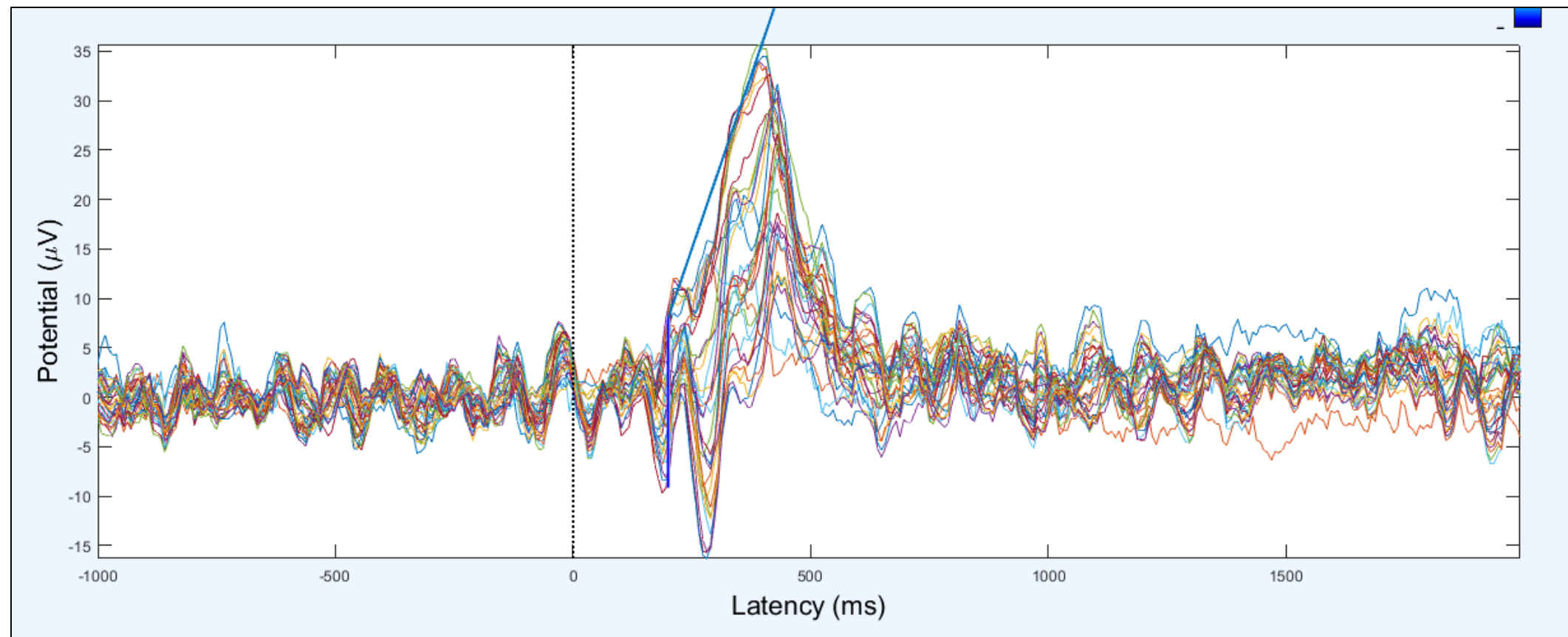
A standard preprocessing pipeline:
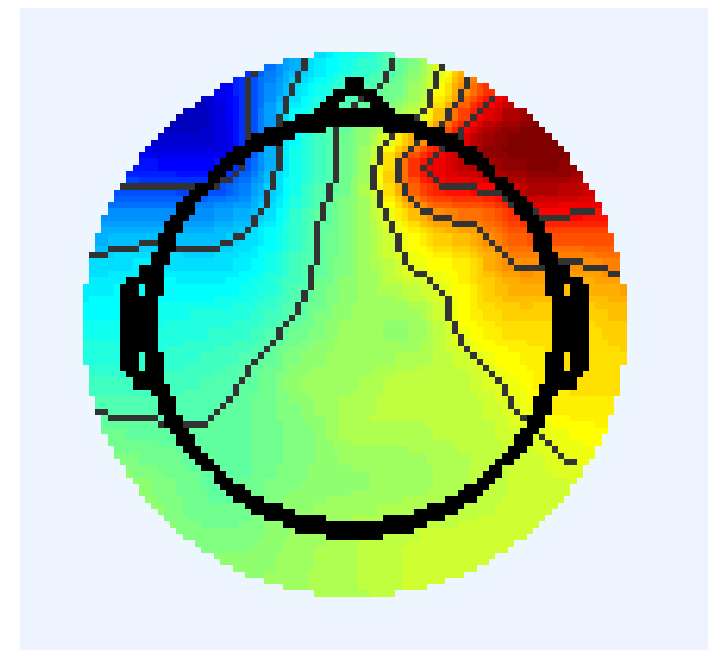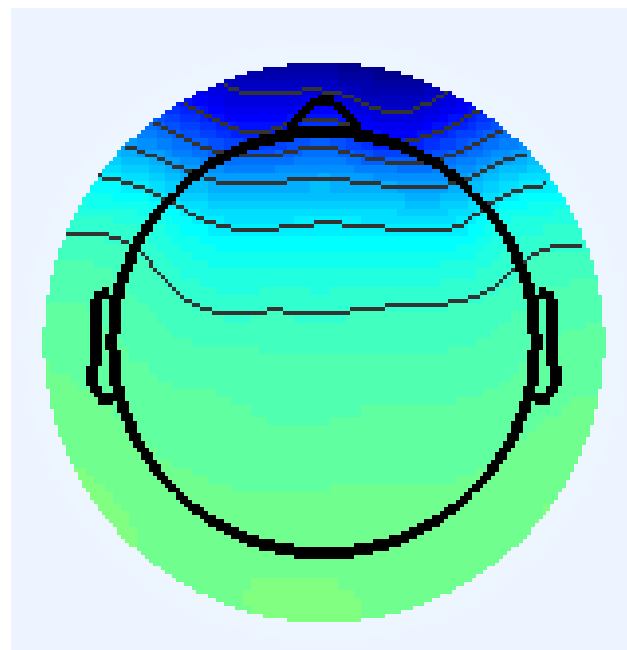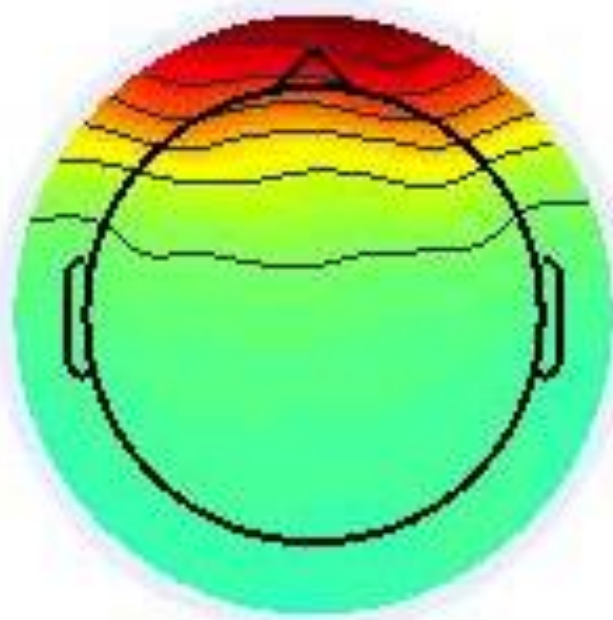## Stage 2

