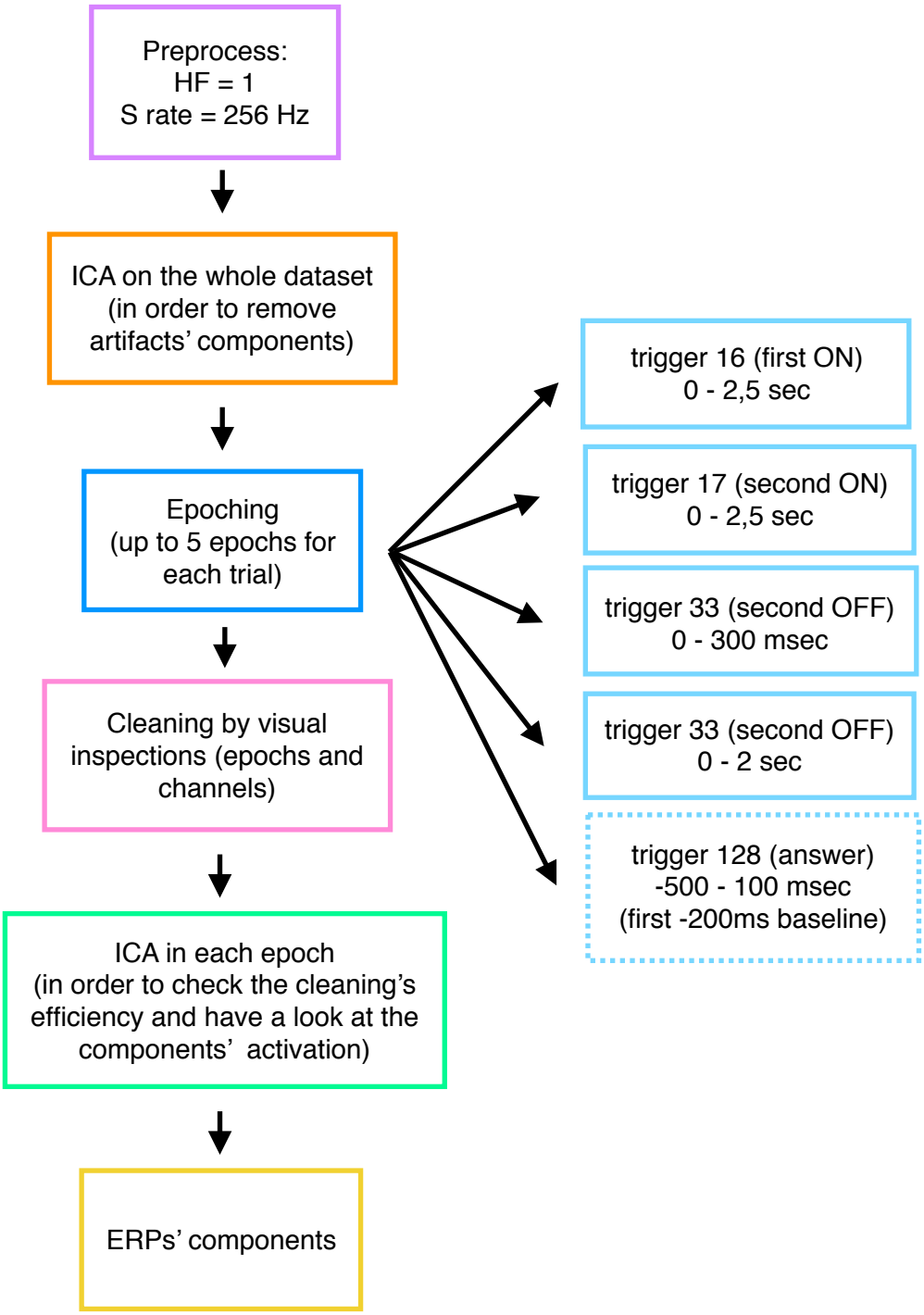
EEG Analysis - Step Overview

Analysis' Scheme

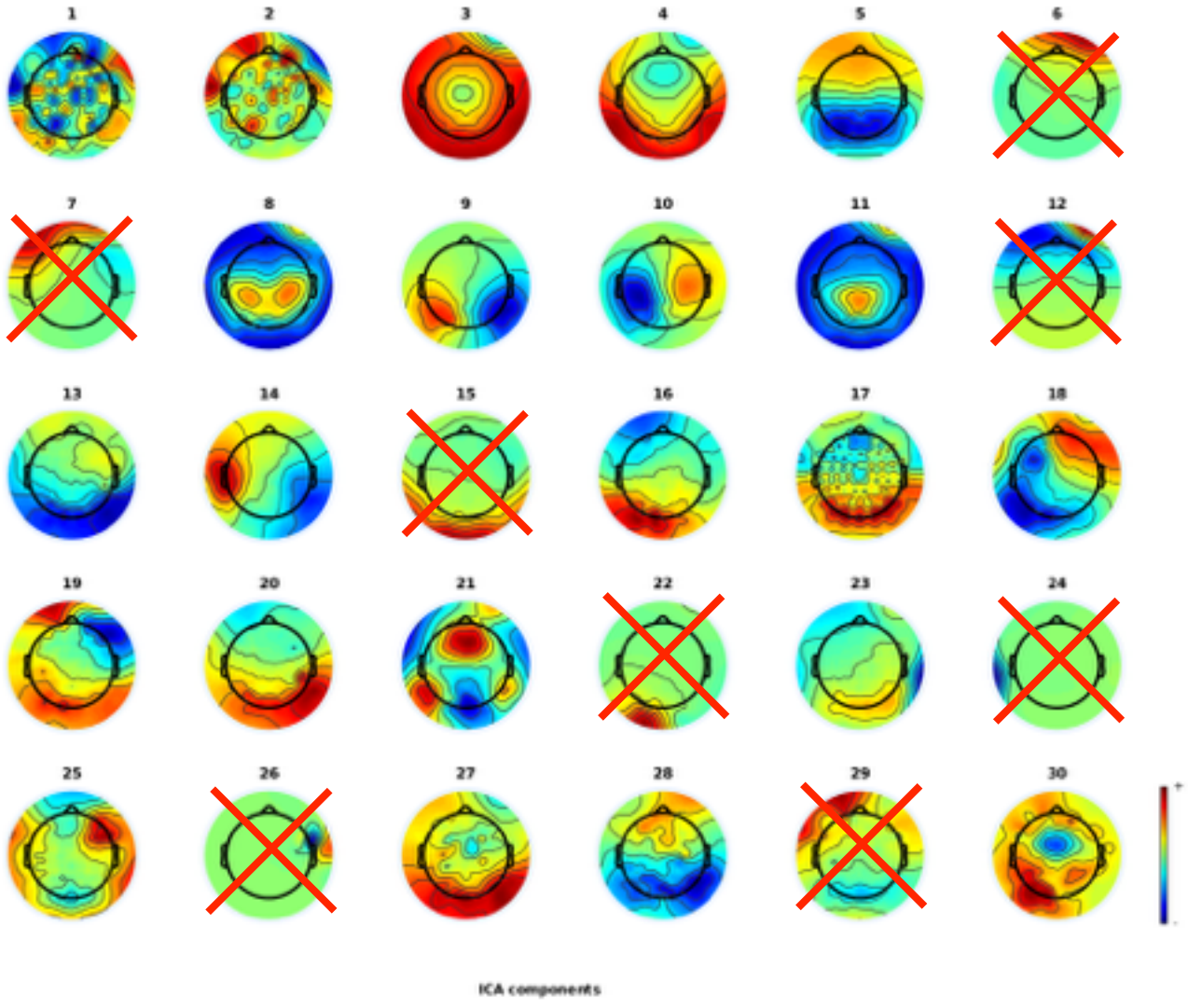


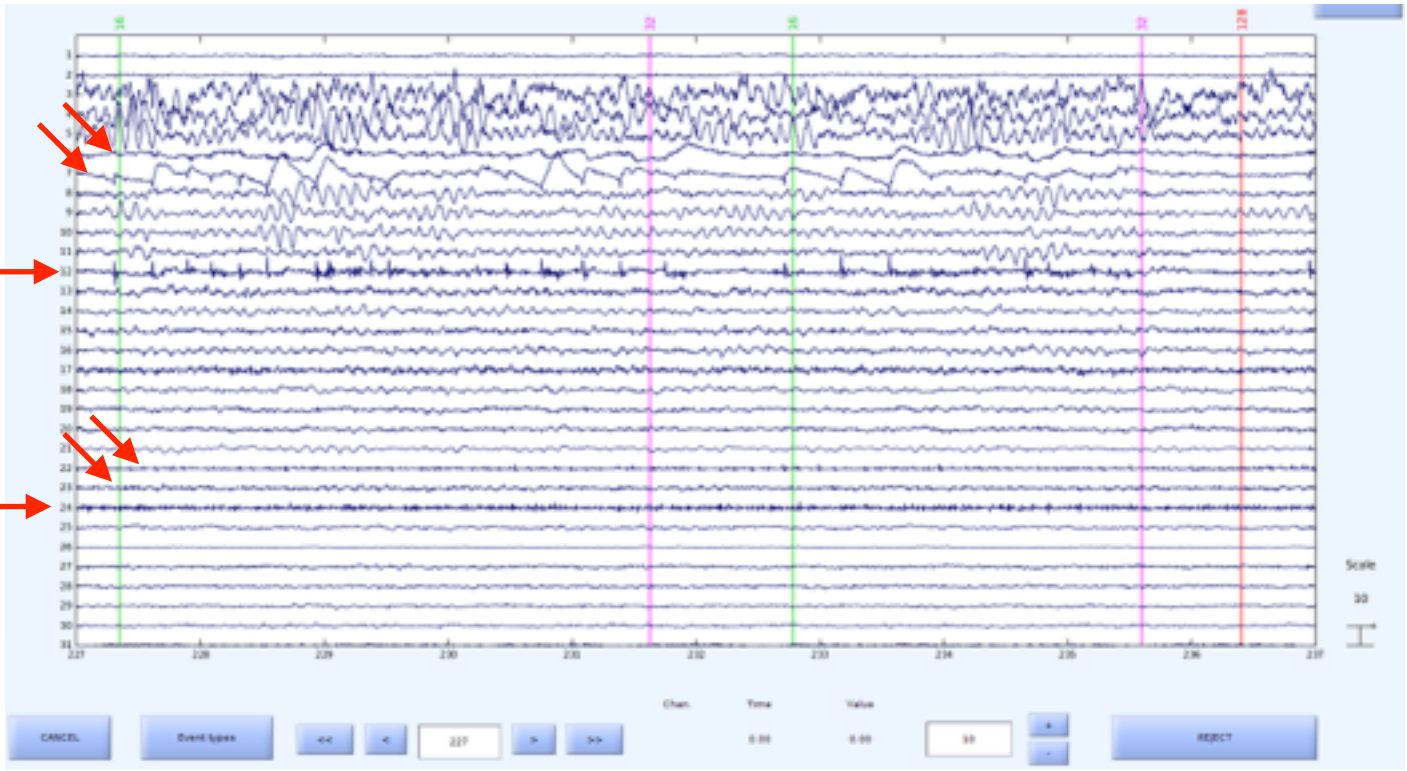
Preprocess

The very first step in preprocessing the data consists of converting the raw data (.cnt extension) in .set files. At the same time, we change the sampling rate (e.g. 256 Hz) and high pass filter the data (HP filter = 1). In the initial steps is important also to account for the deblanking of the triggers. “Unused” channels are also removed in this phase (“*Cz*”, “*HEOG*”, “*Ref*”, and “*CzOtheram*”).

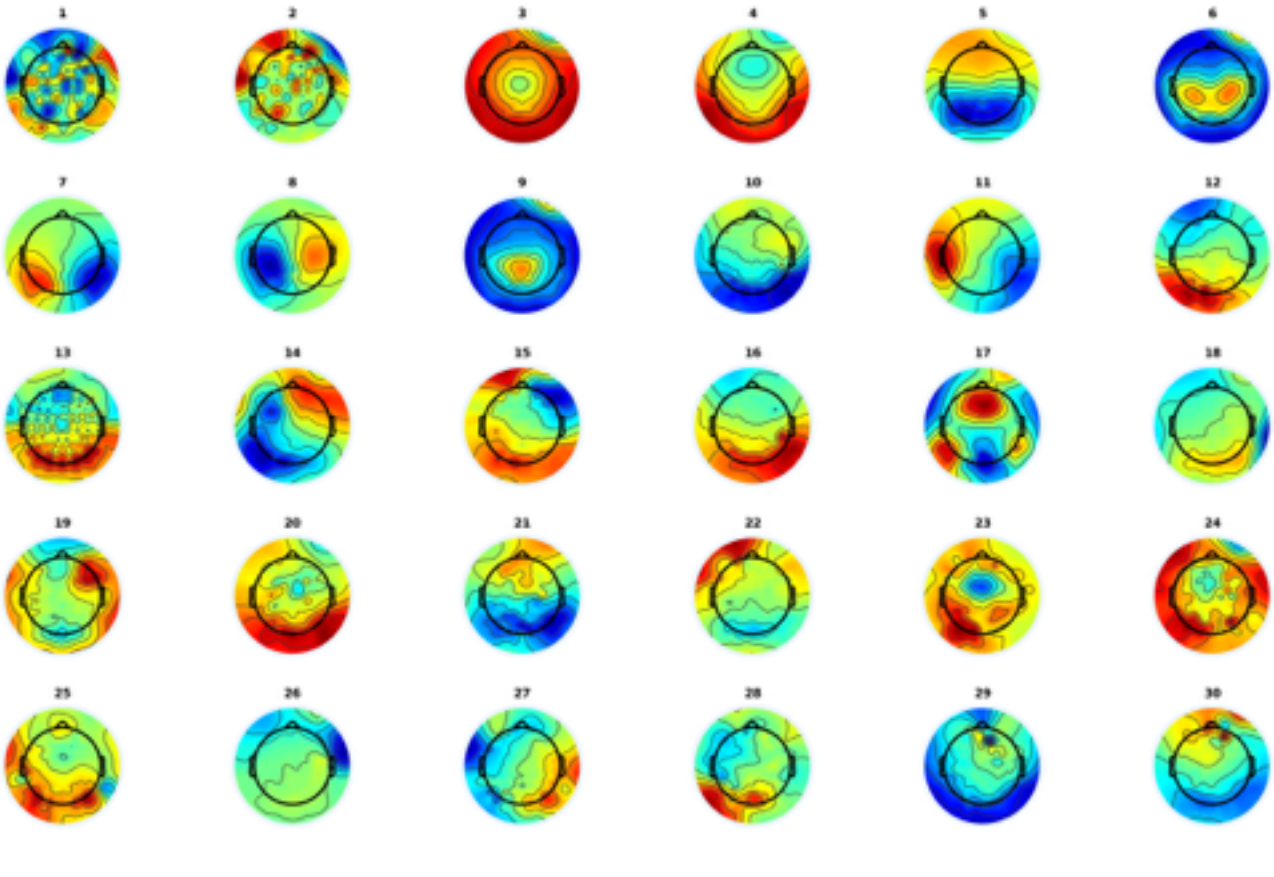
First ICA

Once we have computed these basic initial steps, we want to run an ICA (runica) on the dataset in order to use the components for cleaning the data (i.e. eye artifacts).
