# EEGpal: **Epoching module**

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The module 'Epoching' has three purposes:

A. As its name suggests, it allows you to create epochs from a pre-processed EEG file. In other words, it allows the signal to be divided into several segments of equal length. The origin of the segment can be a trigger/marker or the whole file.

B. The module also allows artefact rejection. In the 'ARTEFACT REJECTION' tab, you can specify a rejection criterion and the epochs that don't respect it will be suppressed/ignored.

C. Finally, the module allows you to average all the clean epochs to create an Event Related File (ERP), which is the most common type of analysis in EEG.
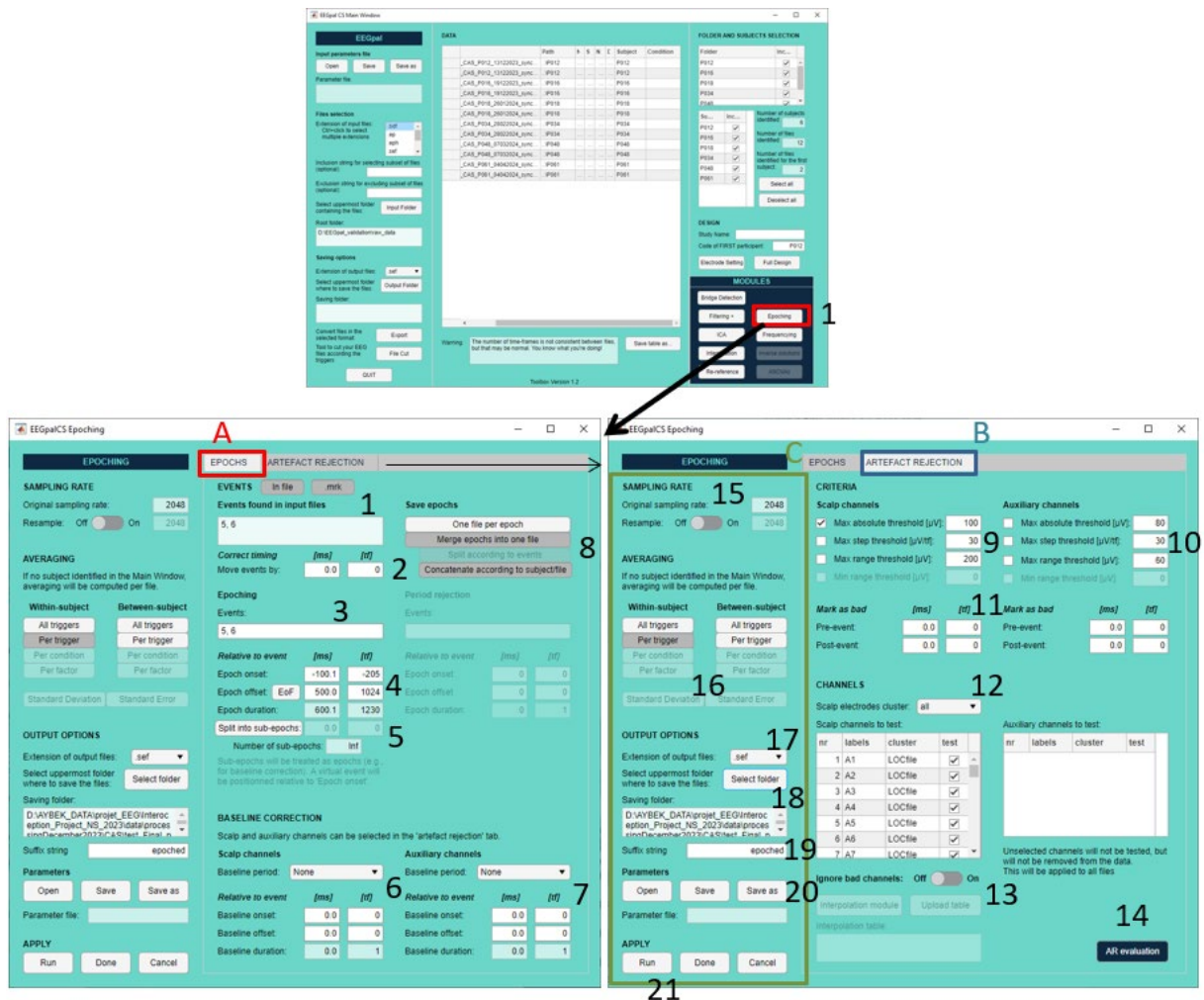
Pannel A: EPOCHS

1. In EEGPal, we have made a distinction between triggers (tags within of the EEG file) and markers (tags recorded in a separate .mrk file). Here, you can choose to work with

triggers (*in file* button), with markers (*.mrk* button) or with both (the default option). EEGpal will list all these different tags in the section *Events found in input files*.

