N400 Extraction Workflow

Prerequisites

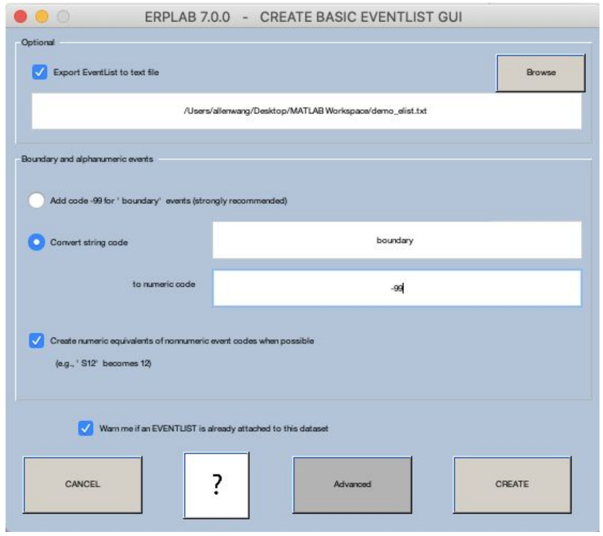
1. Follow the steps in EEG & ERP Workflow until you reach the step titled "Elist and binlister".
2. We will be using a different bin descriptor but following very closely with the ERP extraction portion

Creating the bin descriptor file

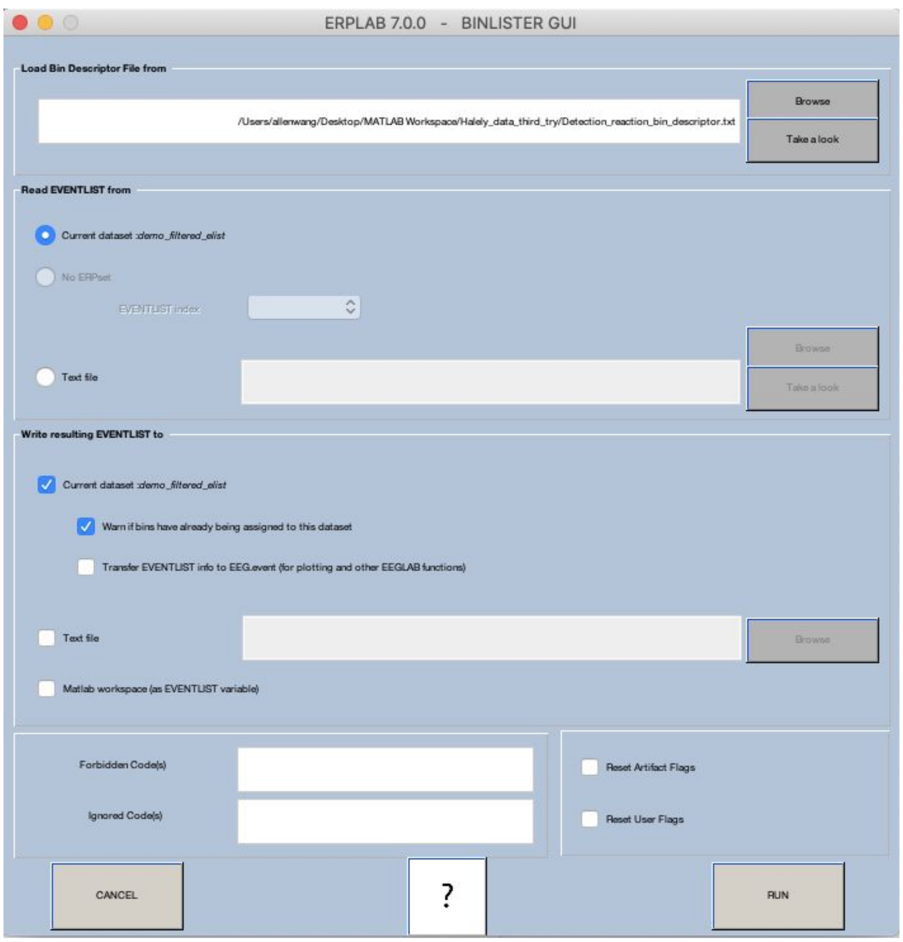
1. Open bin_maker.py using a notepad or another text editor. Around line 47 of the file, there will be a line that looks like "cloze = [0.5, 0.2, 0.1 … " that sets cloze to an array of decimals. Take the cloze values that correspond to the words of interest (the cloze values for words that we are interested in), and paste them in the order of occurrence on this line.
2. Run bin_maker.py. This can be done using the command "python3 bin_maker.py" or "python bin_maker.py " through the terminal in the directory that contains the bin_maker.py file. This command gives three different bin descriptors: bins_words_separate.txt, bins_words_thirds.txt, bins_words_together.txt.
    a. Bins_words_separate.txt contains each word in its own bin
    b. Bins_words_thirds.txt splits the words into three buckets depending on whether the cloze values are in the highest, middle or lowest third of the set of close values
    c. Bins_words_together.txt contains all the words in the same bin