The next steps involves looking at the components (i.e. first 30 components) and the EEG data in order to identify “noise” components and clean our data (for further information see *Plöchl et al., 2012*).





Identified the “noisy” components by visual inspection, we subtract those components from all the channels.
After removing the identified the components, the topoplots look as below:

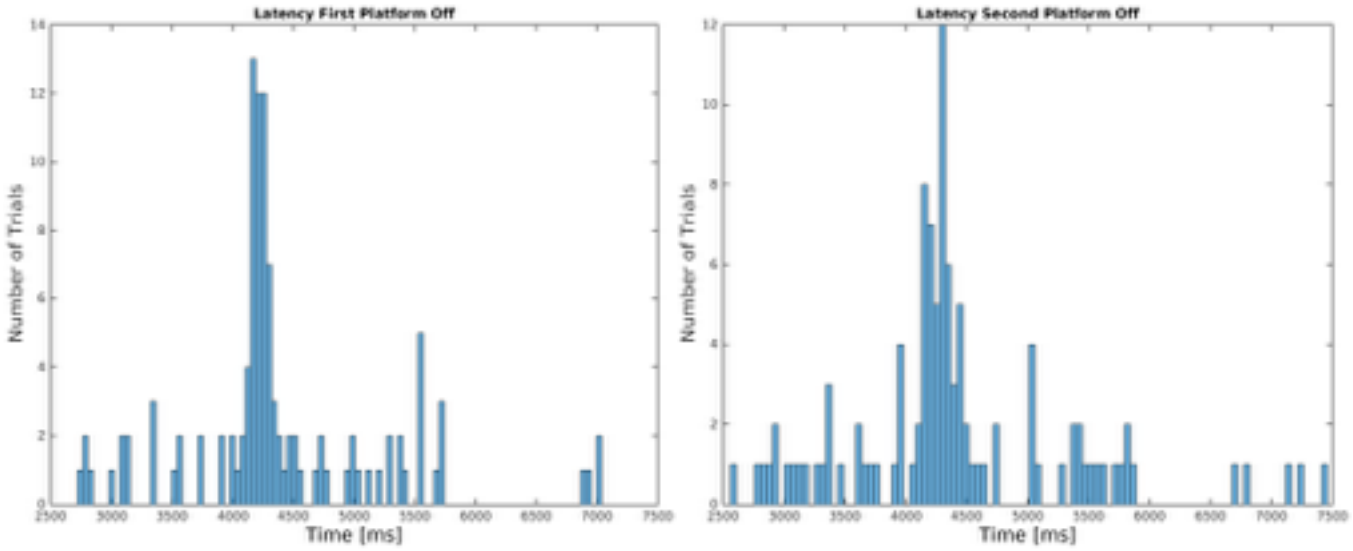


Calculating Latencies

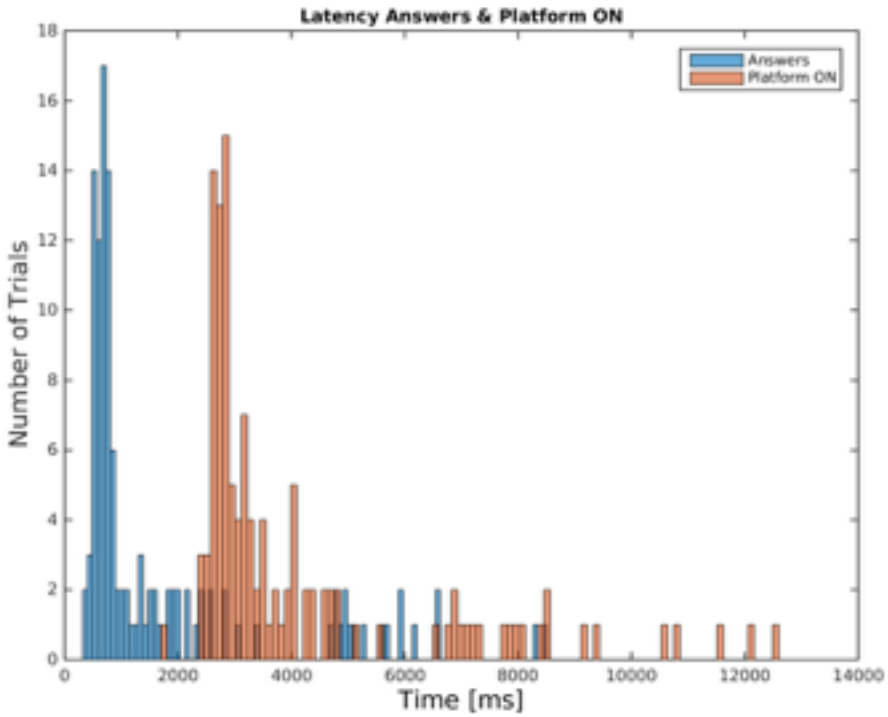
After having cleaned the dataset from “noisy” components (e.g. eye components) through the ICA components, we wish to epoch our dataset. We want to compute different epoching based on the different triggers in order to consider all the different information occurring in each trial (e.g. first rotation onset, first rotation offset, etc.).

For epoching our dataset we should keep in mind some crucial peculiarities of our experiment design. In particular, each condition includes 11 different angles (included the reference angle). Actually, the angles are 12 if we consider also the catch trials (one angle of the catch trials is not in the range of the angles we use for the “normal” trials). This means the different trials have different difficulty based on the angular difference. In the epoching frame, this also means that not all the trials will have the same length. Therefore, we want to calculate the different latencies’s distribution for each trigger.
After having renamed the triggers, one trial looks like:

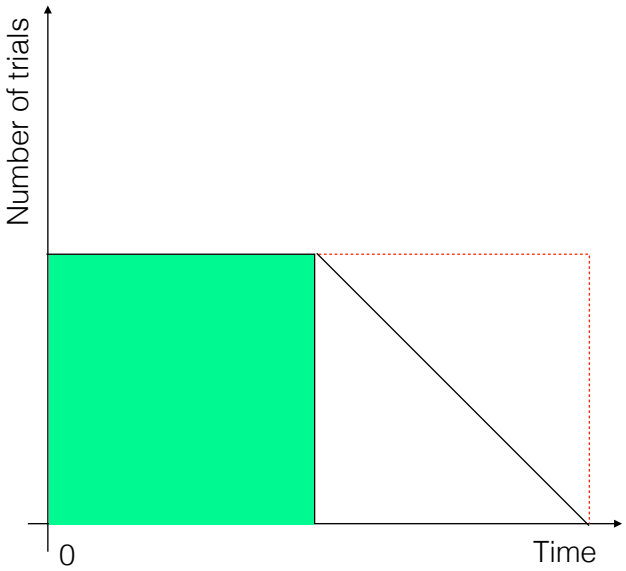
In order to isolate the epoch of the platform onset (triggers 16 and 17), we calculated the latencies of the platform offset (see Fig. below). As the two rotations have a similar latency, we decided to employ the “minimum” latency’s value to cut the epochs, such that in any epoch is included a platform offset (in this case minimum ~2500 ms). The two epochs of the start of the platform will have the same length for consistency (since their minimum latency is really close).



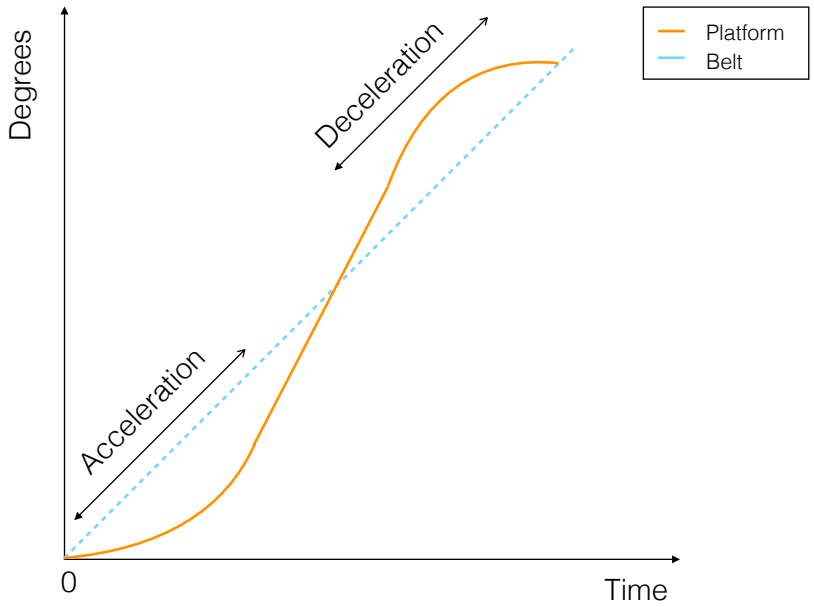
For the epochs of the second platform offset's trigger, we calculated not only the latency of the answers, but also the next platform onset (see Fig. below). As visible in the plots, most of the answers occur within the 2000 ms after the second rotation's offset. Also, in this time window, in only one trial the next rotation's onset happened (we could exclude the trial directly).



A different possibility would be to include all the answers within the first 2000 ms and then include only the trails whose answers happened later in time (see Fig. below). What we definitely do not want is to include all the trials until the last answer occurred, because in such a way we would include a relevant number of information about the next platform's onset (red dashed line).



In the previously plotted histograms, according to our experimental design, we would expect to have 11/12 groups of beans, representing the 11/12 different angles. However, this grouping is not really clear. This is do to the acceleration/deceleration of the platform. Namely, although we employed a constant platform's speed, the initial and final phase include respectively an acceleration and deceleration phase. In such a way, the angular groups are not so distinct anymore. Additionally, the platform is not perfect and there is already associated a certain error in the time of each rotation. The Fig. below explain this property. The blue dashed line represents the belt. In fact, the platform does not have this property, so we would expect to see the distinct groups of angular difference in the histograms of the tactile condition.

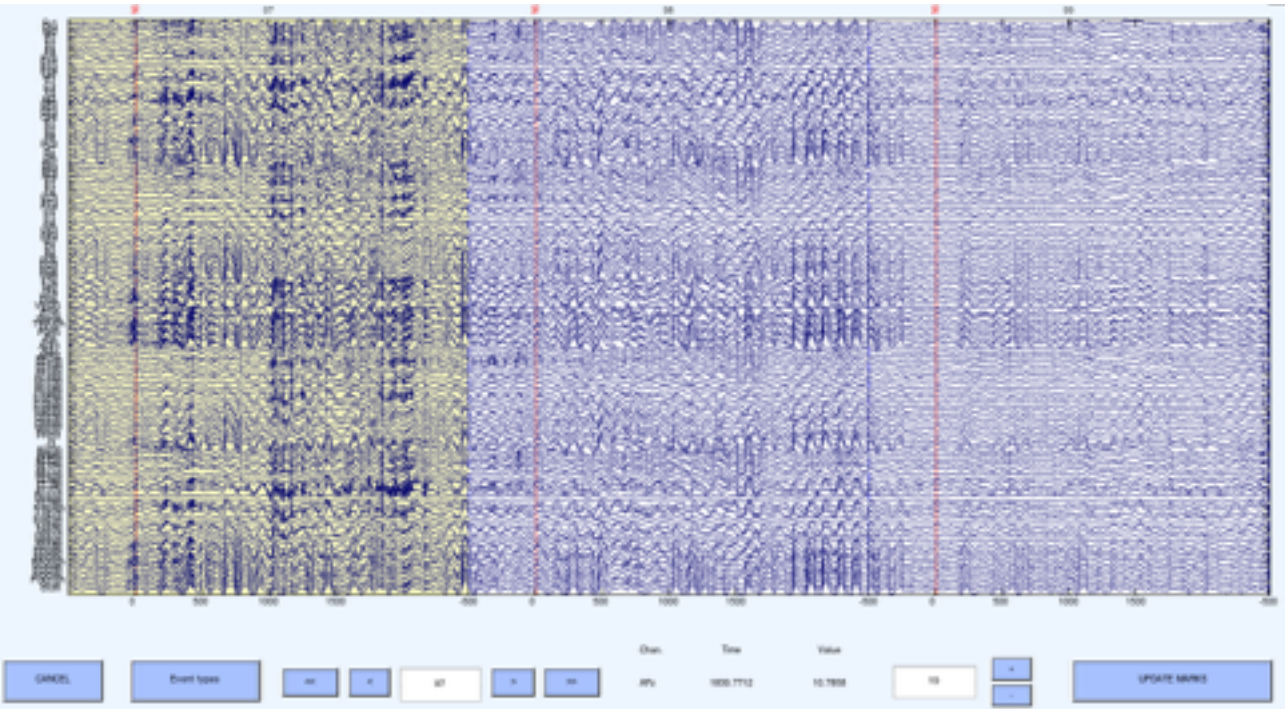


Epoching

We decided to epoch the dataset according to the different triggers. In particular, we want to compute 4 different epochs' cut for each dataset.

