8.10: ERP Analysis

Introduction

An ERP (Event Related Potential) occurs in response to a specific stimulus. This stimulus may be a sensory, cognitive, or motor event. The ERP is the time-locked average of an EEG over many trials involving the same event. The repetition reduces the EEG's inherent signal to noise ratio, so the specific potential related to the event is displayed.   The **ERP Advanced Analysis Module** allows sophisticated ERP analysis.

This document includes a step by step tutorial for using most of the features of the **ERP Advanced Analysis Module.** To use the step by step guide, you will need an ERP recording.

ERP Analysis: Step by Step

Recording a Human ERP Data File

You will need to record an electroencephalogram designed to elicit an ERP in order to complete this step by step guide. The ERP Advanced Analysis Module allows the comparison of the ERPs due to different stimuli.

ERP Advanced Analysis Module: Step by Step

Offline Calculations

The ERP analysis is performed using the **ERP Calculations** dialog, so you should first become familiar with this dialog.

The ERP Calculations Dialog

To display the **ERP Calculations** dialog and familiarize yourself with its features:

1) Open a file with ERP data.
2) Select **ERP** from the **Advanced** menu. Choose **ERP Calculations**, opening the **ERP Calculations** dialog.
3) Familiarize yourself with the **ERP Calculations** dialog, pictured below.
    • On the left are the tabbed dialogs used to configure the analysis.
    • At the right is the XY graph window in which the **ERP Graph** can be displayed.
    • Between the configuration dialogs and the graph are the editable lists of the **Stimuli** and **Segments** to be analyzed and displayed.
    • Across the lower part of the dialog is the **Data Table**, summarizing the calculated average ERP responses for each of the stimuli.
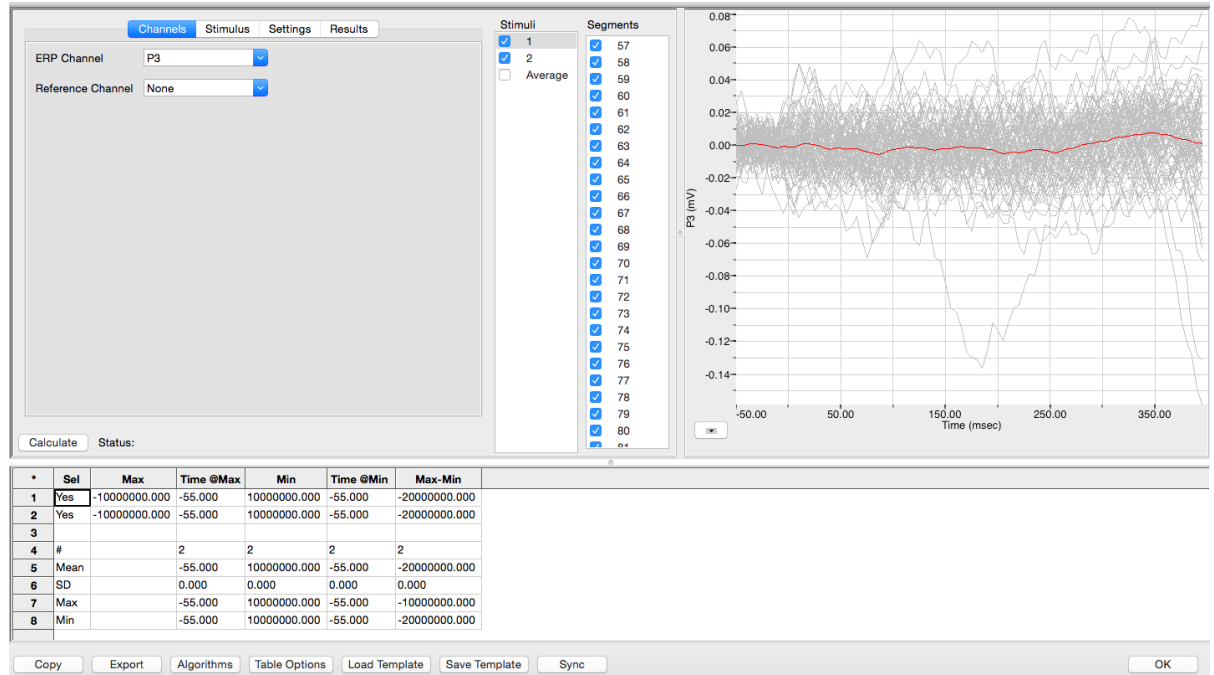
ERP Calculations dialog.

To configure the analysis, the tabbed configuration panels at the left side of the dialog are used.

To configure Channels:

1) Click the leftmost tab of the configuration dialogs, the one labeled **Channels**.
2) From the **ERP Channel** menu, choose the desired EEG electrode from the menu. This is the channel on which the analysis will be performed.
3) From the **Reference Channel** menu, choose the specific electrode to which the ERP channel is to be compared.
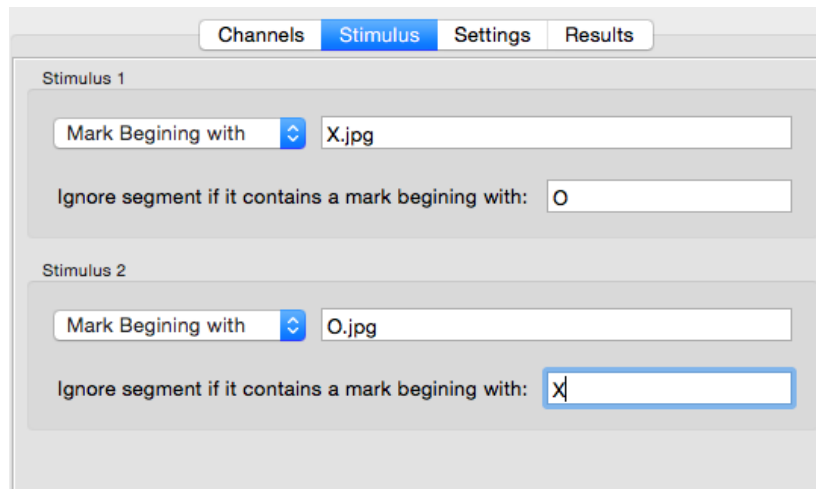4) These choices may be changed at any point during the analysis.
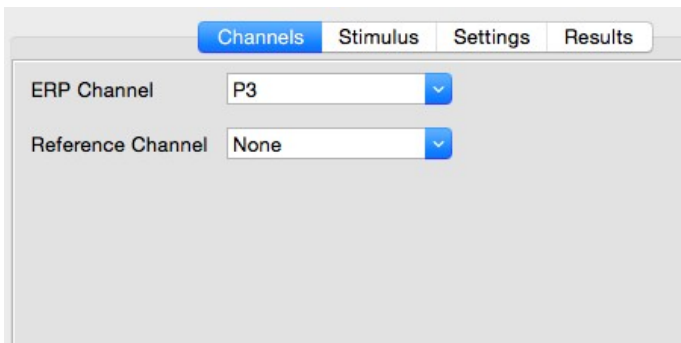
ERP Channels configuration dialog.

Most ERP experiments compare the ERPs in response to two different stimuli.

To configure the **Stimulus:**

1) Click the **Stimulus** tab, which is the second tab from the left in the configuration dialogs. The **ERP Stimulus** configuration dialog will open.

ERP Stimulus configuration dialog.

2) To designate **Stimulus 1**, indicate the mark on the data file that corresponds to that stimulus by choosing either **Mark Beginning with** or **Exact** and entering the relevant text. Alternatively, **Block Start** may be chosen.
3) To designate **Stimulus 2**, indicate the mark that corresponds to that stimulus by choosing either **Mark Beginning with** or **Exact** and entering the relevant text. Alternatively, **Block Start** may be chosen.
4) For both stimuli, segments that contain an incorrect response can be ignored by specifying responses that should be ignored.

To configure the Settings:

1) Click the **Settings** tab, which is the third tab from the left in the configuration dialogs. The **ERP Settings** configuration dialog will open.
2) Both the pre-stimulus and post-stimulus duration to be displayed in the ERP graph can be chosen by entering the desired durations in the appropriate boxes.
3) Choose the desired baseline value by selecting either **Zero**, **Pre-stimulus Mean**, or **Mean** from the **Baseline** menu.
4) Specific ERP components are characterized by the time at which they occur. Choose the time to be analyzed by entering the start and end values in the **Response** text boxes. **Max**, **Min**, **Max-Min**, and **Mean** values within this time window are determined and displayed in the **Data Table**.
5) To exclude segments that fall outside appropriate values, and represent artifacts, enter the allowable segment values into the text boxes in the **Artifact Removal** section.

ERP Settings configuration dialog.

6) Once the **Channels**, **Stimulus**, and **Settings** dialogs have been configured, click the **Calculate** button just above the **Data Table** to start the analysis. The **ERP Graph** will appear in the graph window at the right, and the **Data Table** will be populated with values.

*Important: After any configuration settings are changed, click **Calculate** again, to trigger the revised analysis.*

To display the ERP Graph:

1) Choose **View ERP Graph** from the menu at the lower left of the graph window. The **ERP Graph** will be displayed in the XY Graph window, showing the segments specified in the **Stimuli** and **Segments** lists to its left.
2) There are options to **AutoScale** the **X-axis** and the **Y-axis**. The X and Y axes can also be set manually by using the menu items or clicking and dragging the axis numbers themselves.
3) Copy the graph to the clipboard by choosing **Copy Graph**. The mathematical data from the averages can be exported to a spreadsheet by choosing **Export Avg. Data**.
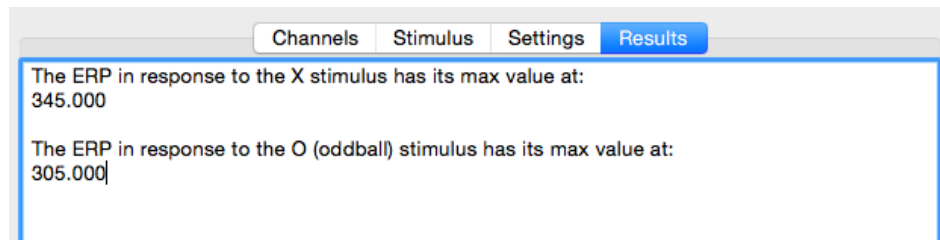

XY Graph menu.

4) Look at the **ERP Graph** and familiarize yourself with its features.
   - The graph displays the checked segments representing responses to one of the two stimuli. They are superimposed on each other and the segment mathematically averaged from all of them is highlighted in red. The individual cycles are in grey and the currently selected segment (from the **Segments** list) is in black.
5) Change the responses displayed by selecting a different stimulus in the **Stimuli** list.
6) Select a different segment in the **Segments** list. Notice that the segment displayed in black changes with your selection.
7) Uncheck one of the cycles. Notice that one of the cycles is deleted from the graph. The red averaged cycle will also change to reflect the new mathematical average. Add the cycle back again by checking its check box.
8) To see just the averages, select **Average** from the **Stimuli** list. Highlight one or the other average in black by selecting **Stim 1** or **Stim 2** from the **Stimuli** list.

To configure the Results:
1) Click the **Results** tab, which is the fourth tab from the left in the configuration dialogs. The **ERP Results** configuration dialog will open.
2) In this dialog, you may enter text, and copy items from the clipboard.

| Channels | Stimulus | Settings | **Results** |

The ERP in response to the X stimulus has its max value at:
345.000

The ERP in response to the O (oddball) stimulus has its max value at:
305.000

ERP Results configuration dialog.
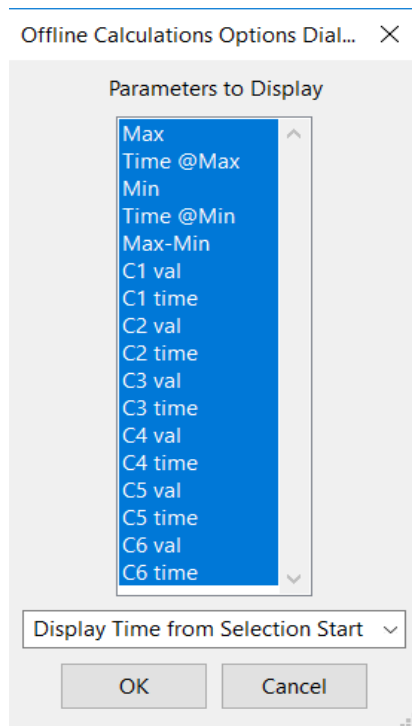
Data Table
The top two horizontal rows in the data table summarize and compare the averaged ERP values (choosing from **Max**, **Time at Max**, **Min**, **Time at Min**, and **Max-Min**) resulting from each of the two stimuli. The averages displayed are those occurring within the time window specified in the **Settings** dialog.

*	Sel	Max	Time @Max	Min	Time @Min	Max-Min	C1 val	C1 time	C2 val	C2 time	C3 val	C3 time	C4 val	C4 time	C5 val	C5 time	C6 val	C6 time
1	Yes	-3.474	122.000	-3.489	472.000	0.015	-3.470	-28.000	-3.474	162.000	-3.486	312.000	-3.487	450.000	-3.490	592.000	-3.470	724.000
2	Yes	-3.490	104.000	-3.526	326.000	0.036	-3.517	-28.000	-3.510	162.000	-3.522	312.000	-3.523	450.000	-3.509	592.000	-3.518	724.000
3																		
4	#	2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	Mean		113.000	-3.508	399.000	0.026	-3.494	-28.000	-3.492	162.000	-3.504	312.000	-3.505	450.000	-3.499	592.000	-3.494	724.000
6	SD		9.000	0.019	73.000	0.011	0.023	0.000	0.018	0.000	0.018	0.000	0.018	0.000	0.009	0.000	0.024	0.000
7	Max		122.000	-3.489	472.000	0.036	-3.470	-28.000	-3.474	162.000	-3.486	312.000	-3.487	450.000	-3.490	592.000	-3.470	724.000
8	Min		104.000	-3.526	326.000	0.015	-3.517	-28.000	-3.510	162.000	-3.522	312.000	-3.523	450.000	-3.509	592.000	-3.518	724.000

The Data Table.

To use the Data Table and export values:

1) Click **Table Options** at the bottom of the dialog to see a list of all the ERP parameters that can be displayed in the **Data Table**. These parameters and calculations are all defined in the **ERP Advanced Analysis Module: Reference** section.

2) Choose the options you wish to include in the analysis and display in the **Data Table**. Choose whether you wish to display the **Time from the Start of the Selection** or the **Time of Day** of the recording. Click **OK**.

Table Options dialog.

3) Click the asterisk in the upper left corner of the **Data Table**. The **Autosize** option adjusts the size of the cells for optimal display. The **Copy Selection** option will copy any selected cells to the clipboard.

4) Click **Algorithms** to see the definitions of the parameters and calculations.

5) To copy all the calculated data in the **Data Table** to the clipboard, click the **Copy** button, or click the **Export** button to export the data. The data are exported in a tab (*.txt) or comma (*.csv) separated text file, and the graph can be exported as a Portable Network Graphics (*.png) or JPEG (*.jpg) image.

6) To load the analysis configuration for the current analysis, click **Save Template** to name and save the settings. Clicking **Load Template** when the module is reopened will display the list of previously saved templates.