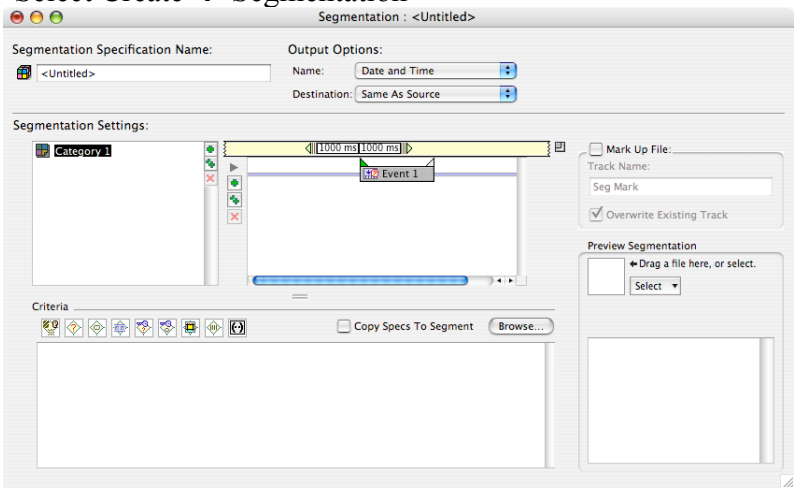
Data Analysis Methods: Net Station 4.1
By Peter Molfese

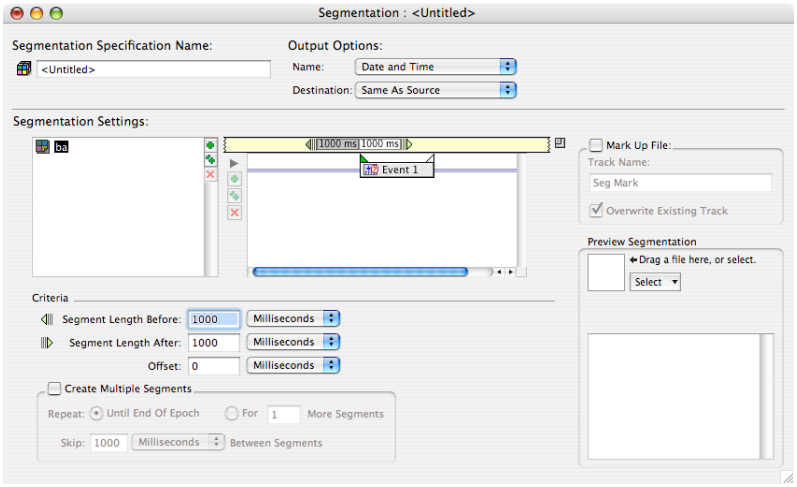
**Preparing Data for Statistics (preprocessing):**

1. Rename your files to correct any typos or formatting issues.
    a. The General format for naming files is: study_subject #_task
        i. Example: SLI_0001_POA_1
            1. In some studies with a test-retest paradigm attach the session number to the end of the filename
        ii. Example: 2yr_2011_6x25
2. Backup your renamed files to a DVD
3. Copy all of your files from the data server or hard drive onto a local computer for processing.
4. Segmentation:
    a. Segmentation is the process of breaking the ongoing EEG signal into event-related epochs of approximately one second.
        i. The most typical segment length is 100 milliseconds before a stimulus and 900 milliseconds after the stimulus.
    b. Each study has a unique segmentation that is based on the type of stimuli used, the type of responses collected.
    c. In Net Station open the Waveform Tools (Command-T)
    d. Select Create → Segmentation