I. epoch 16 (0 - 2500 ms)

II. **epoch 17 (0 - 2500 ms)**



III. epoch 33

a. only decision phase, no answers included (0 - 300 ms)

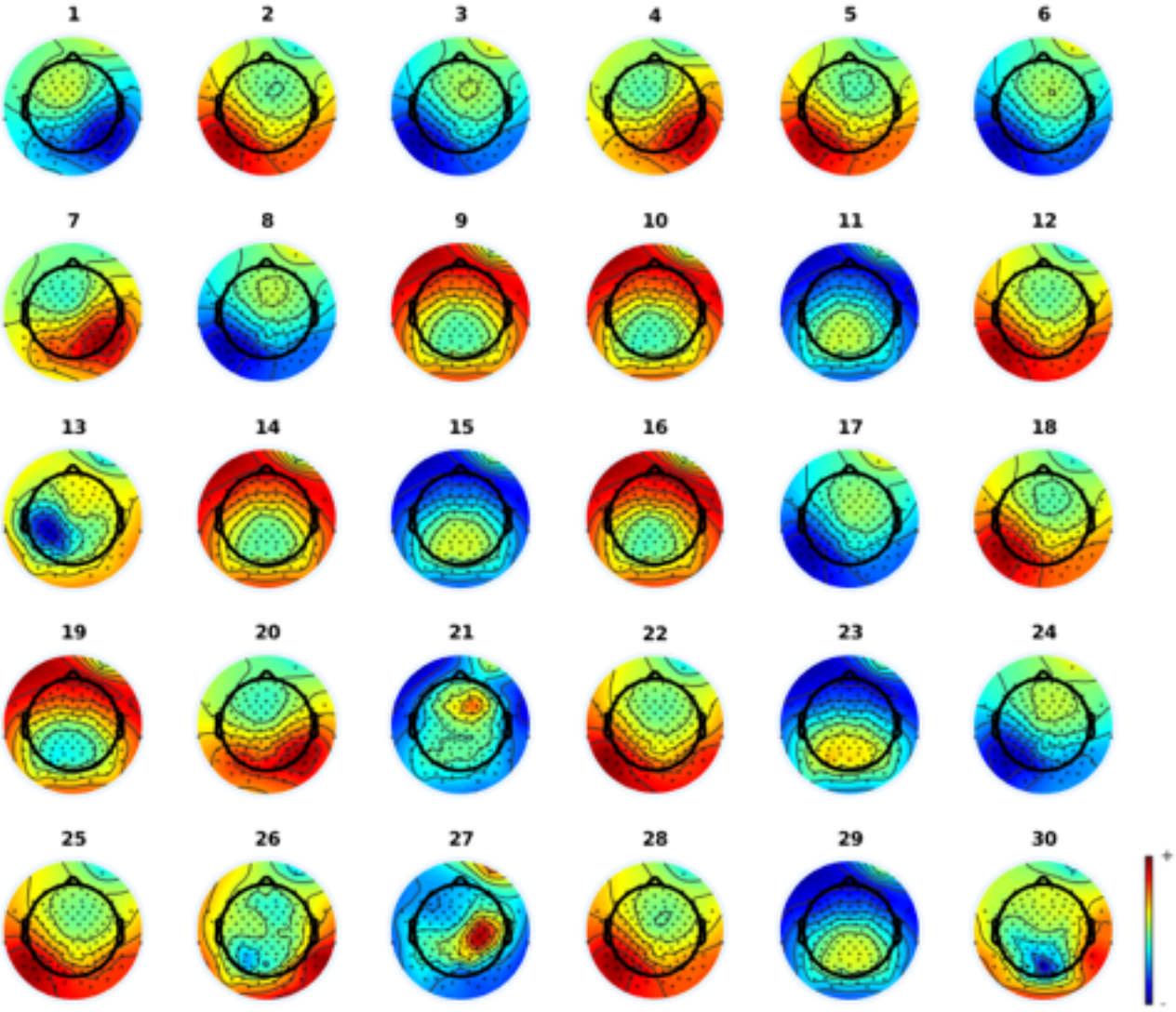
b. answers included until no next start of the platform is included (0 - 2000 ms)

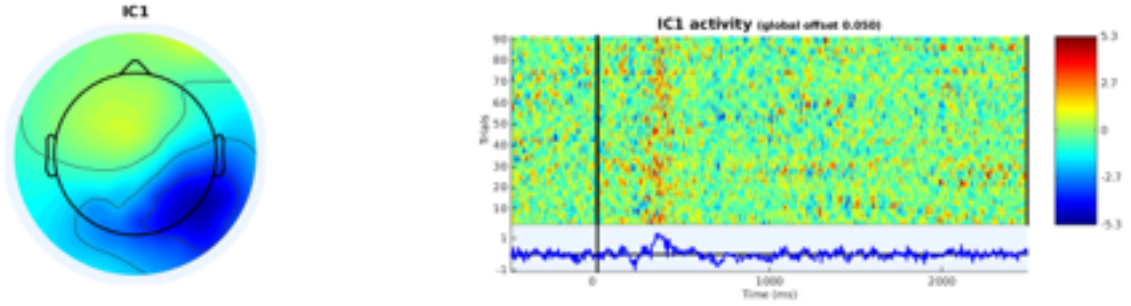
ICA for each epoched dataset

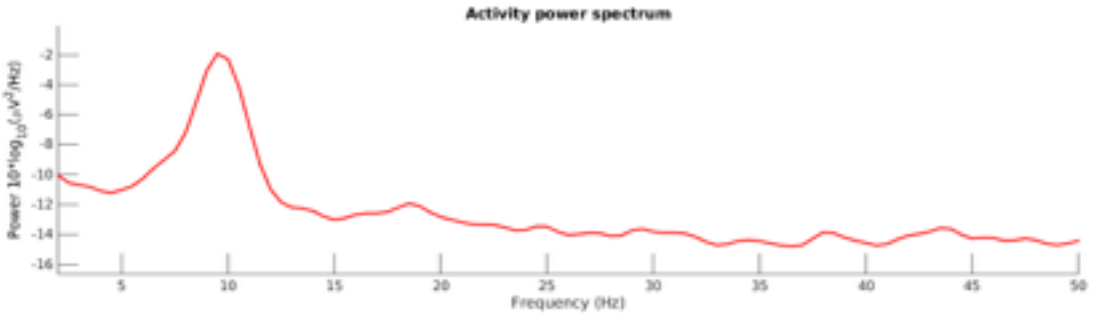
We run a second ICA on all the datasets for the different epochs. The main purpose of these second ICA, contrary to the first, was not to remove noisy components (unless needed) but rather to look at components' activations.
For each dataset we looked at the first ~ 30 components and plot the correspondent ERP. We also decided to include a different approach plotting the ERPs in which the trials are sorted by trials' difficulty (see plots below). Below are reported a few example.

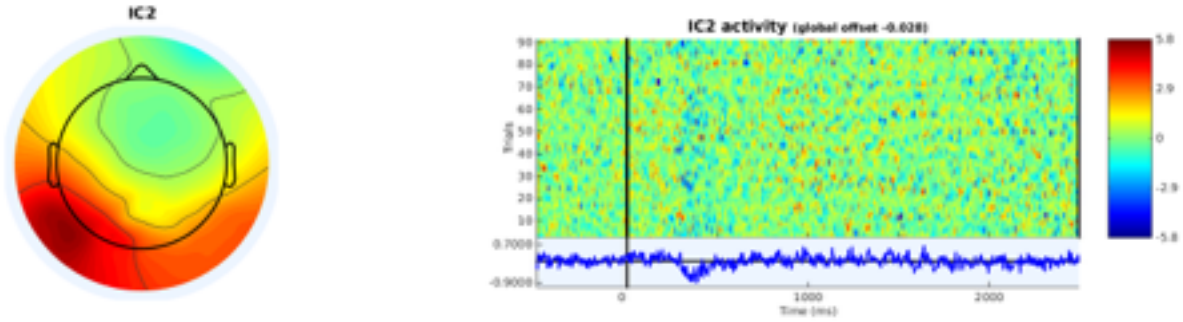
subj 32_sess3_bimodal

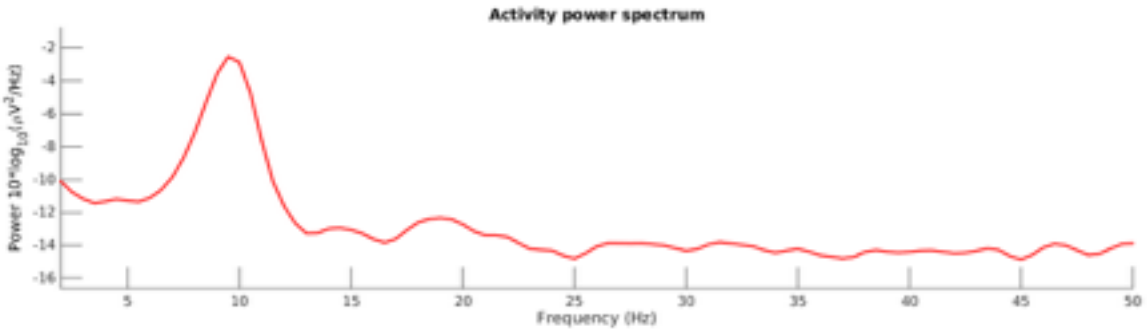
epoch 16

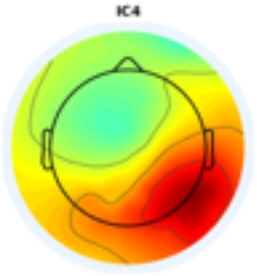


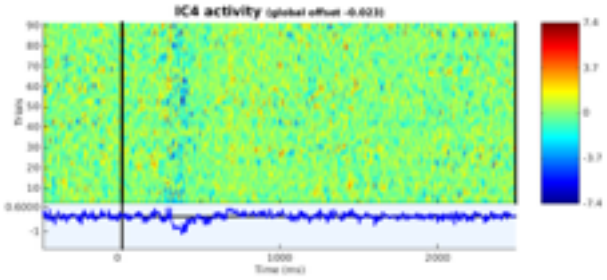

IC1
IC1 activity (global offset 0.050)
Trials
Time (ms)