2. You have the option of moving the position of the event if you wish (e.g. to take account of a systematic timing error between the events and the stimulation due to technical reasons, such as display delays measured with a photodiode sensor). You can specify a negative delay to move before the event or a positive delay to move after the event. Enter the delay either in milliseconds or in TF.

3. Specify the Events you wish to examine (by using comma or space to separate them). Values must be listed in the section *Events found in input files*.

4. Specify the duration of the epoch. It is important to note that the time is relative to the event. This means that if you want to include a period before the event, you must enter a negative value for the onset (in this example, the epoch length will be 100 ms before the event and 500 ms after the event). The onset and offset can be entered in either ms or TF. For the offset, use the *EoF* (=end of file) button if you want your epochs to last until the end of the file.

5. The *Split into sub-epochs* button permits to create sub-epochs. This option is typically used if you want to divide all your EEG files into epochs without taking events into account (typically used in frequency analysis where the signal needs to be divided into small equal parts). See the FAQ for more details.
   Note: The field Number of *Sub-epochs* as well as the *Epoch offset value* when **EoF** is enabled, give values in relation to the first file in the list. However, if you have several files of different lengths, these values will be adjusted for each file.

6. The *baseline correction* consists of subtracting the mean amplitude of a specified period of the epoch (the baseline) from the whole epoch (see the FAQ for a more detailed explanation of its use). You can choose between several baselines:
   a. None: No baseline correction applied
   b. Whole epoch: Compute the mean amplitude on the whole epochs as baseline
   c. Pre-trigger period: Compute the mean amplitude before the event as baseline
   d. Custom selection: specify yourself the period of the epoch to but considered as baseline (Warning: this period must be inside of the interval specified in the Epoch in **4**).

7. The same as the point **6** but only for the Auxiliary channels if you have specified any in the **Electrode Setting** option of the main EEGpal windows.

8. This is the saving option related to the epoch computation with :
   a. *One file per epoch*: Record a separate file for each clean epochs
   b. *Merge epochs into one file*: Record one file with concatenation of all clean epochs
   c. *Concatenare according to subject*: Concatenate all the clean epochs per participant

   Note: 'Clean epoch' means epochs which survive to the *artefact rejection*

Pannel B: ARTEFACT REJECTION

9. There is three possible ways to detect bad signal inside of an epoch:
   a. *Max absolute threshold*: Define a maximal threshold amplitude. If this amplitude is reached by one or more electrode(s) during one or more TFs, the epoch will be discarded.

b. *Max step threshold*: Allows the detection of amplitude jumps in the signal. If the amplitude difference between two time points reaches the specified threshold, the epoch is discarded.

c. *Max range threshold*: If the difference between the highest and lowest amplitude in the epoch reaches the specified threshold, the epoch will be discarded.

The output will be an Epochs_Summary.xlsx file with details of how many epochs have been rejected by each criterion. See the FAQ for more details.

10. Same as 9 but only for the Auxiliary channels if you have specified any in the **Electrode Setting** option of the main EEGpal windows.
11. Need to be add
12. <mark>Functionality currently not available</mark>. Must be updated. You can choose to exclude one or more channels from the artefact rejection test. Deselect the channel you don't want to test.
13. <mark>Functionality not currently available</mark>. Must be updated. Automatically ignore electrode marked as bad by eeglab clean_rawdata toolbox.
14. **Facultative:** AR Evaluation is a tool that allows the artefact rejection tests to be performed by recording only the Epoching_Summary.xlsx and modifying the marker of the input file to indicate whether the epochs have been accepted or rejected. A backup copy of the pre-modification marker file is recorded in the same location as the input files.
WARNING: It is important to understand that this is only an additional tool and is not mandatory to perform a standard epoching/averaging analysis.

Pannel C: Averaging (ERP creation) as well as saving parameters

15. You can resample your data to a different sampling frequency (the new frequency must be specified in Hz). This is typically used if you want to downsample your data.
16. **Averaging**: Here you can define how you want to average your data:
    a. Within-Subject: ctivate one of these two options to have one or more averages per participant. This is the default option if you have performed an ERP analysis:
        i. All triggers: average all the epochs of all the events that you specified in **3**.
        ii. Per trigger: make a separate average for each event you specified in **3** (most used in ERP research).
    b. Within-Subject: Compute an average across participants. This is used to compute the Grant Average in ERP analysis.
        i. All triggers: average all the epochs of all the events that you specified in **3**.
        ii. Per trigger: make a separate average for each event you specified in **3** (most used in ERP research).
17. Select the format for the output files.
18. Select the destination folder where the results files will be saved (note: it reproduces the input structure. For example, a folder per participants if the input files where in subfolder).
19. The suffix added to the input filename to obtain the output filename
20. You can save a parameters file which will recode all the chosen options for a later processing (**save** and **save as**). You can use the button **open** to call a previous saved parameters file.
21. Click on **Run** to carry out the processing parameterized in the Filerting module. The button **Done** will close the Filtering module without perform the processing but keep in memory your parameters if you open again the Filerting module. The button **Cancel** closes the module without processing and without keep the entered parameters in memory.

FAQ

What the output looks like?
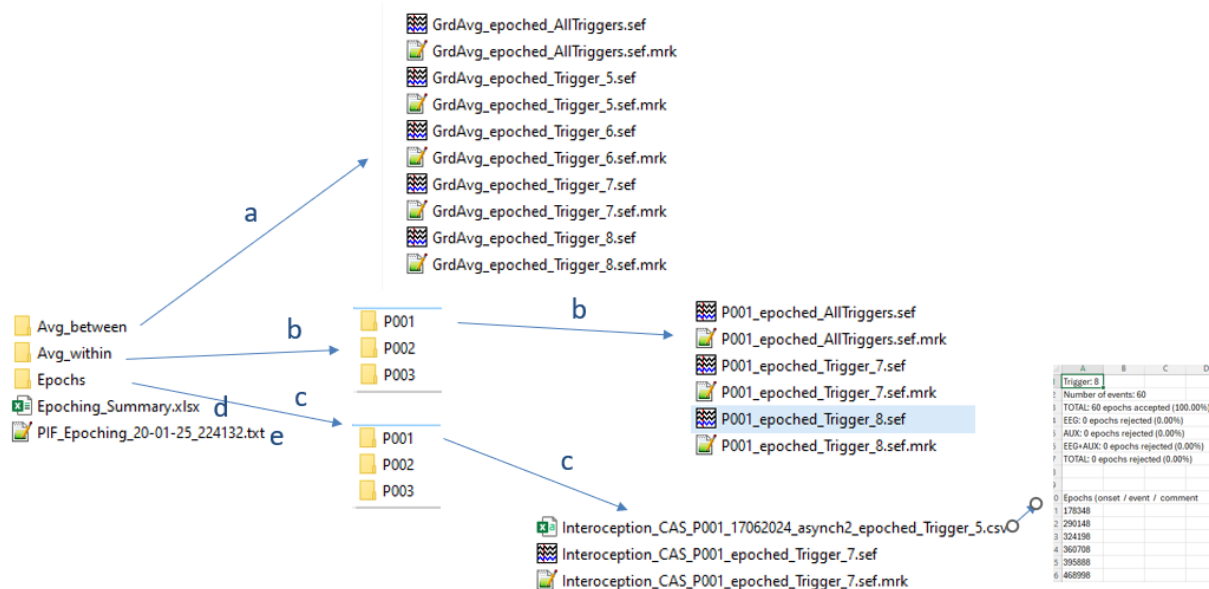
a. Between-subject averaging output (specified in **16**). A folder containing all the grant averages between subjects. In this example the 'All Triggers' option has been selected (file *GrdAvg_epoched_AllTriggers.sef*) as well as the 'Per Trigger' option (file *GrdAvg_epoched_Trigger_*.sef*).

b. Within-subject averaging output (specified in **16**). The folder contains one sub-folder per subject (or per file if no subject has been specified in the EEGpal main window). In this example the 'All Triggers' option has been selected (file *P001_epoched_AllTriggers.sef*) as well as the 'Per Trigger' option (file *P001_epoched_Trigger_*.sef*).

c. Output for the epoch saving option (specified in **8**). The folder has the same structure as the input file. In this example, the input file has been saved in various sub-folders (P001, ...). In this example, the 'Merge epochs into one file' option has been selected. It creates a .csv file with the details of the start of each epoch, as well as the information of whether they were rejected and by which criterion (*Interoception_CAS_P001_17062024_asynch2_epoched_Trigger_5.csv*). The .sef file contains the EEG signal for all concatenated epochs (*Interoception_CAS_P001_epoched_Trigger_7.sef*) and the associated marker file (Interoception_CAS_P001_epoched_Trigger_7.sef).

d. The Epoching_Summary.xlsx file: please see next FAQ question for more information

e. The Processing Information File (PIF) with a summary of all the parameters selected before pressing on the Run button.

What is in the Epoch_Summary.xlsx file and how should I use it?

This file summaries the number of epochs accepted and rejected by the ARTEFACT REJECTION. Here is the meaning of its columns name:

- *Trigger*: the events processed (as specified in **3**)
- *TotalTriggers*: the number of events detected for each file

- *nEEGrejected*: number of epochs rejected by the specified criterium in **9**
- *nAUXrejected*: number of epochs rejected by the specified criterium in **10**
- *nTOTALrejected*: total number of epochs rejected (addition of nEEGrejected and nAUXrejected)
- *nTOTALaccepted*: number of epochs accepted
- *pcEEGrejected*: percentage of number of epochs rejection according criterium specified in 9
- *pcAUXrejected*: percentage of number of epochs rejection according criterium specified in 9
- *pcTOTALrejected*: percentage of the total number of epochs rejected
- *pcTOTALaccepted*: percentage of the total number of epochs accepted

This file can be used to identify outlier participants. The general rule is that participants with less than 66% of accepted epochs could be an outlier. This is not a hard and fast rule, but you should check this type of data carefully and consider discarding it.

How can I use the Epoching module for my frequency analysis or to reject periods of bad signal?

In the frequency analysis it was necessary to split the signal into small equal parts (epochs) and remove those with a bad signal. In this particular case, leave the Events field empty (**3**), select the whole file with an Epoch onset=0, Epoch offset = EoF (**4**) and activate the Split into sub-epochs option and select the length of these sub-epochs (**5**) (for example 2000ms). In this case the entire EEG file will be split into epochs of 2000ms and each of them will be tested for artefact rejection (B). To record a new file with all the clean epochs concatenated, select the Merge epochs into one file option (**8**). You will then use this file in the Frequencying module, using an epoch length of the same size as the sub-epoch duration you have specified in this module.

When should I use baseline correction?

As explained in the point, baseline correction consists of subtracting the mean amplitude of a specified period of the epoch (the baseline) from the whole epoch.

The most commonly used option is to use the whole epoch as the baseline to compensate for the general amplitude differences along the EEG recording (mainly due to signal drift). It allows for a more comparable amplitude between epochs (correction by this relative baseline).

Some authors prefer not to use a baseline to avoid losing significant differences between conditions (it is true that a baseline correction makes the result more reliable, but also more conservative).

In some cases, a pre-trigger baseline is used. This makes it possible to ensure that the amplitude at the event is 0. However, this is only valid if one makes the hypothesis that there is no effect of anticipation or any signal related to the event before it, which is rarely the case. This is why this option is usually not used.

Which method of artefact rejection should I use?

The three methods proposed by EEGpal has been use in the literature. The *Max absolute threshold* is the default method use by Cartool. In our laboratory (using a Biosemi system), we usually use a threshold between 80 to 100 µV. In practice, the *Max range* does a similar job.
There is no hard and fast rule as to which one to use. Look at the summary file generated as output to see how many epochs were rejected according to each criterion.