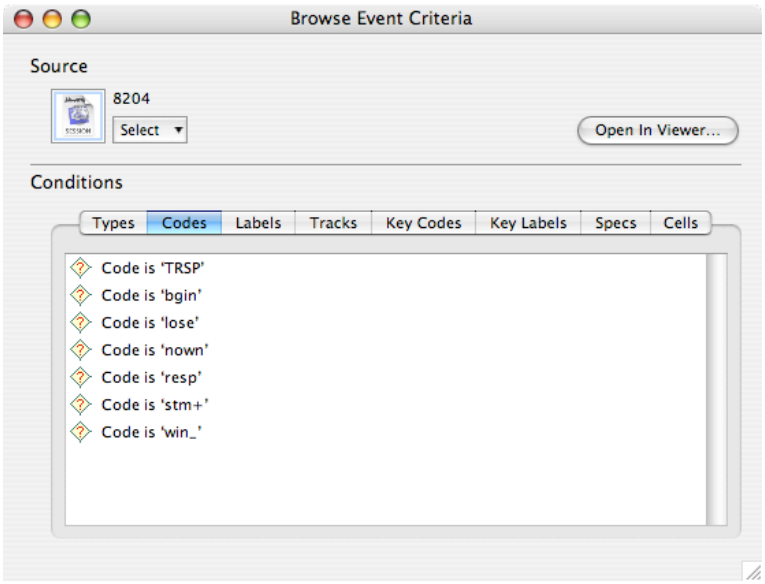

    e. Categories exist for each type of ERP that you wish to create. You might have a category for each stimulus (/ba/ /da/ and /ga/), you might also have a category for each type of response (correct vs. incorrect). Follow the steps to create your segmentation.
        i. Click on "Category 1" to name your category. Category names should be short but informative and consistent.
            1. Try ba++
        ii. Now click on the center pane where it says 1000 ms and 1000 ms, and change the values to 100 ms in the first field and 900 ms in the second field.

iii. In the offset field below enter the offset for your stimuli – located on your timing test sheet for the particular system used for collection.
    1. Different stimuli may have different offsets, double-check each categories offset!
    2. Offsets may change throughout the course of a study – it is not uncommon to go back into your segmentation and change those values for different subjects recorded at different times.




iv. Click on the Event 1 box to bring back the original window look. Using the ++ symbol next to your category name duplicate your category and rename them to represent all the categories you wish to segment on.

v. Now click on browse. In the new window – drag one of your Net Station recording files into the white box to get a window like that shown below.



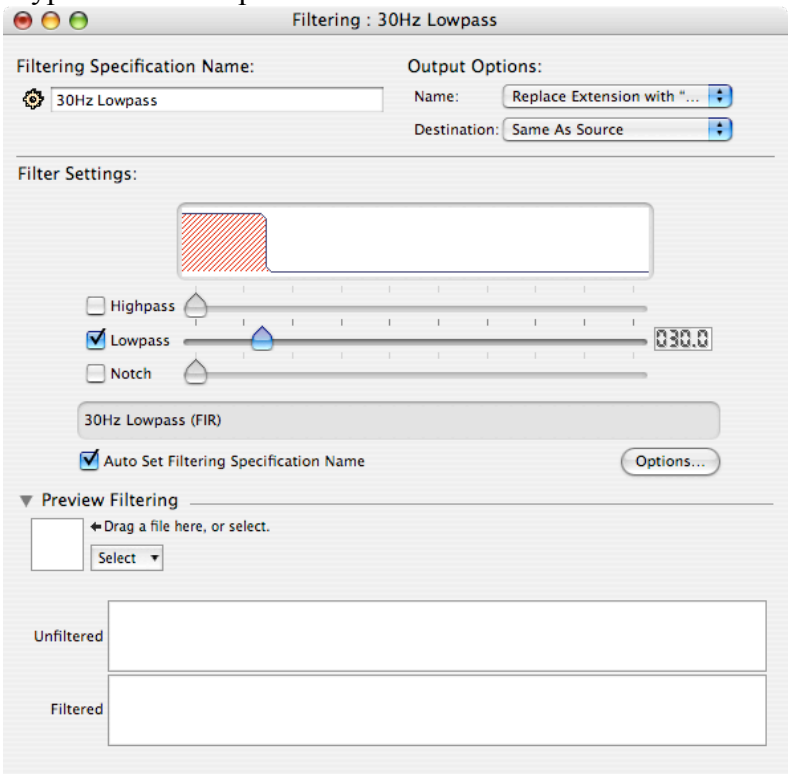

vi. Click on the codes tab. Depending on how your E-PRIME or PsySCOPE project was coded you have some decisions to make

here. If you have codes like ba++ da++ ga++ or win, lose, etc, then you should be able to create your segmentation based on your codes alone.

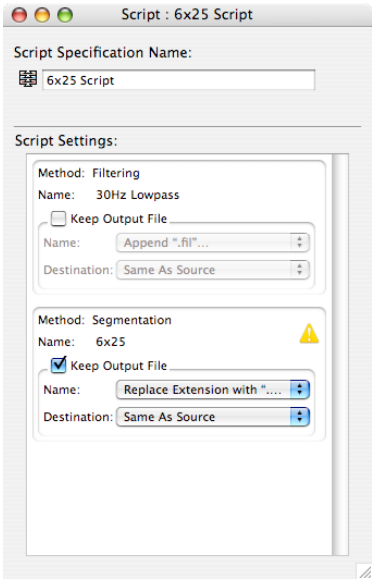
vii. Drag the code associated with your category from the window above to your segmentation "Criteria". Repeat this process for each of your categories. Some window spacing might be needed.
    1. If you want to evaluate whether the trial was answered correctly or not – you need a "Specs" value called "Trial Spec Evaluation is 1" for correct or 0 for incorrect. Add this to your segmentation Criteria if you wish to segment only correct or incorrect trials.

viii. Close your browsing window and drag a file to your preview segmentation pane. If the results are as expected close your segmentation window (saving it) and proceed to the next step.