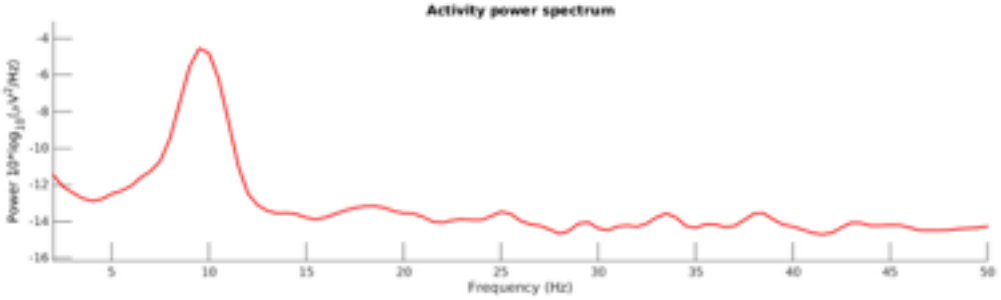

Activity power spectrum
Power 10*log10(uV^2/Hz)
Frequency (Hz)

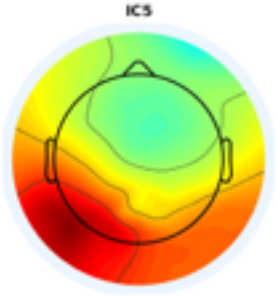

IC2
IC2 activity (global offset -0.028)
Trials
Time (ms)

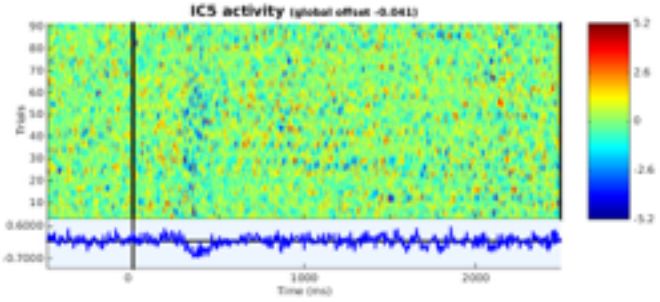

Activity power spectrum
Power 10*log10(uV^2/Hz)
Frequency (Hz)

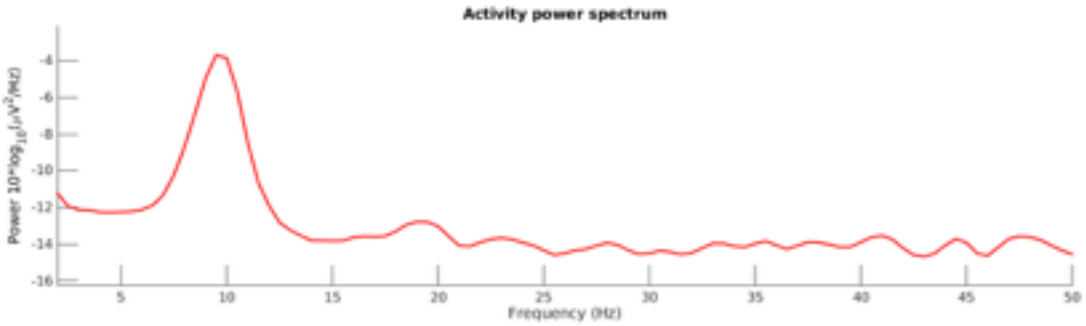

IC4

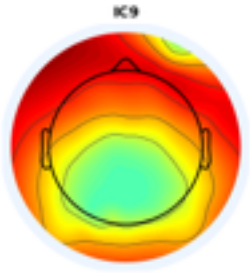

IC4 activity (global offset -0.023)
Trials
Time (ms)

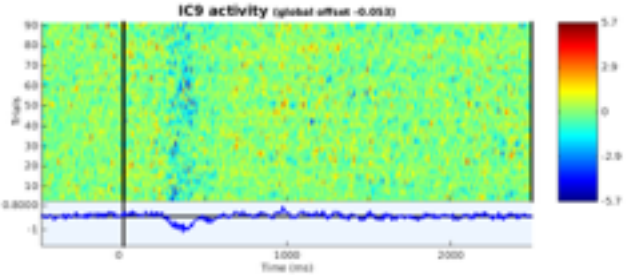

Activity power spectrum
Power 10*log10(μV²/Hz)
Frequency (Hz)

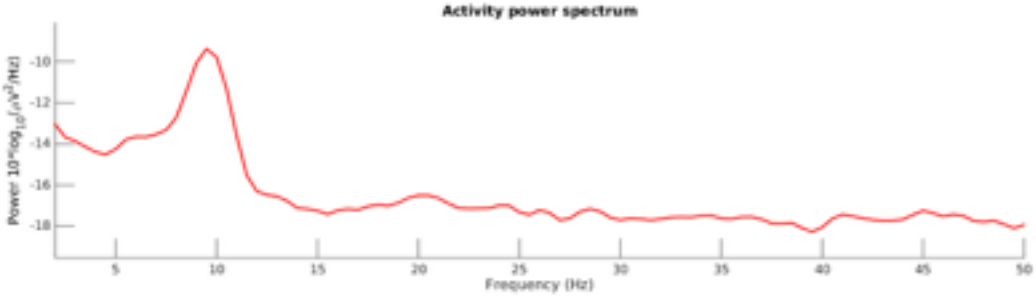

IC5


IC5 activity (global offset -0.041)
Trials
Time (ms)


Activity power spectrum
Power 10*log10(μV²/Hz)
Frequency (Hz)

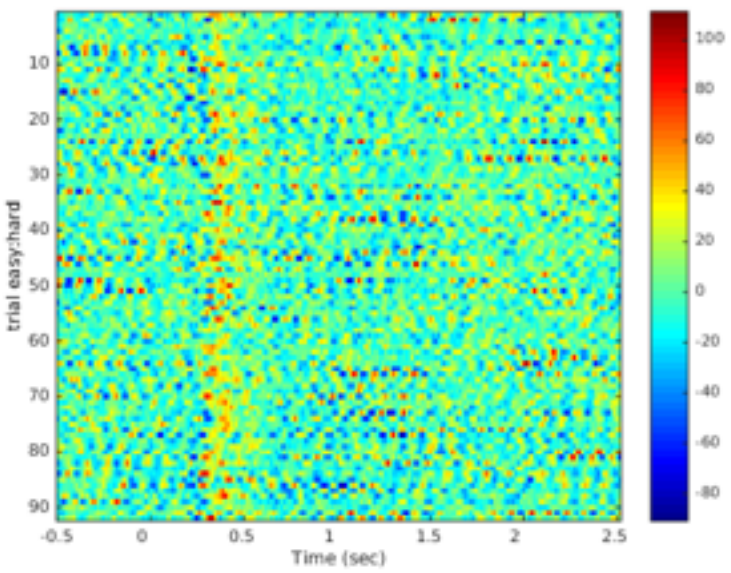

IC9


IC9 activity (global offset -0.053)
Trials
Time (ms)

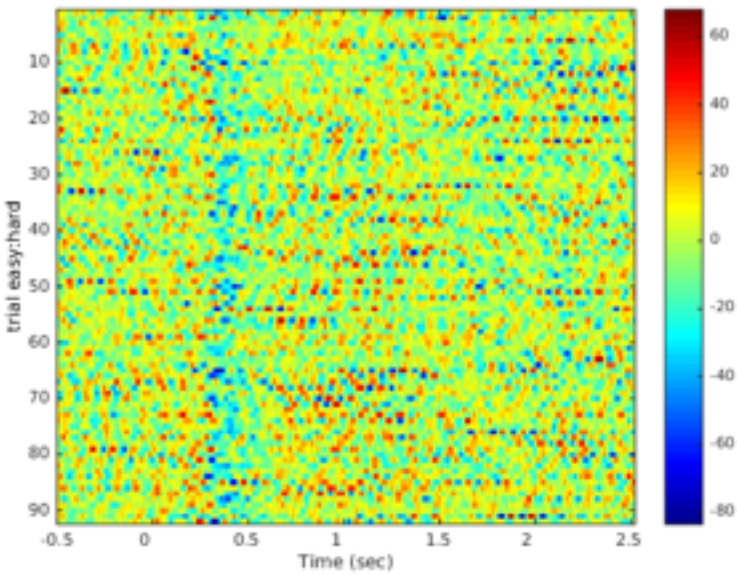

Activity power spectrum
Power 10*log10(μV²/Hz)
Frequency (Hz)

Trials can be also sorted by difficulty (given the 11 subconditions):

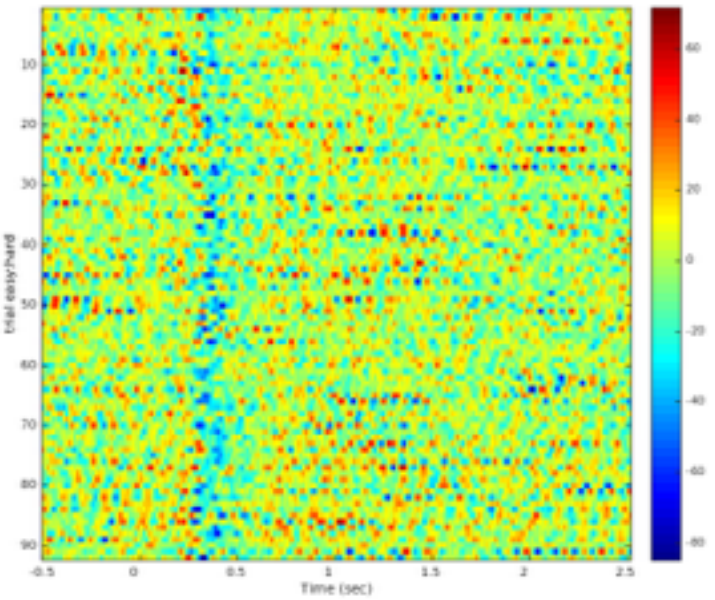
IC 1



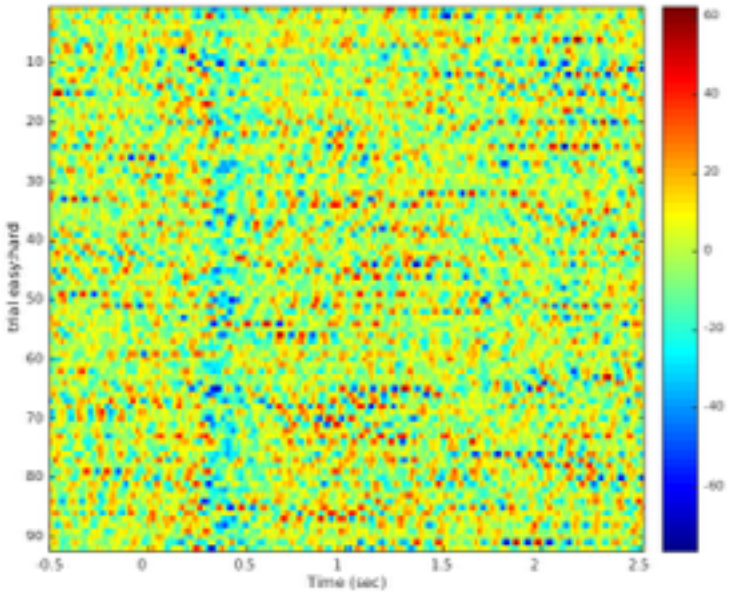
IC 2



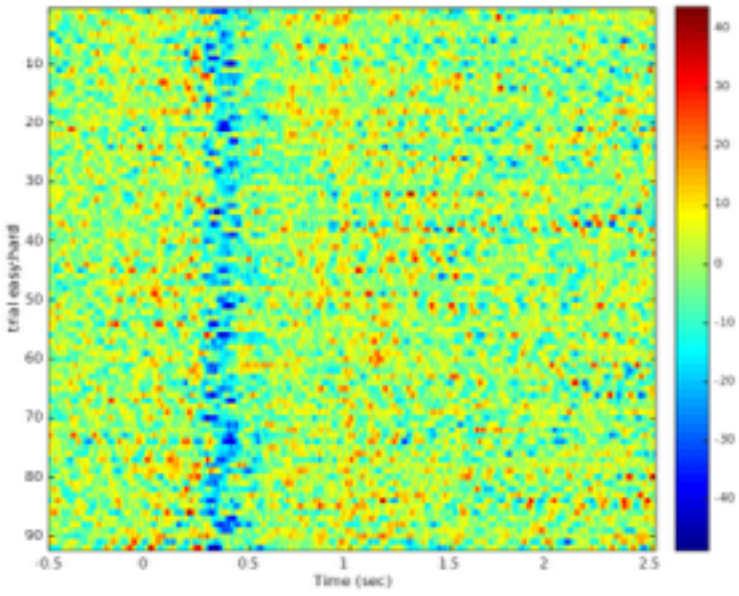
IC 4



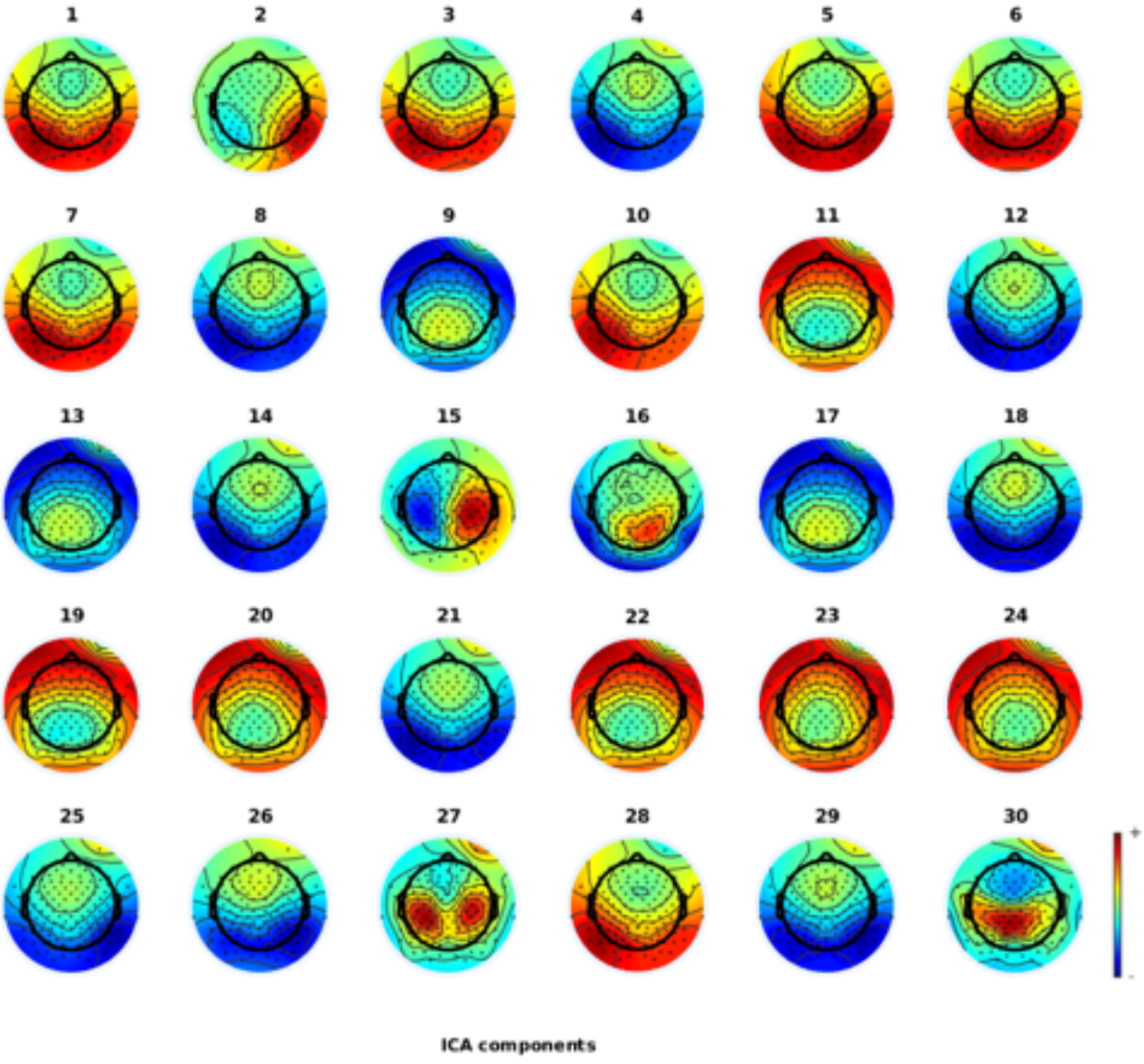
IC 5



IC 9



epoch 17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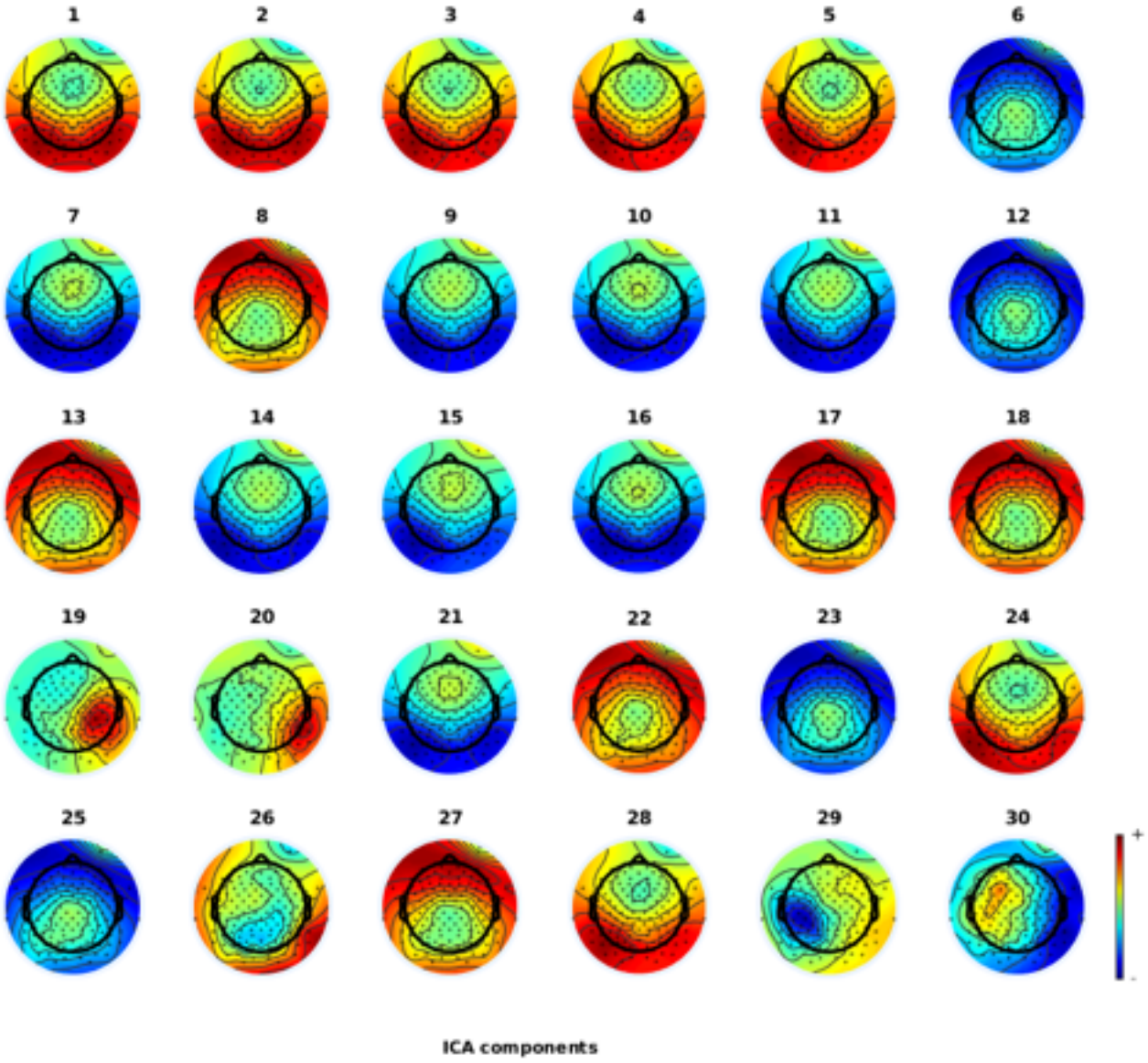
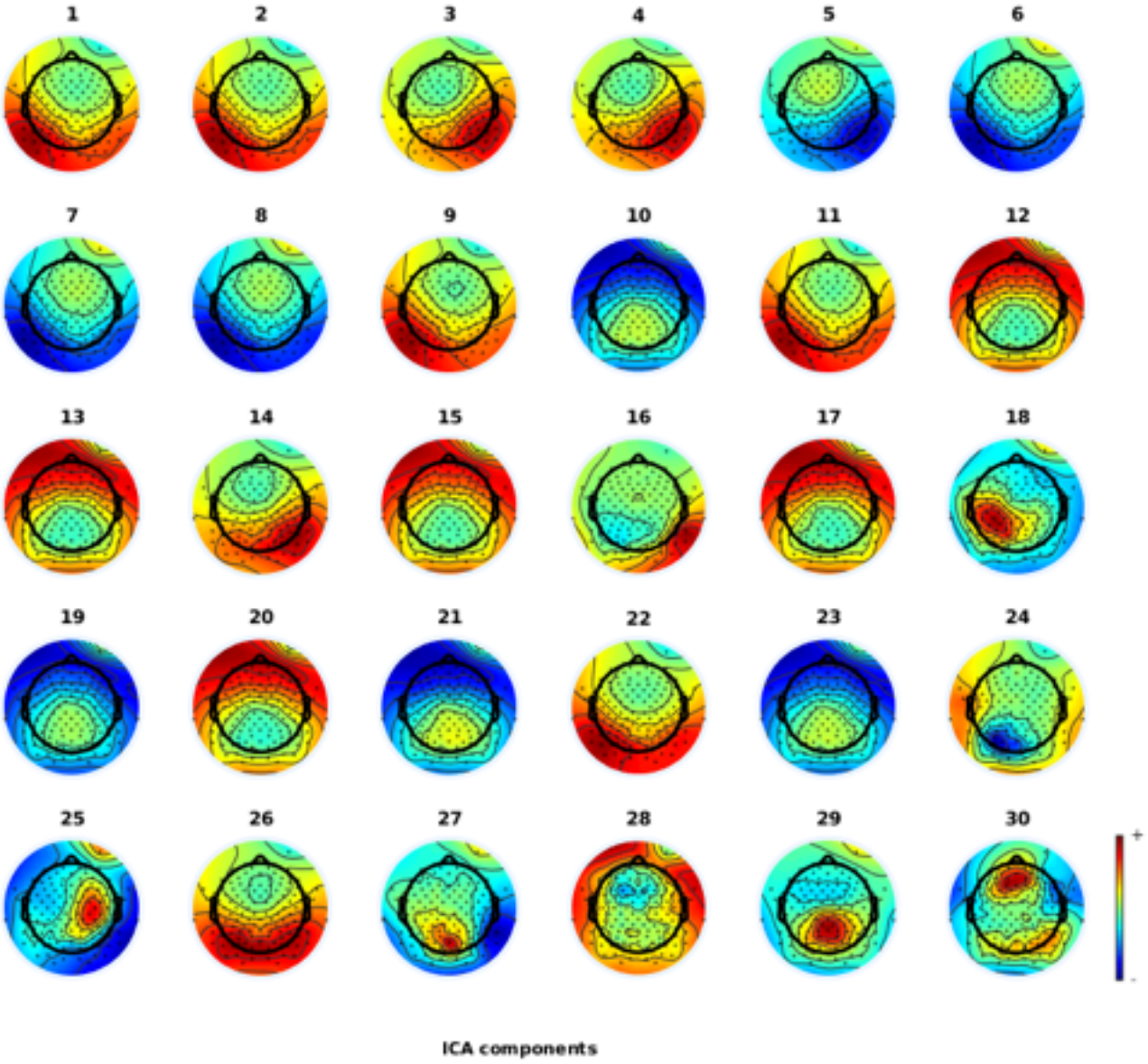
ICA components