Merge the runs back into a single file (if necessary/desired)

Baseline correct the epochs (again)

Perform an ICA

Interpolate any missing or noisy channels

Manual Identification of Eyeblink Components:

A standard preprocessing pipeline:
Stage 3

Remove the eyeblink components that the user has manually identified

Baseline correct epochs

Rereference epochs

Second Manual Removal of Bad Epochs
[remove any residual eyeblinks that survived correction]

A standard preprocessing pipeline:
Stage 4

Perform a final automatic rejection of noisy epochs

Perform a final ICA analysis
   (not necessary for preprocessing, but the ICA components may be useful for analysis)

Perform a current source density (CSD) analysis

Baseline correct post-CSD

Make files compatible with ERPlab
   (optional – only for when you are using ERPlab for ERP analyses)

Clean up output directory

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Further resources:
A preprocessing pipeline for EEGLAB

Over the last couple of years, our lab has developed a preprocessing pipeline which incorporates all of the steps that I have gone through above.

It's still in beta, but for those interested, the latest version can be found on my github page:

http://github.com/danielbrianbennett/eeg-preprocessing

It needs to be updated to work with MATLAB 2015 & EEGLAB 13 (coming this month), so if anyone is interested in using it before then, make sure to use MATLAB 2012 & EEGLAB 12.

A standard preprocessing pipeline:
MATLAB interface

Code as follows:

EEGPreprocessing('K7.edf','stage1',@config_DARPAK)

Where   K7.edf is the name of the raw datafile

stage1 is the name of the preprocessing stage to do

@config_DARPAK is the name of the config file