5. Filter setup
    a. Most ERP experiments are recorded with a bandpass range of 0.1Hz to 100Hz. For our purposes we're usually only concerned with what happens from 0.1Hz to 30Hz. So you will need to create a filter tool to "filter down" to the new range.
        i. Some studies may only look at frequencies in Theta (4Hz-7Hz), the same type of tool can be employed in such investigations.
    b. Typical filter setup

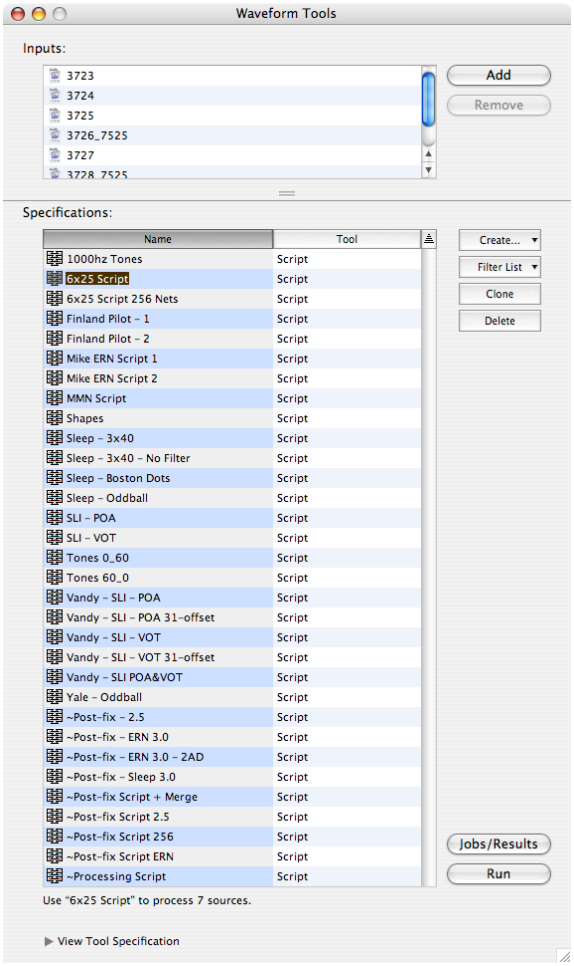



    c. Save your filter and proceed to the next step.
6. At this point you are ready to create your first script. Using the Waveform tools, create a script with your filter step followed by your segmentation.