epoch 33

a) No answers included

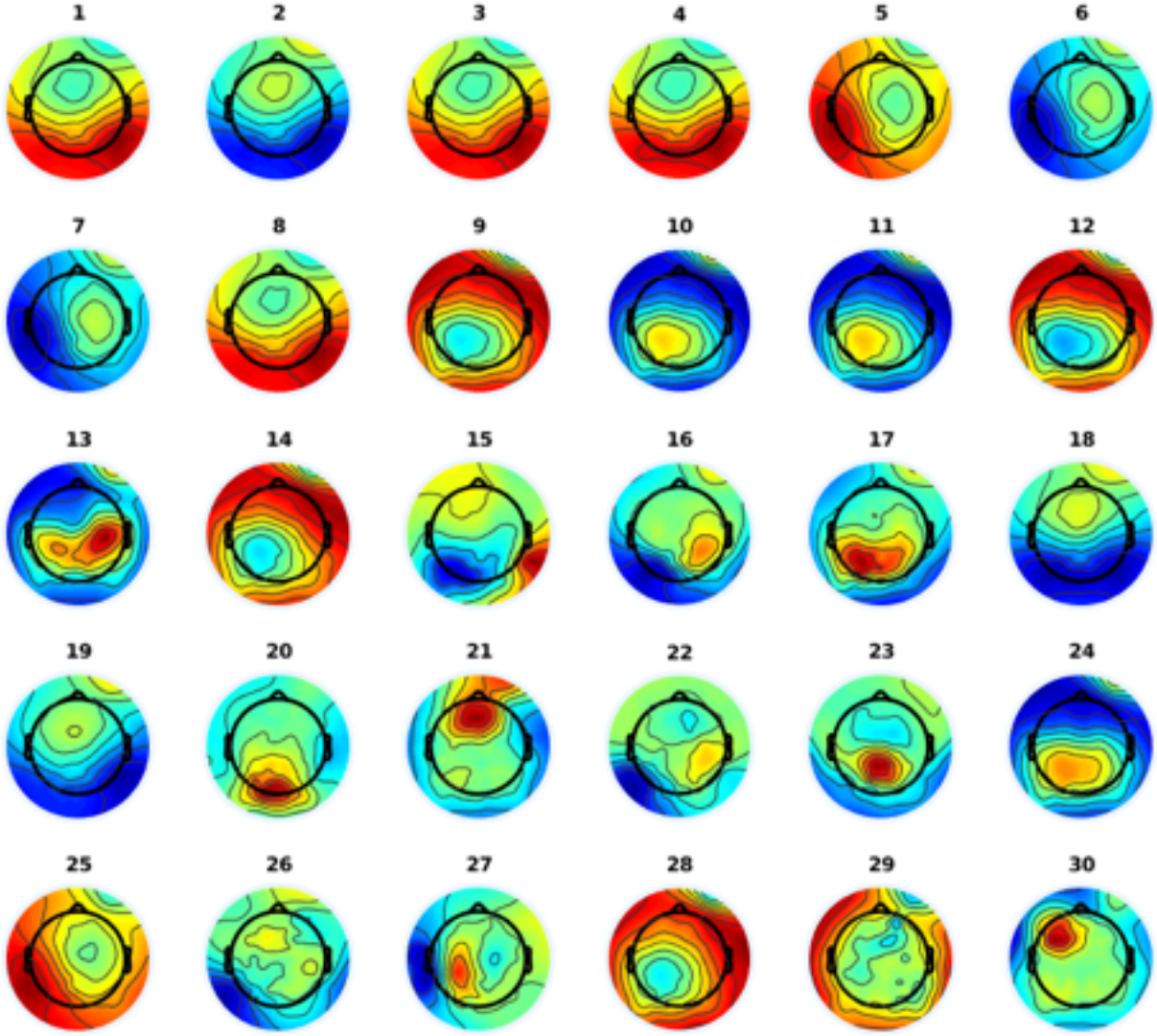


b) First answers included

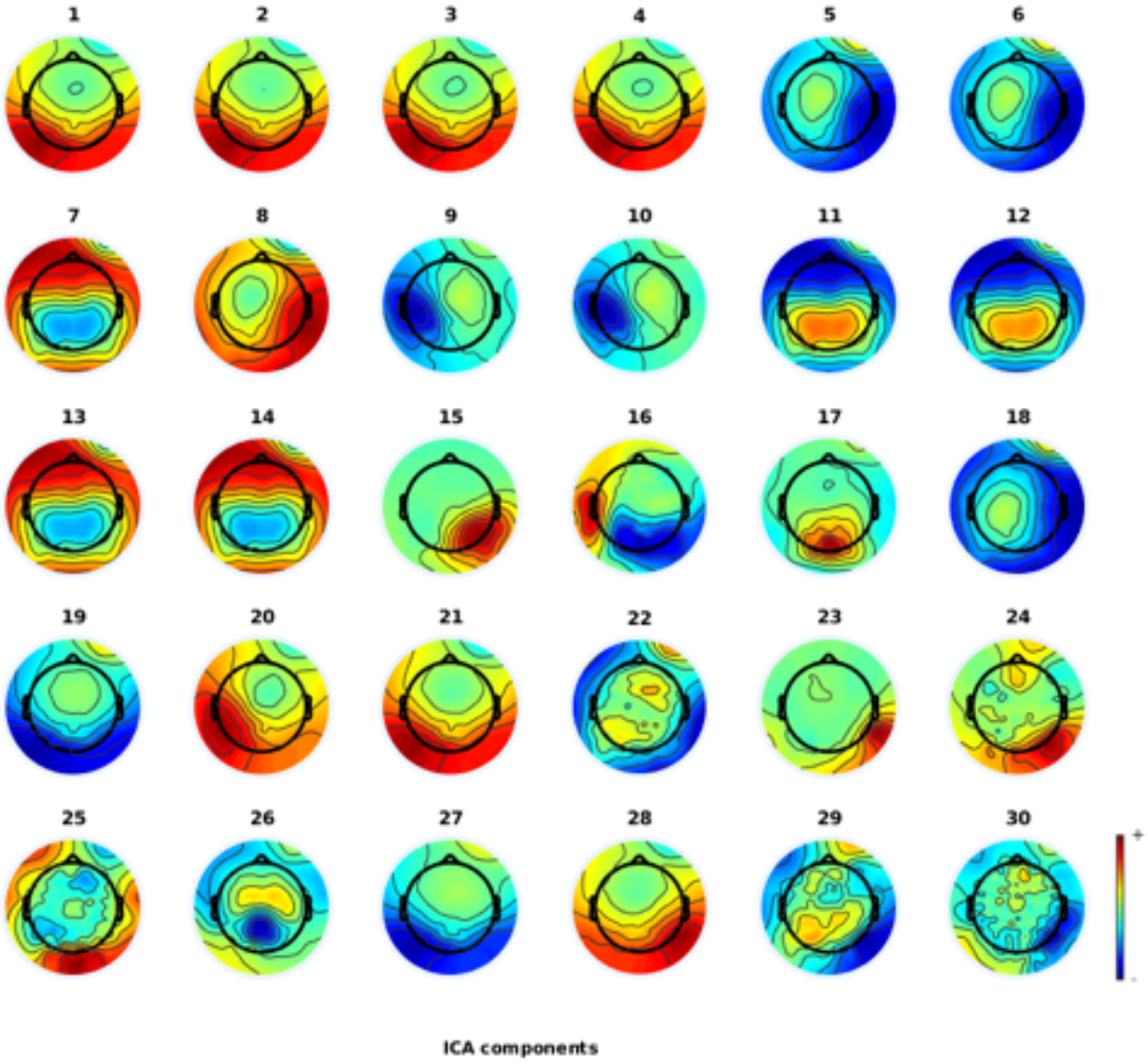


subj 32_sess3_vestibular

epoch 16



epoch 17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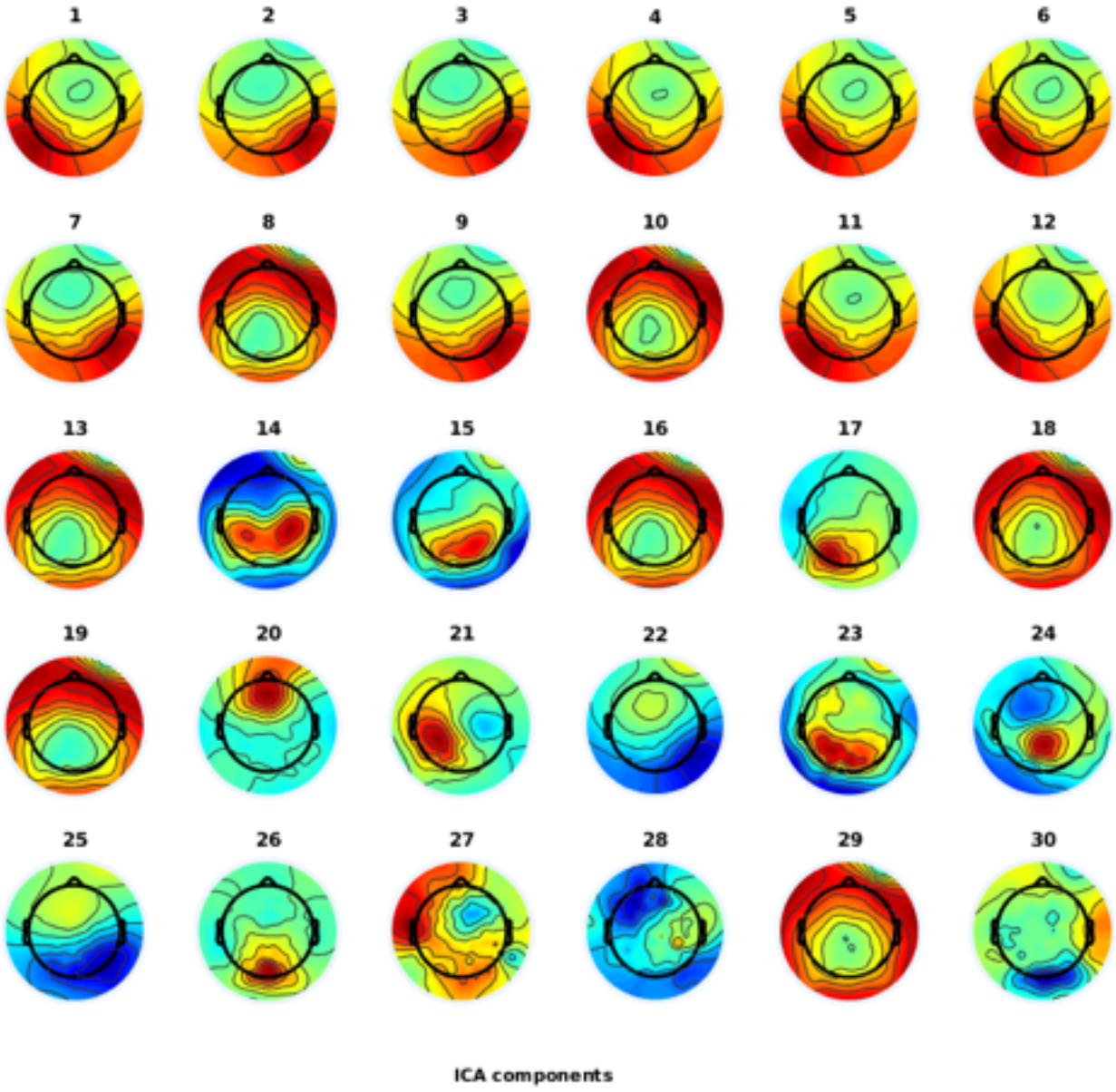
ICA components

epoch 33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ICA components

Points of discussion

- Is our approach good? What shall we change/improve?

- Do we have a “standard” methods to reject components?! Are we doing good?

- Frequency Space —> do we want to look at specific components or do we want to go back to the electrodes-base?

- How do we compare different conditions?

- How to deal with all the alpa activation/components? Do wee keep them?!?

- How to we deal with different subconditions (n = 11) representing the trials’ difficulty?

- What’s next?

- We want to look for any correlation between reaction time and performance —> we have to do it now that we have reaction time implemented in our script.

- We sort trials differently (according to reaction time or trials’ difficulty for example) —> see plots above.

- issue with the belt (last setup issue to solve).

- analyze the new data (all the 3 conditions).

- proceed the analysis.

- - - - - - - - - - - - - - - - - *experimental design question* - - - - - - - - - - - - - - - - -

- If we record several sessions (as the original design), how do we combine them? Do we want to change experimental design (i.e. one session)? —> If we localize electrodes up to 4 hours and more per session, and even if we do it see dbqns project of CAN (they have problems because with EEG even within subject there is a lot of variation), poor participants’ motivation after the first session.
  Alternative? Focus on the EEG and increase a bit the number of trials for each session (i.e. 165 trials per block).

- Do we want to exclude the catch trials?

- If we don’t want to calculate the JNDs, do we really need to have all these subconditions (11)? Maybe we could reduce them?