Elist and binlister

1. Before continuing check `EEG.event` to see if it is the correct set of events (in this case they should be of the form 1000, 2000, etc corresponding to the words).
2. Through the EEGLab menu bar click > ERPLAB > EventList > Create EEG EVENTLIST. This will give you an ugly GUI like the one below. Save it as a separate text file if the event list has not been made yet and accept the default settings. This is an event list that is compatible with binlister that will allow you to group certain events together to be viewed on an ERP plot later.



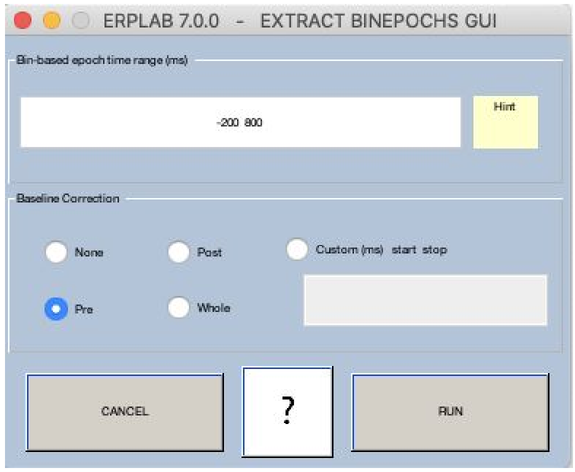
3. Using the bin descriptors from above, from the EEGLab menu bar click > ERPLAB > Assign bins (BINLISTER). This gives the GUI below. Typically the default fields are fine; make sure that the elist used is the one made from step 1. Afterwards run and save the dataset.



4. Repeat for all three bin descriptors created from above.

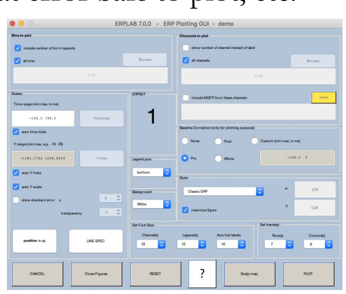
Extracting epochs

1. Now we have to extract the epochs for the events in each bin. To do this from the EEGLab menu bar click > ERPLAB > Extract bin-based epochs. This gives the following GUI. The arguments specify how long before the event and after the event you would like to extract. Adjust to fit your needs and hit run. Finally, save the dataset.