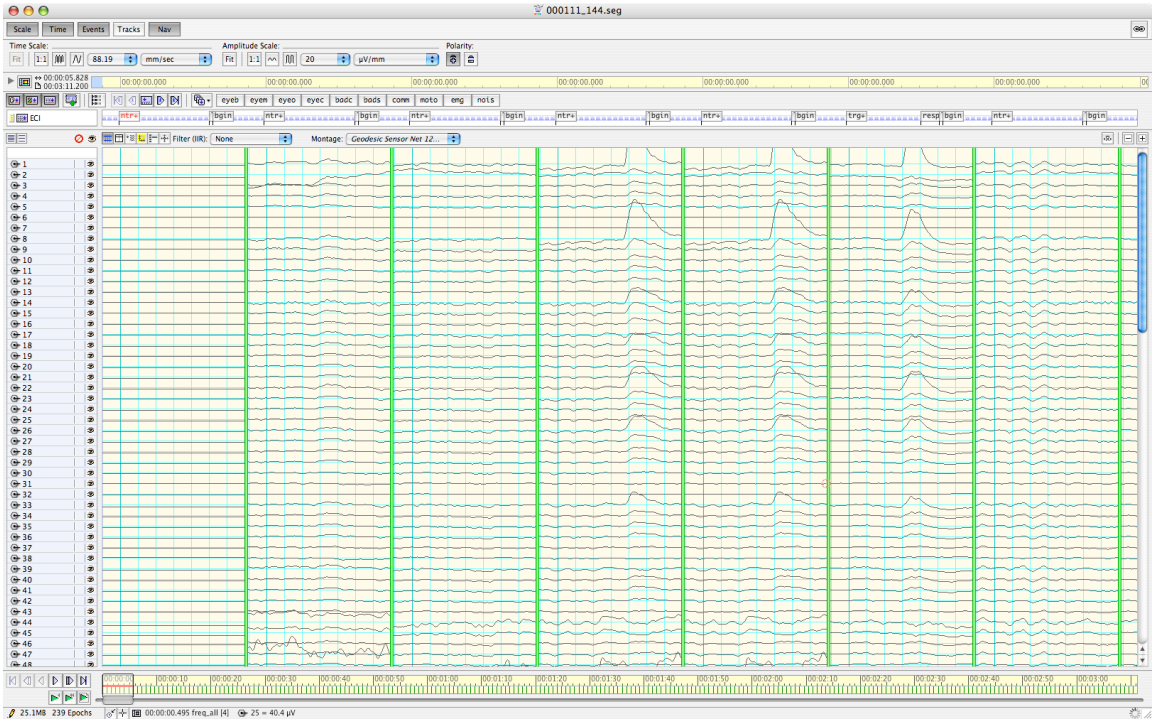



a. Your script should look like the window above. If you have a yellow triangle appear next to your tool, it simply means that the tool has been changed since being added to the script. Do not be alarmed.
b. It is not always necessary to keep intermediate files for later use – uncheck any steps you don't wish to keep. Often if you are going to reprocess a file you will either start from the beginning or from the step just after segmentation – thus it is always important to keep your original files and your segmented files.

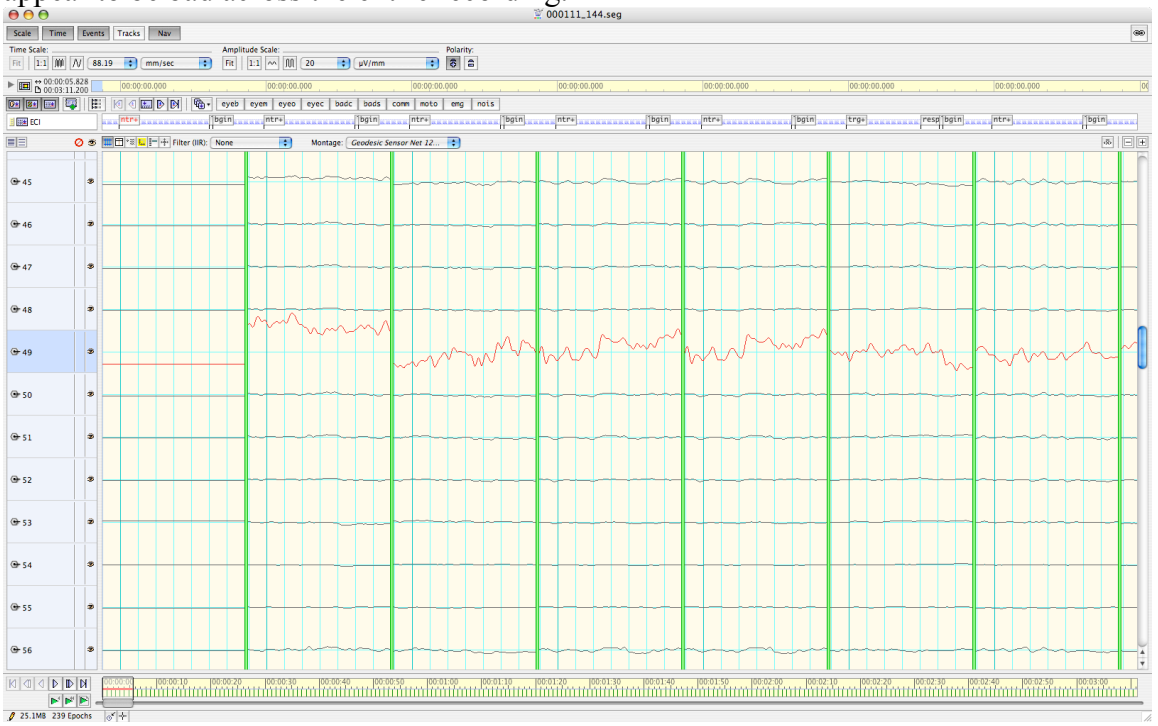
7. Using the waveform tools load your files into the "Inputs" pane of the window, select your script and click Run. To view ongoing progress – click the Jobs/Results button to bring up a progress window.



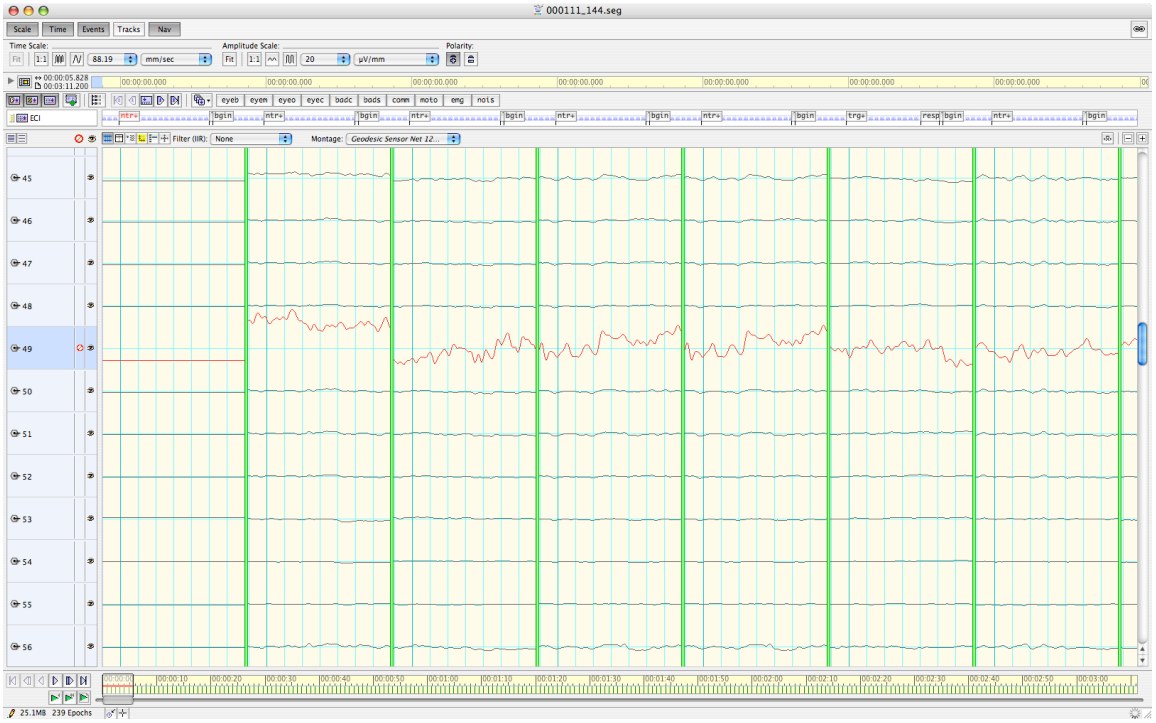

8. Congratulations. Any files you input should now be both filtered and segmented. Take a moment to pat yourself on the back and also to backup your newly segmented files.
9. Visual Inspection
    a. The next step in processing your data files is to visually inspect them for "bad channels". While Net Station has several routines for also inspecting bad channels, as well as identifying eye blinks and eye movements, a quick visual inspection can aid this process. The main thing to look for is bad eye blink and eye movement channels; these will often be interpreted by Net Station as the subject blinking throughout the entire experiment.
        i. The eye channels are listed later but usually include: 125, 126, 127, 128, 1, 8 26, 33 for the GSN200 nets.
    b. Open up each of your segmented files one at a time. You will be presented with a screen like that pictured below.

c. 


d. At this screen, scroll up and down, left and right to find channels that appear to be bad across the entire recording.

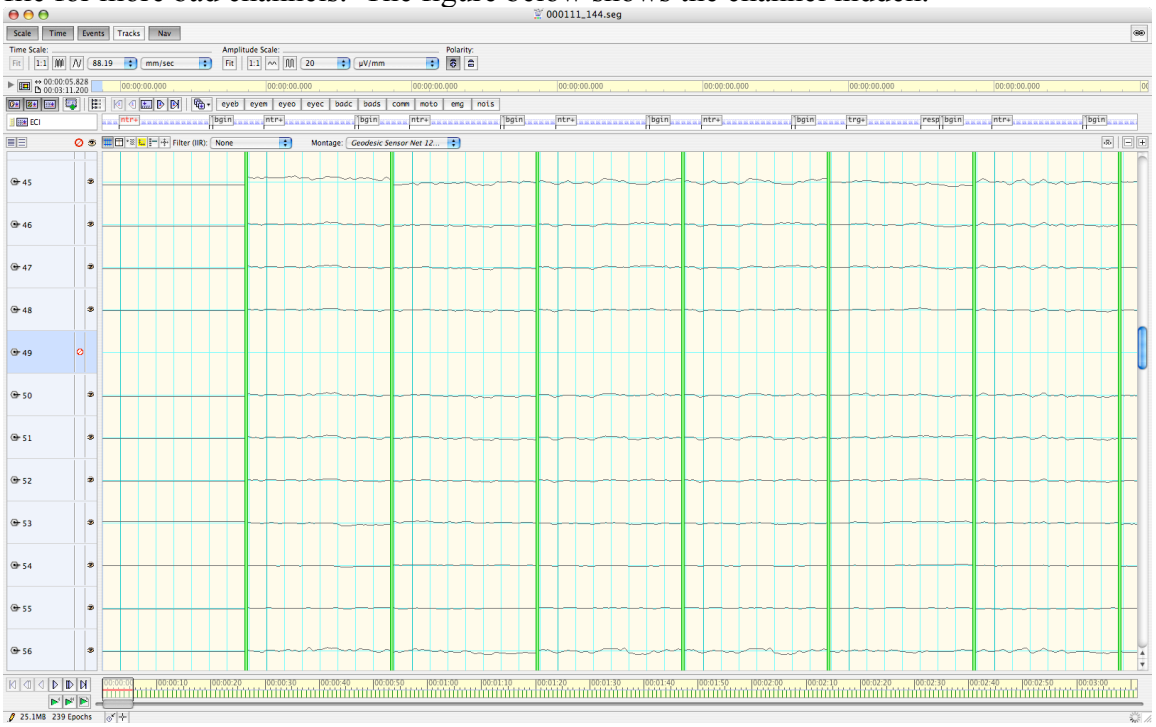
e. 


f. Channel 49 looks to be bad throughout the entire recording. Click on the num 49 to mark it in red. Double check that it is bad throughout the entire recording (or the majority of the recording).

g. 


h. After determining that channel 49 was indeed bad for the entire recording, hold the option key and click just to the right of the number field (just to the left of the eyeball). Holding option will change the cursor from to show arrows on either side of it as you mark the channel bad. This symbolizes that the channel is marked bad for the entire recording.

i. Now that the channel is marked bad for the entire recording, click on the eyeball to hide the bad channel as you continue surveying the rest of the file for more bad channels. The figure below shows the channel hidden.

j. 

10. So far we have filtered our data to a particular pass-band spectrum, segmented our data on our events of interest, and surveyed our data for bad channels (particularly bad eye channels). The next steps involve creating another script with several steps to take the data through the rest of the process.
11. In the Waveform Tools, create a new script. Call it "Processing Script" or "Stage Two". Create the following tools and put them into the script in the order presented.
    a. Bad Channel Correction, Artifact Detection, Bad Channel Correction, Average Reference (Montage Operations), Baseline Correction, Averaging.
        i. See settings for various tools below and explainations
    b. While order does not necessarily make a difference for several steps (averaging, baseline correction, average reference), it is important that all of your files go through the same order. For the purposes of this tutorial, the averaging step is last because the author finds the "AVE" extension to be pleasing by comparison to other extensions.
12. The Artifact Detection tool is about to change. To get you through the rough patch I'll explain a bit of the philosophy behind detecting artifacts and some sample values. Artifacts are simply anything in your EEG recordings that are not coming from the brain. These could be electrical nose (60Hz), eye blinks, eye movements, head movements, bad electrodes, wire electrical induction, external factors, the list goes on.
    a. Bad Channels are channels that are either not getting a signal from the participant, bad electrodes, or electrodes that might be measuring something other than cognitive processes – such as heart beat or GSR. True, we've gone through the recording and marked channels bad that were bad throughout the recording, however we have not marked channels bad that might have been bad in just one or two segments. The Artifact Detection tool can take care of this.
        i. Bad channels can be defined as having no variance, or having rapid uncontrolled variance. I often find it is helpful to measure some bad channels in a data set before setting a threshold. If you are setting thresholds based on slope (fast average amplitude and differential average amplitude) then I would suggest the values of 200μV for fast average and 150μV for differential amplitude. If you are using "pure" thresholds you might consider a sudden change of 100μV.
    b. Eye Blinks are measured by differential amplitude between channels above and below the eye. In other words, eye blinks are considered vertical eye movements. There are different theories on what is actually triggering the typical "eye blink" spike in EEG. Some suggest it is muscle movements controlling the eyelids, while others suggest that it has to do with the polarity of the eye (negative retina in the back, positive front) that changes when the eye blinks. Eye blink thresholds are usually set around 125μV to 150μV. I suggest 150μV in most cases, as blinks of this

amplitude will often not average out of your ERP as cleanly as smaller blinks unless you have a large number of trials.

i. Net Station uses several eye blink channels, which vary depending on the net configuration you are using.
    1. GSN 200: 8, 126, 26, 127
    2. HydroCel 128: 8, 126, 25, 127
    3. HydroCel 256: 18, 238, 37, 241

c. Eye movements are measured as horizontal eye movements. Similar to eye blink measurements, the EGI nets have several eye movement channels that are used to detect thresholds of amplitude. A setting of 100μV to 150μV is usually sufficient to pickup most eye movements that will interfere with your data.
    i. Net Station uses several eye movement channels, which vary depending on the net configuration you are using.
        1. GSN 200: 125, 128
        2. HydroCel 128: 125, 128
        3. HydroCel 256:226, 252

d. These eye blinks and eye movement values might have to be modified for your data set. Children often have larger eye movements and eye blinks than adults. It is important that you are rejecting eye blinks and eye movements instead of regular data.

e. Restricted Search
    i. You only want to look for artifacts in your area of interest. If you segmented a one-second epoch then you might restrict your range to 100 ms before the event and 600 ms after the event. Otherwise you will likely pickup on the blink participants make between trials.

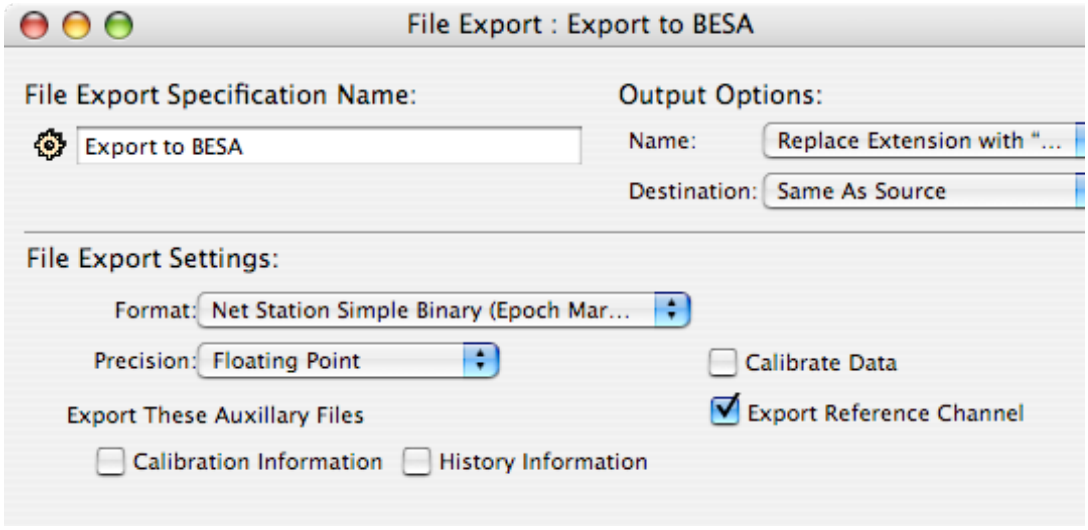
f. In the end it will be important to make sure all of your categories are equally represented. Having one stimulus average composed of 60 averages while all the others are composed of 30 averages could introduce effects that are not there due to the differences in amplitudes, latencies, and waveform shape durations.
    i. The technique of using identical numbers of averages is called "weighted averaging"

13. The bad channel correction tool has no user level settings. The basic idea is that it interpolates the bad channels by averaging together the surrounding channels. At the same time it takes into account that the total amount of voltage on the head at any one moment should equal zero (positively on one side should be balanced by a negativity on the other side).
14. Average Reference (under Montage Operations)
    a. Normally during recording all channels are referenced (compared) to one electrode, usually Cz (vertex of the head). This process often results in electrodes close to the vertex having smaller amplitude than those electrodes further away from the vertex. This is normal. Average Reference is a process of "re-referencing" the data after it has been recorded to "fix" this issue. While you could re-reference the data to any

point or electrode on the head, the Average Reference has gained acceptance in recent years. The general idea is that you subtract out the common activity registered by all electrodes. In essence then all electrodes become the reference.

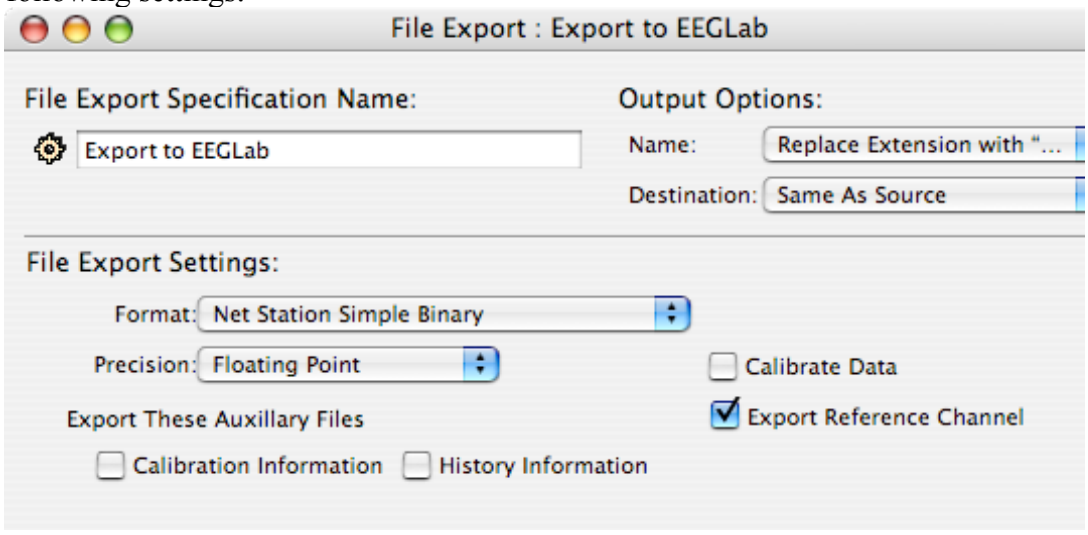
b. In this tool it is important to have the correct net selected. Incorrectly specifying your net will halt your script prematurely.
c. Another option in this tool is PARE correction. PARE looks to correct an issue where the top and sides of the head are measured more than the inferior parts of the head. Typically we leave this option unchecked.

15. Baseline Correction
    a. Typically the baseline is 100ms long and is before the segmentation event. There are two ways of setting this up. You can say "Start of Segment" and is 100ms or you can say "Segment Time = 0" and the baseline begins 100ms before sample and is 100ms long.
    b. Several people will argue that baseline correction must be the absolute last step in your process. However, if you experiment baseline before and average averaging you will see the results are the same – in fact doing baseline correction or average referencing before or average averaging is mathematically equivalent.
16. Averaging
    a. Averaging is the process of averaging together all trials of a particular stimulus to form a single waveform composed of all presentations of a stimulus. Thus if you presented /ba/ 150 times, you would end up with one waveform for /ba/ that would be all of those waveforms averaged together.
    b. Typically you want to handle source files separately and handle subjects separately. If you were creating a grand average you could use "Together" for both options, but for the SPSS & PCA parts of our analyses we will use the separately options.
    c. Make sure you copy events.
    d. Also, to aid in your data review, check the box to exclude subjects with fewer than 60% (number may change) of good trials per category. You could also set this to a specific number of samples that you wanted going into your average. Net Station 4.2 promises weighted averaging – which will make later reviewing steps easier.
17. Exporting
    a. Now that your data has been preprocessed it is ready for ERP analysis. Here you have a number of decisions to make depending on the type of analysis you wish to perform.
    b. If you wish to use BESA to find source dipoles, scalp coherence, source coherence, some forms of FFT, and a variety of other techniques, you will want to export your files to the Epoch-Marked Simple Binary format.

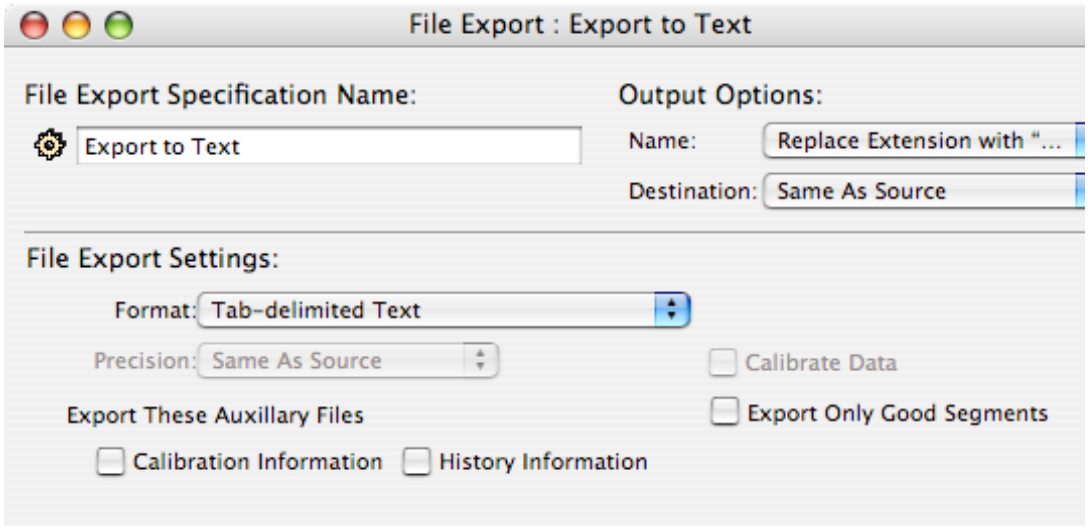
i. 


ii. Notice that the calibrate data checkbox is unchecked. This is because the data has been calibrated and adjusted throughout the preprocessing stages of analysis.

c. If you wish to export to EEGLab (a Matlab toolbox) for further analysis, use the following settings:

i. 


d. If you wish to export to SPSS or ERPScore, use the following settings:

i. 
File Export : Export to Text
File Export Specification Name:
Export to Text
Output Options:
Name:
Replace Extension with "...
Destination:
Same As Source
File Export Settings:
Format:
Tab-delimited Text
Precision:
Same As Source
Calibrate Data
Export These Auxillary Files
Export Only Good Segments
Calibration Information
History Information