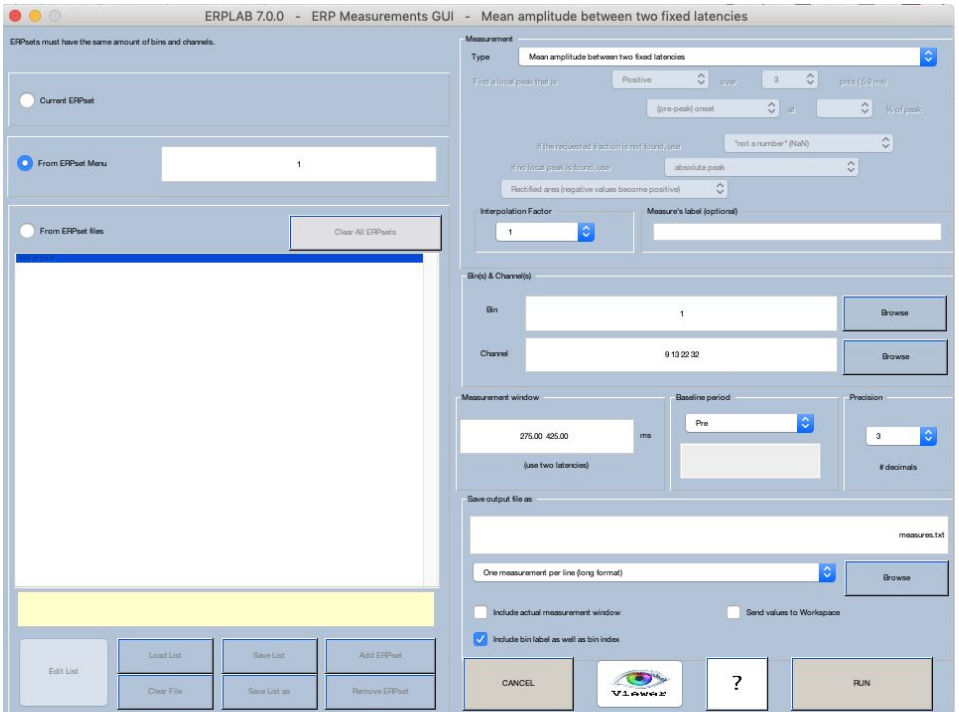
Compute and plot ERP

1. It may be good to plot the ERP corresponding to the bin descriptor that contains all the words. This gives a rough picture of what the N400 would look like averaged across all words. For the N400 specifically, we focus on the centro-parietal nodes which show the signal the strongest. At this step, it's also good to identify which electrodes are perhaps more telling and which
2. To compute the averaged ERPs, from the EEGLab menu bar click > ERPLAB > Compute averaged ERPs. The default fields in the following GUI suffice. Make sure that the correct dataset is selected and hit run. This will prompt a second GUI which will ask you to save the ERP set.
3. Finally, to plot the ERPs, from the EEGLab menu bar, click ERPLAB > Plot ERP > Plot ERP waveforms. This gives the following GUI, which allows you to select which bins to plot, which channels to plot, what error bars to plot, etc.



Extract the N400

1. Now, we are working with the ERPset. On the menu bar, select > ERPLAB > Measurement Tool. A menu like the one below pops up:



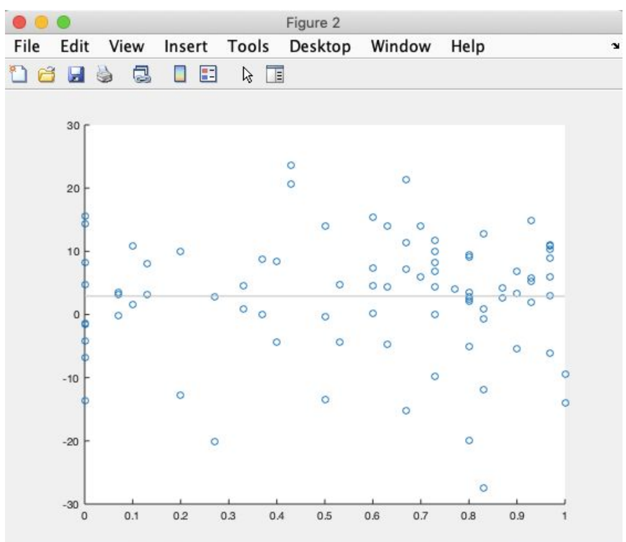
2. Make sure the correct ERPset is selected. To extract the N400, we find the mean amplitude between two fixed latencies. For children, this range can be from 350 to 550, and for adults this may occur earlier. We perform the analysis under the range 300 to 500, which are the parameters for our measurement window.
3. In bins, make sure all bins are selected (this should happen for both extraction of all words separately, together, or in thirds). In channels, select the channels that will be analyzed, which are usually the centro-parietal nodes for the N400. Finally, name the output file and run.

Cloze value vs. N400 scatterplot

1. This scatterplot is relevant for the ERPset containing all words with cloze values recorded in separate bins. The goal is to go from the text file from the "Extract the N400" step to a scatterplot. First check the file with the extraction from the measurement tool. It should look something like this:

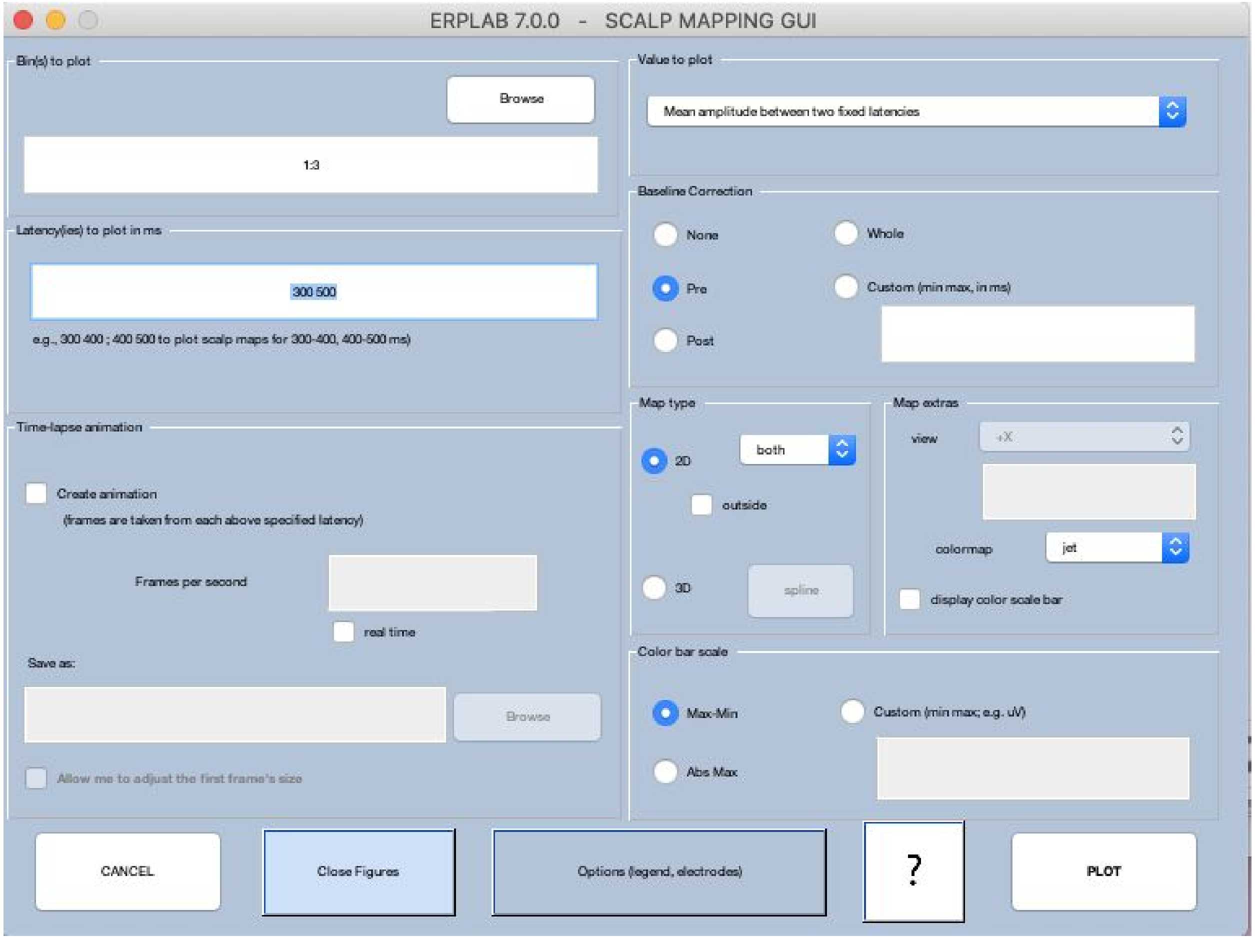
	value	chindex	chlabel	bini	binlabel	
1	value	chindex	chlabel	bini	binlabel	
2	8.825	9	CP1	1	event_1000	demo_wor
3	6.879	13	Pz	1	event_1000	demo_wor
4	3.574	9	CP1	2	event_2000	demo_wor
5	-0.342	13	Pz	2	event_2000	demo_wor
6	-8.347	9	CP1	3	event_3000	demo_wor
7	-5.340	13	Pz	3	event_3000	demo_wor
8	-22.132	9	CP1	4	event_4000	demo_wor
9	-20.007	13	Pz	4	event_4000	demo_wor
10	28.242	9	CP1	5	event_5000	demo_wor
11	21.255	13	Pz	5	event_5000	demo_wor
12	13.687	9	CP1	6	event_6000	demo_wor

2. We convert this text file into a table by running a command in MATLAB like `x = readtable("measures.txt")` the variable x now stores the table and "measures.txt" should be replaced with the file which contains the measurements.
3. The N400 values are stored in the first column. Depending on how many channels are in the file, you may need to use array indexing to extract the values. In the image above, to extract the Pz N400 values into an array, we use the command `n_array = table2array(x(2:2:end,1))`. This command for example extracts starting from the second row, every other row's value in the first column.
4. Load the array of cloze values from cloze.mat. Inside should be an array (in my case called part1_cloze) that contains an array of the cloze values in the order in which they appear in (and thus the order of the bins).
5. Using the command `scatter(part1_cloze, n_array)` followed by `lsline`, we can create a plot that looks like the one below. Using more analysis tools, we can find the error, slope, equation, etc. As you can notice, for this trial, the results aren't very pretty.



Generating scalp maps

1. Generating the scalp maps are most relevant for the ERPsets that contain all the words in the same bucket or the ERPset with words split into three sets. Following the Snedeker lab, we will create the scalp maps for the lowest third and highest third cloze values.
2. In the EEGLAB menu bar, select > ERPLAB > Plot ERP > Plot ERP scalp maps. The following UI pops up.



3. Set the arguments in the UI to be exactly as those used in the extraction of the N400 described above. This gives the figure below: