NeuroField
Event Related Potential
Continuous Performance Task

Contents

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OVERVIEW

NeuroField Event Related Potential (ERP) is a continuous performance task (CPT) assessment tool that is designed to measure visual and/or auditory brainwave responses and reaction time to a GO NOGO task. The purpose of which is to examine ERP latency, P300 difference between GO and NOGO conditions, and lack of cross frequency coupling or synchronization responses on a repetitive CPT task.

REQUIRED EQUIPMENT

You will need the following equipment to run the NeuroField ERP Software:

- NeuroField EEG amplifier, either a Q20 or a Q21 EEG
- Mouse, ideally a "gamer's Mouse" i.e. the Razer "Mamba" wireless mouse which has a fast response time. Note: You can try using a track pad, but you do want something that is fast.
- Intel i7 CPU (or higher), Windows 10 Pro, 16 Gb RAM and a nVidia Display Adapter.

SOFTWARE OVERVIEW

NeuroField ERP is a computerized GO NOGO continuous performance task. NeuroField ERP is setup out of the box as a GO NOGO continuous performance task. However, NF ERP also allows the user to create both visual and/or auditory GO NOGO tasks very easily. The setup interface is easy to use allowing the user to create more complex tasks that replicate what has been done in the ERP research.

NeuroField ERP reflects the state of the art in ERP assessment. A carefully designed timing system ensures that ERP stimuli are matched with the EEG data. The amount of GO NOGO trials per assessment is preset to 300 but are also user definable. Upon completion of the assessment the EEG data can then be analyzed in EEGLAB which will generate ERP images and plots. NeuroField ERP will generate reaction time data that shows performance changes over the course of the assessment. This data can be loaded into the STUDY module so as to observe change from one assessment to the next over time. All data collected in NeuroField ERP is exportable in various formats. The reaction time data can be exported in text, Word, or Excel formats for further research and analysis.

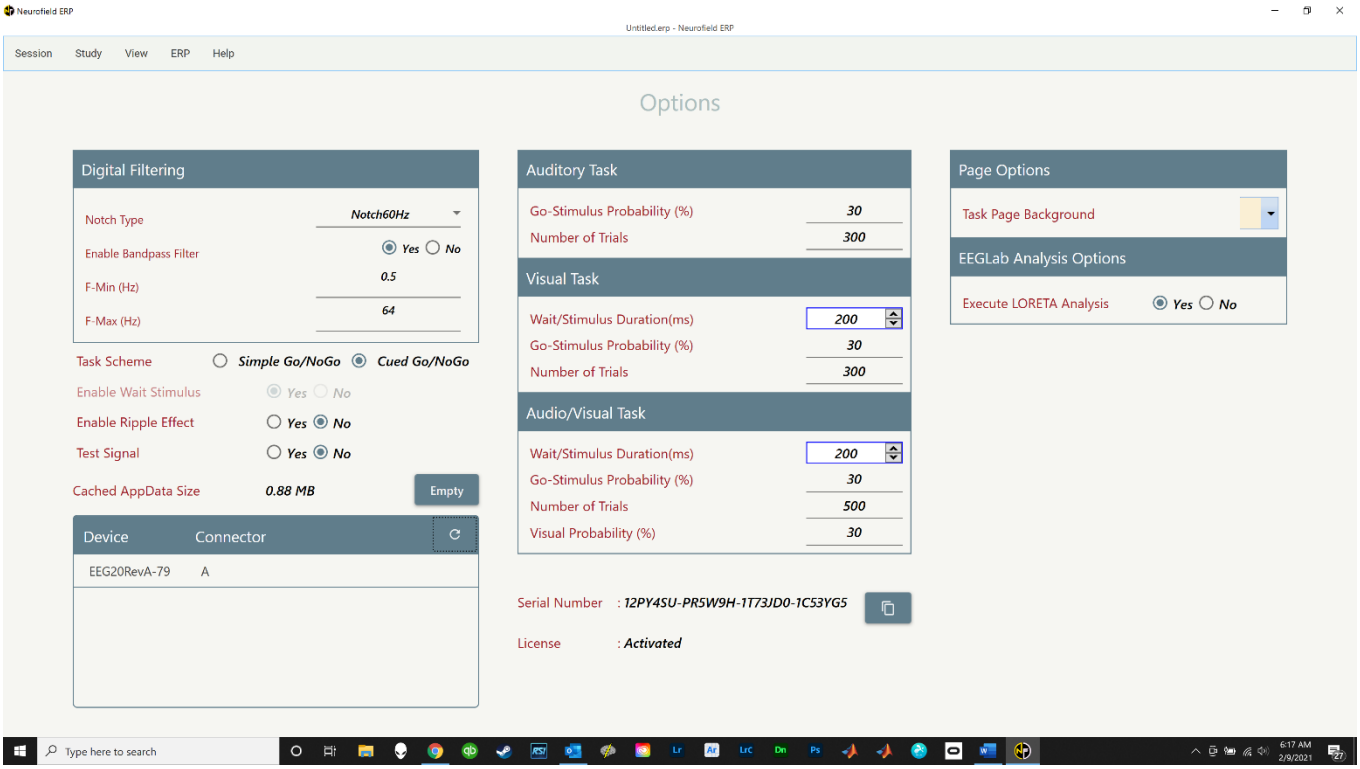
SESSION DASHBOARD

When you launch the program, you will enter the Session Dashboard. From here you can go right into a Task from this screen:

- Auditory Task
- Visual Task
- Auditory/Visual Task

Each one of these tasks takes about 15-20 minutes (300 trial task). To activate the buttons on the right side of the page you must enter a first, last name and date of birth. The "start" buttons for each task will then begin the

assessment. Before starting a task you will need to setup the type of GO NOGO task that you want to do and then explain the task to the user. To setup the task click on Session and then Options.



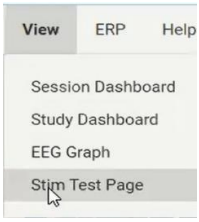
On the Options page you can setup the GO NOGO task that you want to run along with being able to setup digital filtering, program activation and to confirm that that the NeuroField Q20/21 amplifier is connected. The program will default to a simple GO NOGO task. The warning stim is on by default. The ripple effect and test signal are off by default. The program cache stores program data.

Each of the GO NO tasks can be configured by changing the GO probability percentage and the amount of trials you run for each task. It is recommended that the GO probability be set to 30% or less. The amount of trials run will increase ERP resolution, but long tests can fatigue the person and yield bad data. The auditory GO stim is 100 milliseconds and 1000 Hz. The visual task can be toggled to run at 100-800 milliseconds per trial. It is recommended that the visual stim be set between 100-200 milliseconds.

NFERP will install itself and begin in trial mode. In this mode you can run any task, set options and stimulation types. The EEG data that you generate during these tasks will NOT be saved and you will NOT be able to export the data until the program is activated. To activate NFERP send an email with your serial number to contact@neurofield.org and you will be sent an invoice to pay online. Once payment has been received and verified you will be sent an activation code that you enter in the options screen.

Once you have setup your options navigate to the stim test page by clicking on view -→ stim test page.

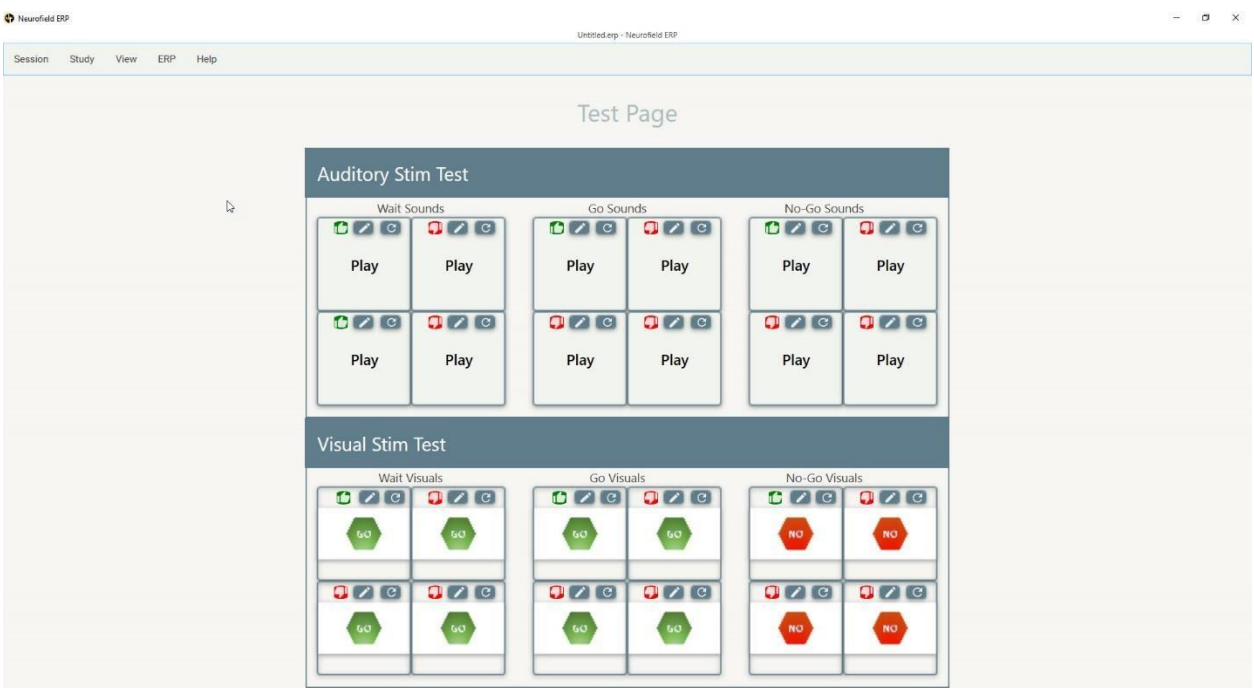
STIM TEST PAGE



The stim test page allows you to setup multiple auditory and visual GO NOGO task configurations. NeuroField ERP default setup is a simple GO NOGO task that includes one WAIT, one GO and one NOGO stimulus. The default settings will yield simple, but important ERP data and is the recommended method to use when you begin using ERP's in clinical practice.

You have the option to setup two GO NOGO test types; Simple GO NOGO and Cued GO NOGO. In the simple GO NO task one WAIT, one GO, one NO GO stimulation is enabled. The user clicks only when the WAIT and GO stimulation match. To make the task more difficult you can have the user count the amount of times they click on the GO match. In the cued GO NOGO task only the WAIT and the GO stimulations are enabled. Here you setup at least two visual and auditory WAIT tasks regardless of the task that you run be it visual, auditory and/or auditory/visual.

To enable a stimulation click on the "thumps up" or "thumbs down" icon. To change a stimulation, click on the pencil icon. You can change the visual and auditory stimulations with your images or sounds. To reset the stimulation back to the program default, click on the reset icon.



<u>It is critically important that your client understands the instructions before running a Task</u>. On the main menu navigate to the stimulus test page by clicking on View and the Stimulus Test Page. Then read the instructions exactly as are they written below for the specific task that is being administered. Once the instructions are read to the person have them repeat back to you what they are being asked to do. The administrator of the test is required to confirm that the subject understands the instructions. If the administrator of the test feels that the subject cannot verbalize or does not understand the instructions of the test, then it is permissible to have the subject take a practice test of 10 trials. To do this simply start the test and as each trial occurs the administrator verbally tells the subject to GO (click the mouse one time) or NOGO (No click). The subject should be able to learn the task within 10-20 trials. Once the administrator observes at least five correct trials then stop the test. Then restart the test with no assistance from the administrator. If the subject cannot learn the task then the test should not be administered as the result will not be valid.

The instructions for the visual task are as follows:

"This test is a visual matching and reaction time task.

You are going to SEE a green 

or a "red" 

on the screen. Your job is to click the mouse one time when you see two GO's in a row. When you see two GO's a row you are to click the mouse one time as fast as you can, but be careful not to click on a GO and a NO."

The instructions for the auditory task are as follows:

"This test is a auditory matching and reaction time task.

You are going to HEAR a "high pitched" GO sound or a "low pitched" NO sound. Your job is to click the mouse one time when you hear two GO sounds in a row. When you hear two GO sounds a row you are to click the mouse one time as fast as you can, but be careful not to click on a GO/NO pair."

The instructions for the combined task are as follows:

"This test is a visual and auditory matching and reaction time task.

You are going to SEE either a "green" 

, a "red" 

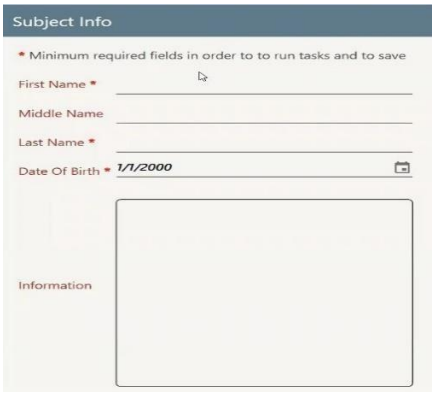
on the screen or you will be HEAR a "high pitched" GO sound or a "low pitched" NO sound. Your job is to click the mouse one time when you see or hear two GO events in a row. When you see or hear two GO events in a row you are to click the mouse one time as fast as you can, but be careful not to click on a GO/NO pair."

RUNNING AUDIO, VISUAL, & MIXED TASKS

Once you have set the number of Trials (and any other necessary settings) on the "Options" page and you have explained the instructions to your client, you can start a auditory, visual or combined auditory/visual task. All of the tasks are administer in the same way. To do this:

1. On the Main Menu, click on View/Sessions Dashboard to bring up the Dashboard.

ENTER CLIENT DATA



2. To start a session, you must enter:
    a. First Name
    b. Last Name
    c. Date of Birth

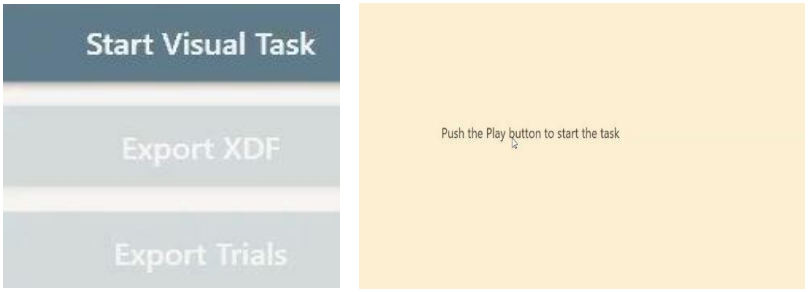
    These are the minimum fields required to run a task.
3. Notice once you enter the information, each of the buttons to start a Task become activated.

At this point, make sure that the client has the EEG cap on the head with good impedance values and is ready to go.

RUNNING A TASK

The following instructions explain how to run a visual task, but the auditory and auditory/visual tasks utilize the same instructions. To run a Visual Task:

1. From the Session Dashboard, click on the "Start Visual Task" button. It takes you to an empty Visual Task screen. This is the screen that the client looks at while taking the test. The subject should be positioned so that they are sitting directly in front of the monitor and have easy and comfortable access to the mouse.



2. While the client is taking the test, the administrator can observe the raw EEG to ensure proper recording of the data. If you have a 2nd monitor, you can open a floating window that can be moved to another monitor for viewing while the client is testing. Notice up in the left-hand corner of the screen are 4 icons.

Click on the far-right icon. The floating window will open, and you can move it to the 2nd monitor to view the EEG. The EEG window should NOT be visible to the subject as it will distract the person and invalidate the test.

3. At this point, before beginning a session you want to repeat the instructions for your client. Move your cursor over the first button in the upper left-hand corner of the window, it will say "Play".

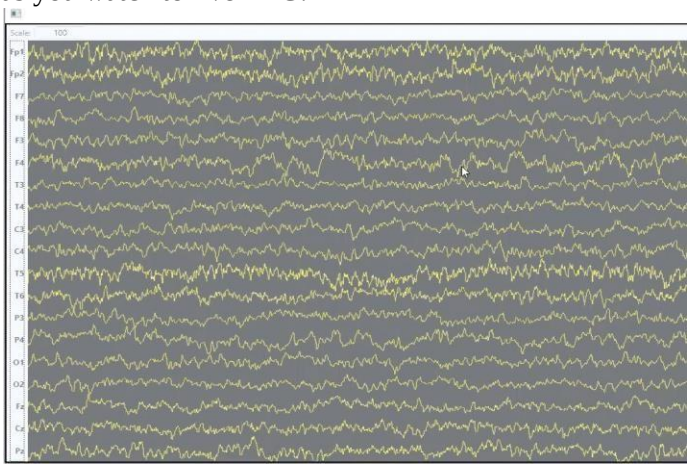
Click on the "Play" icon. The Visual task will start up, the EEG will start running and begin the recording automatically. Immediately after clicking on the Play button, give control of the mouse to the subject. You do not have to do anything else.

4. Notice the lower left-hand corner of the screen. There are 2 sets of numbers.

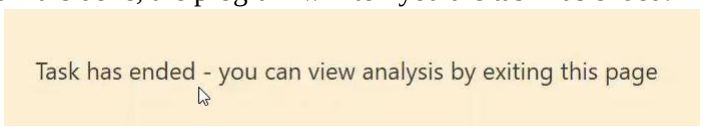
- A Timer - This tells you have much time has elapsed
- A Trial Counter – This tells you what trial they are on i.e. 17 of 300.

You can track where they are in the test and you can update them as they are going along. For some people it is comforting to know where they are in the trial. For others it's difficult to listen to an update and stay on task. We recommend that you do not give the subject any information as they take the test other than encouragement to complete the task and to remain focused to the best of their ability. Bringing attention to the trial counter can cause the subject to focus on it instead of the center of the screen.

5. Take a look at the EEG window on your 2nd monitor. Here you can set the Scale to Zoom in or Zoom out as you watch to live EEG.



6. When it is done, the program will tell you the task has ended.



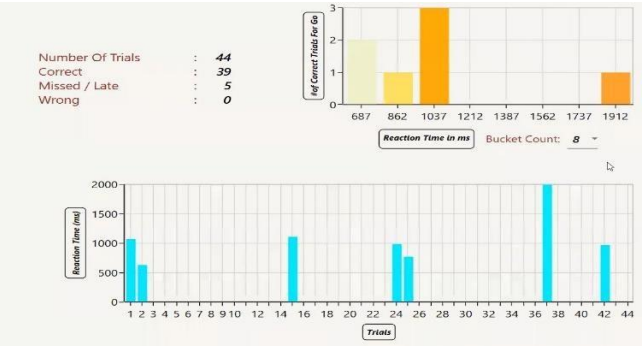
You can stop the task at any time, and it will save the data wherever you stop it. Again, notice the buttons at the upper left-hand corner of the screen. Scroll your cursor over 2nd icon in the middle and it will say "Stop". Click on it and it will stop the task.

7. To exit the page, scroll your cursor over the 3rd icon and it will say "Exit". Click on it and it will take you to the "Visual Analysis" screen.
8. SAVE YOU SESSION DATA. Click on Session and then SAVE. You will be prompted to name the file. The .ERP extension will be added to the filename. All of your EEG and session data is contained in this file location as the saved .ERP file.

VIEWING TASK DATA

Visual Analysis Screen

When you exit a Task, the "Visual Analysis" screen comes up automatically.



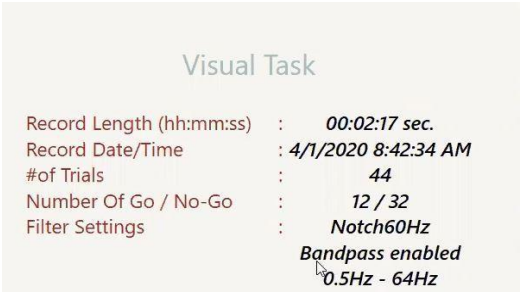
- Number of Trials that were completed.
- How many of them were correct.
- How many of them were missed or late
- How many of them were wrong.
- Your Actual Reaction time every time that your clicked it.

It's important to view the client's pattern of reaction times over the course of a test. It is a good idea to take a screen shot of this page. Again, the research has shown that for anyone 14 yrs old and above, a response time of around 600 msec or less is considered a good response time.

Visual Task Summary

You are now done with the task and can return to the Session Dashboard. To do this:

1. From the Main Menu, click on View/Session Dashboard to go back to the Session Dashboard.
2. Notice the Visual Task area of the Dashboard.



You will see the data for the last Visual Task that was run.

SAVING. ERP SESSION FILES & RELOADING SESSION DATA

You have now completed a run through the visual ERP task. All the data – Audio, Visual and Mixed – will be saved in file with an ".ERP" extension file. To do this.

1. In the Main Menu go to Session/Save and a File Explorer window will open up.
2. Go to the top-level folder for your Client and name the file "ERP1Session".
3. Save it as an .ERP file.

All of data you collected is saved in a single session file. You can now come back later, reload the program, and Open this session. To do this:

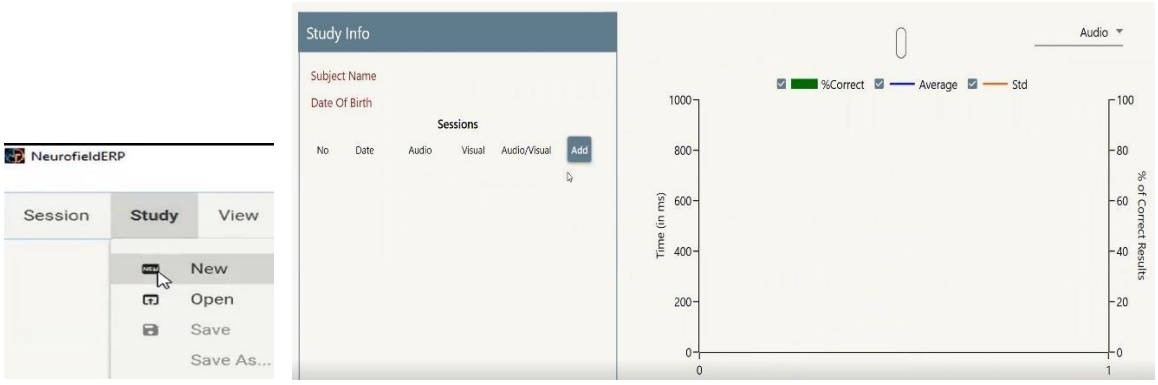
1. In the Main Menu, go to "Session/Open and in File Explorer open the Session .ERP file you just saved to reload the data. It will load all three of the Tasks at one time.

RUNNING A STUDY

SINGLE STUDY

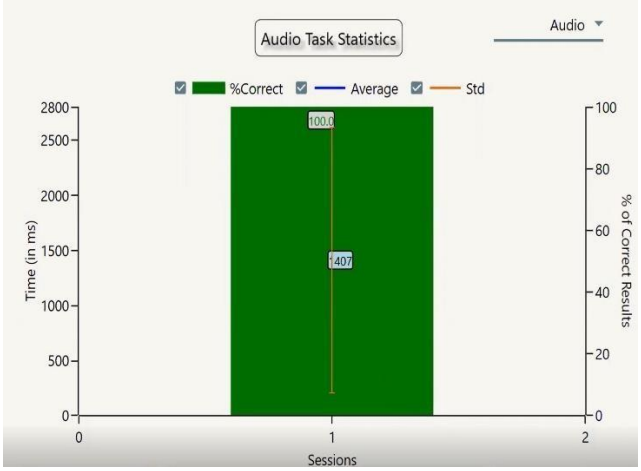
Now that you have completed your ERP tests, you can look at the reaction time results over time by running a "Study". You can create a new Study or open an existing Study. To start a new study do the following:

1. In the Main Menu click on Study`/New.



A blank Study window will appear.

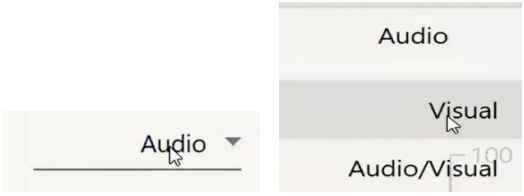
2. In the "Study Info" section of the window, click on the "Add" button that is highlighted to add the .ERP Session file.
3. In File Explorer click on the ERP1Session.erp file you made in the previous section and click "Open". The software will load the data for whatever tasks you ran during the session.



Note: there is only 1 session of data in this "Study Info" example. If you have done 3 or 4 sessions of ERP tasks you add each of them in and they will be consecutively numbered in the "Study Info" Sessions list and in the "Statistics" Sessions graph. See next section below for details.

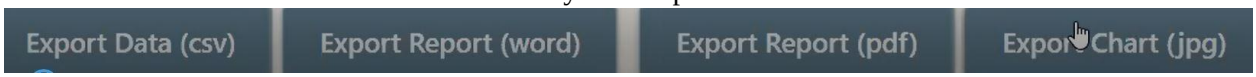
4. Notice the "Audio Task Statistic" window. What you see is:
   - ✦ Time in msec displayed on the vertical axis
   - ✦ "Response Time" label in msec – number in the middle of the graph
   - ✦ Standard Deviation in the mean response time – yellow vertical line in the graph 5.

Notice the upper right corner of the "Statistics" window says "Audio".



Click on "down-arrow" and a drop-down appears with Task options available to study.

6. Select the "Visual" option and the Visual task information loads for you to study. Or, click on the "Audio/Visual" and the Mixed task data is loaded.
7. At the bottom of the screen is a set of buttons that allow you to export the data.

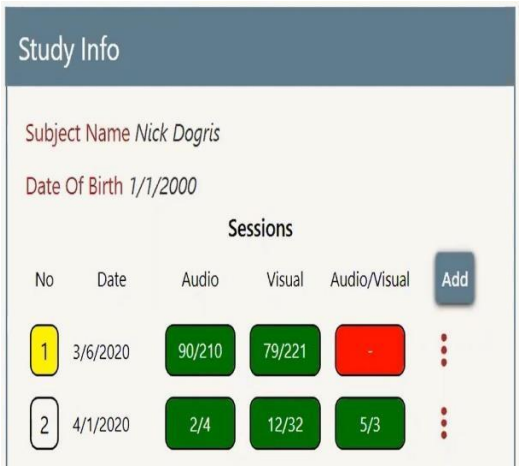


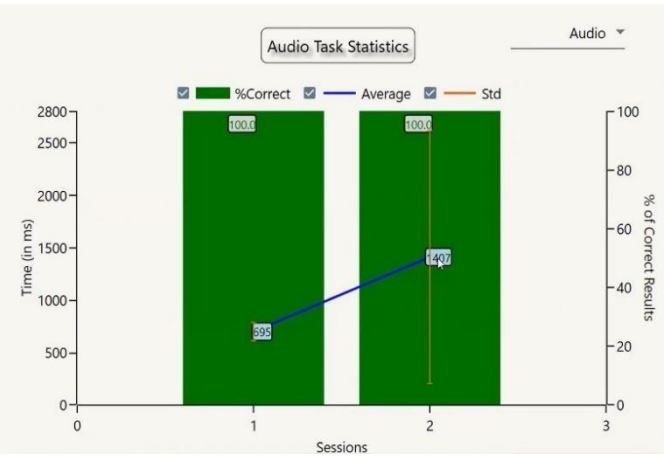
You can export the data in any of the listed formats.

MULTIPLE STUDIES

If you've done more than one session with a client, you can add it to the study and compare the statistics between each session. To do this:

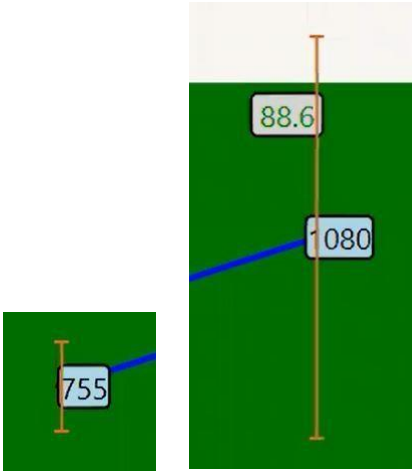
1. Click the "Add" button and navigate in the File Explorer to the session file you want to add, and it will be added to the list in chronological order.





Now you have two tasks loaded and you can compare the difference between two different sessions.

2. Session 1 in the Audio shows a latency of 695 with a very short variability. Note: The example above and directly below is from two different clients with the goal of showing the ability to add multiple session data. So you most often you won't see it go in this direction, you would see it going in the other direction where latency has moved closer to the ideal of 600 – 1000 msec.
3. Switch the Task Data to Visual and notice Session 1 again.



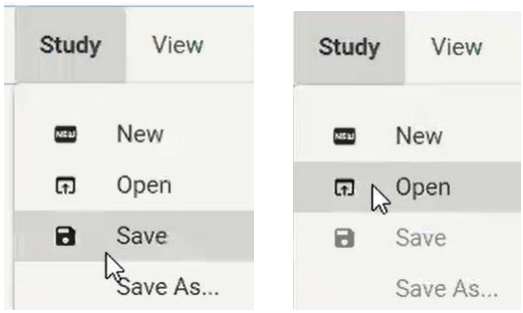
This same client had a latency of 755 msec with a very short variability represented by the yellow line. Whereas the Client representing Session 2 show a latency that is concerning with a lot of variability represented by the long yellow line. This is very helpful because here you can identify what their baseline capability is and then track how they are changing over the course of time. Another good idea is to save the number of "Go's" that they reported in the filename to track as well.

Also important to note is that the "Testing Effects" are low in this type of a test, which keeps the test valid over time. If the client takes the initial test on Monday and then again on Thursday, the client might know they are going to get a stimulus, but they don't know when they are going to get it because that varies. The client might remember what the test is, but they cannot anticipate the randomness of the task.

SAVE & OPEN THE STUDY

What you can do from here is Save the "Study". To do this:

1. Click on Study/Save and File Explorer will appear.



2. Navigate to the client's folder, at the same level as ERP1 that you used to save the Task data and name the " Study1" and the ERP software will add a .study extension to the filename.

You can also Open a "Study" that you have previously saved and add data to it. This allows you to build up the Study over time. To do this:

1. When you have completed additional tasks, you can add them to the Study. On the Main Menu go to Study/Open, as seen in the image on the right above, and the Study with existing Sessions/Tasks will Open.
2. Click on "Add" to add more data to it without having to open each file individually. Then you can Save the Study once again with the additional data.

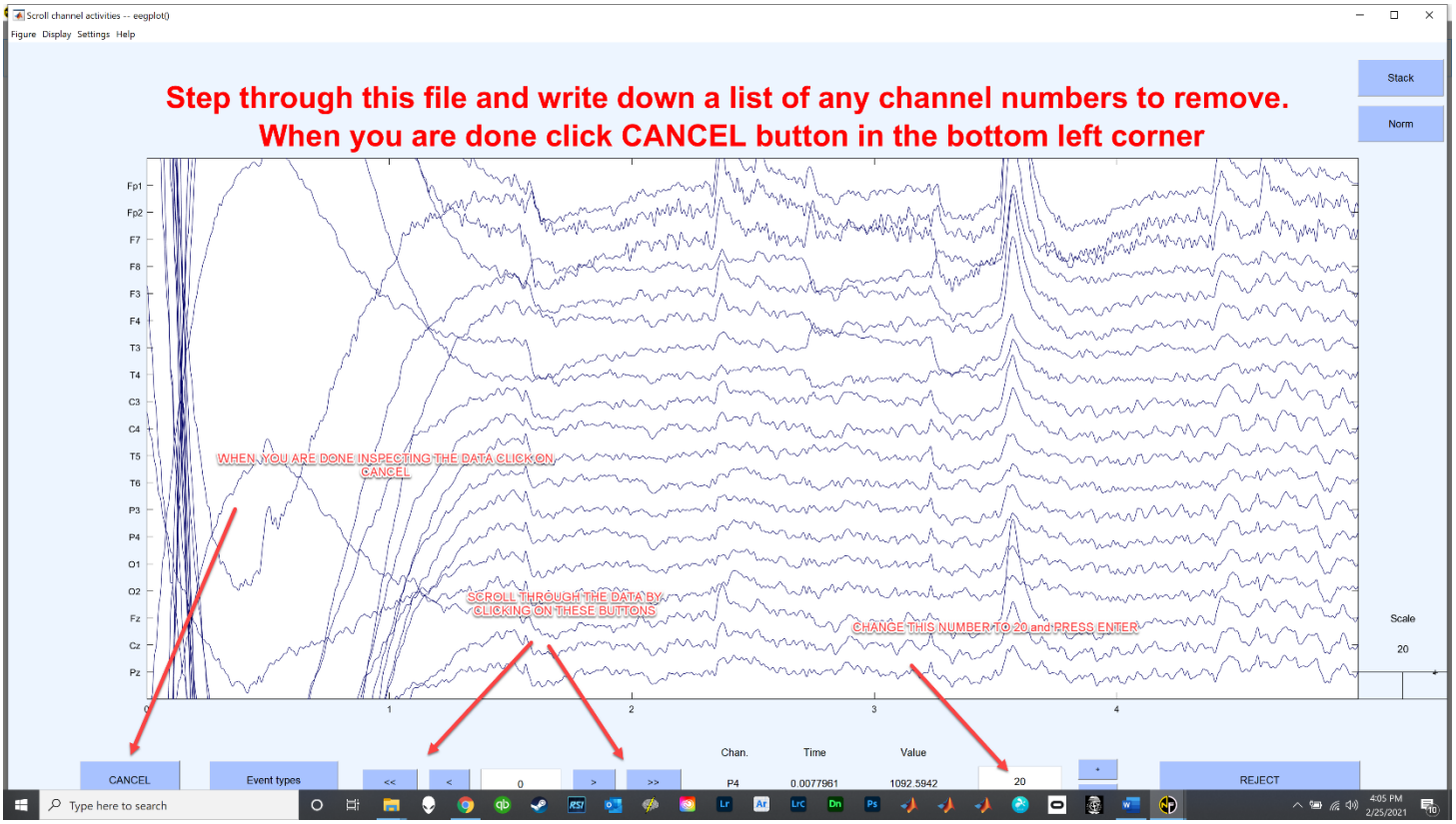
ANALYZING THE DATA

Once the test is complete you can analyze the EEG data. NeuroField ERP utilizes the open source software EEGLAB to conduct its analysis. EEGLAB is a robust platform that has far reaching capabilities and can be found at https://sccn.ucsd.edu/eeglab/index.php for more information.

Delorme, A. and Makeig, S. (2004). EEGLAB: An open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. Journal of Neuroscience Methods, 134(1):9– 21.

If you do not have data loaded, go to session, then open and select a .ERP file to analyze. On the toolbar click EEGLAB analysis.

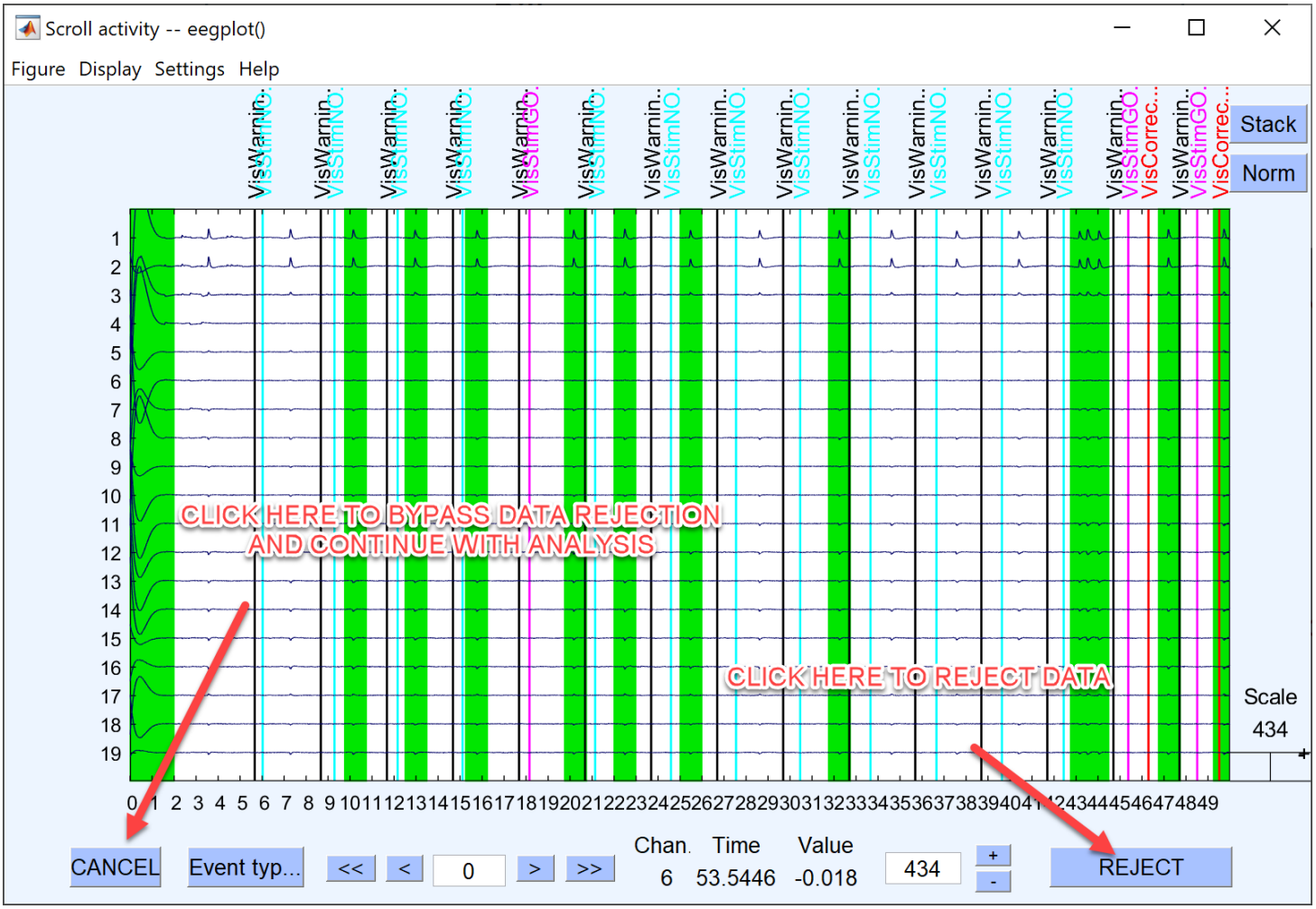
This process takes roughly 15-20 minutes to complete. To start it is best if you copy your ERP data file into its own folder. The analysis creates a lot of data and can easily clutter your folders, so the best practice is to make one folder for each ERP session file you create. The analysis begins by opening a window prompting to create a file name for the EEG data. NeuroField ERP will then save the data in XDF format and begin the analysis. ERP analysis is conducted in multiple steps. The first step is to reject bad channels in the EEG data. You will see this screen pop up.



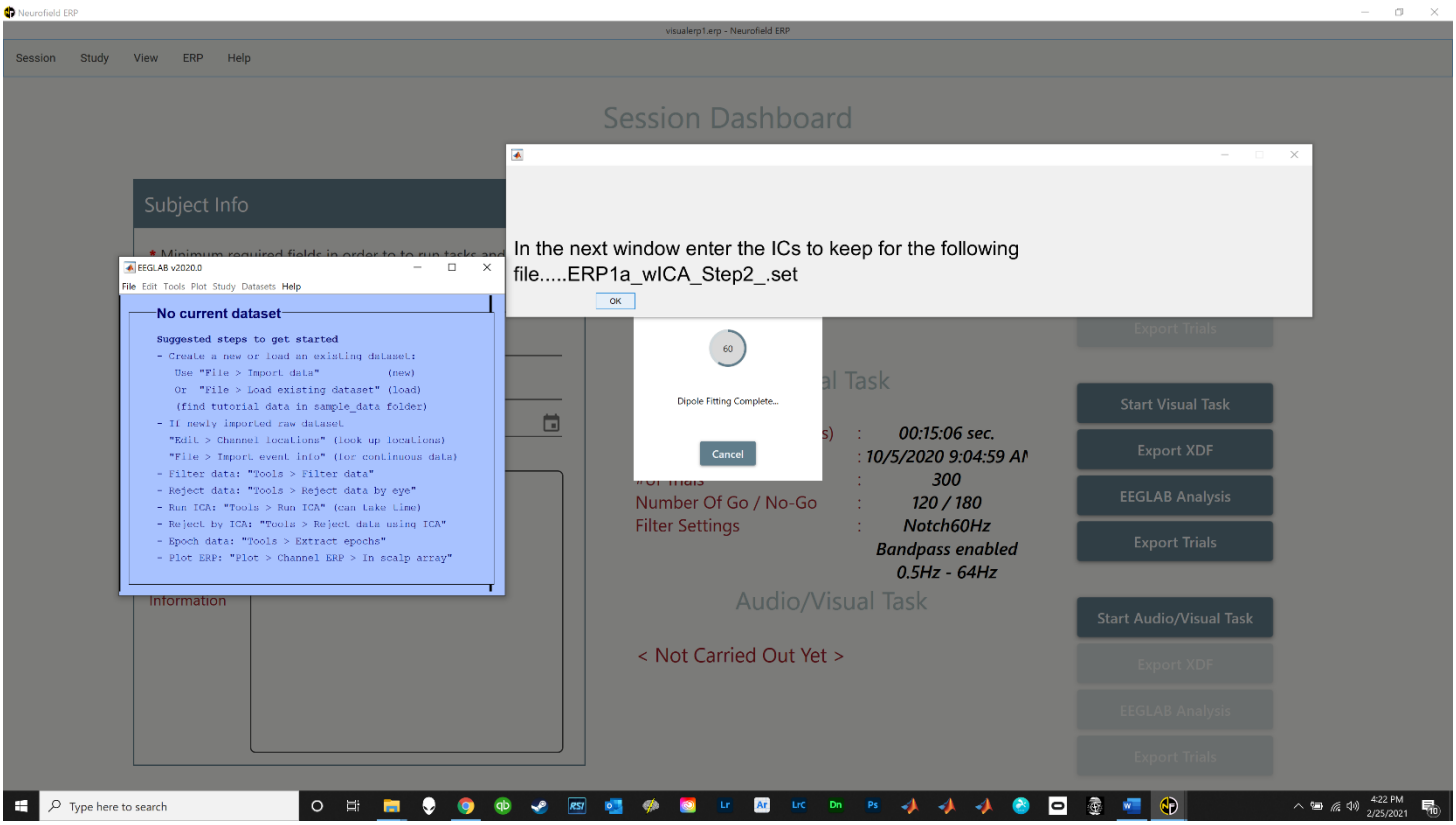
IF you see flat lines and no identifiable data change the zoom control number to 20 in the lower right-hand corner of the screen. Then scroll through the data to confirm that the channels are good using the right and left arrow buttons. Write down the names of any channels that you wish to reject and then click on the cancel button.

NeuroField ERP will then launch an auto edit program and select segments of the data that it thinks are artifact. Your job is to review the epochs that the program selects and then either reject them or accept them. You can accept what the program presents to you and then click on the reject button to continue or you can click on the cancel button to bypass this process and continue on with the analysis.

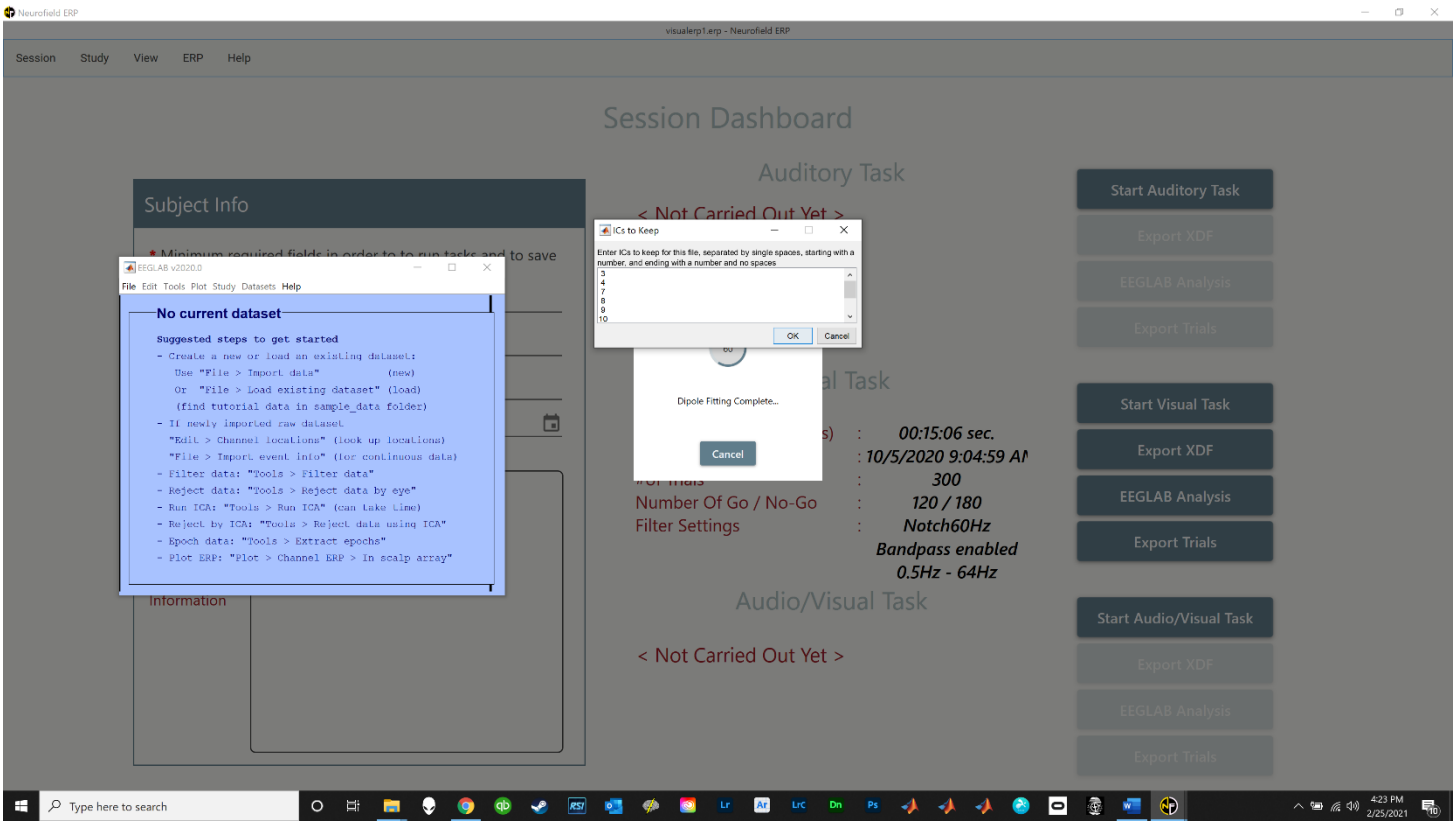
You can also work through the entire file and make changes to what the program selects by right clicking on each segment which will save the data instead of selecting it. This process can be tedious and take a long time. In most instances simply rejecting the data is the best course of action, however, in some cases running AMICA can also remove artifacts and do a better job than this process. You can always run the analysis again as the original data will not be impacted by this process.



Once the data rejection process is complete NeuroField ERP will launch the adaptive mixture independent component analysis (AMICA) on the data. AMICA is a learning algorithm that can "learn" the temporal signatures of the data for the purpose of "seeing" underlying neural activity. It can be used to "clean" the data and remove eye blinks and other artifacts as well. This process will take around 15 minutes. Do not interrupt the process of close the program during this time. Once it is completed NeuroField ERP will launch ICLABEL which is a program that is designed to help you categorize the independent components identified in the AMICA process. A number of images will be flashed on the screen and when the process is complete you will see this screen.



Click ok and then you will see this screen.



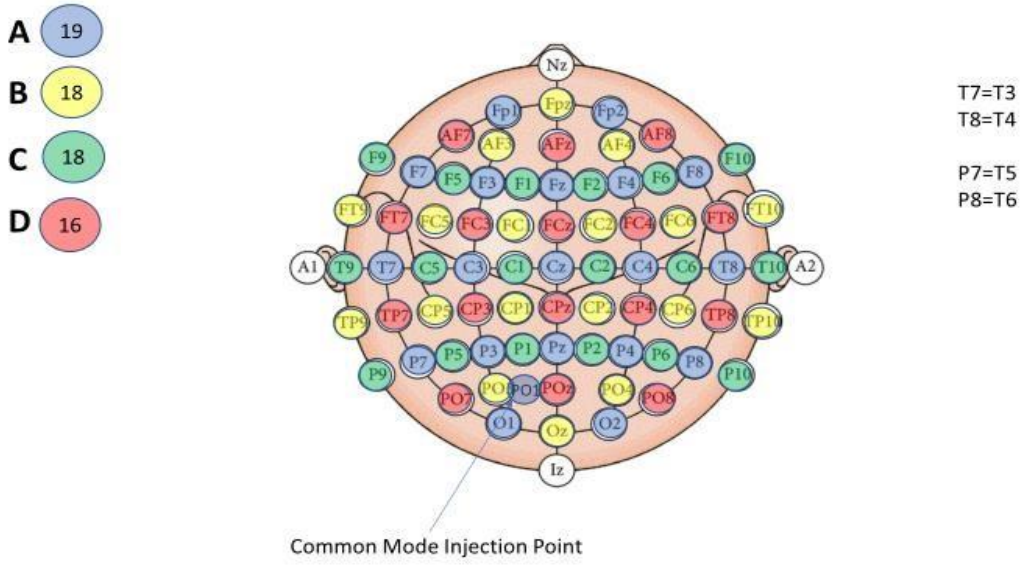
AMICA allows the user to remove artifact from the data so as to reveal true neural functioning. At this point in the analysis NeuroField ERP is telling you which components it wants to keep. Your job is to review the components and to either accept or reject the list that of components that are being presented in the text box.

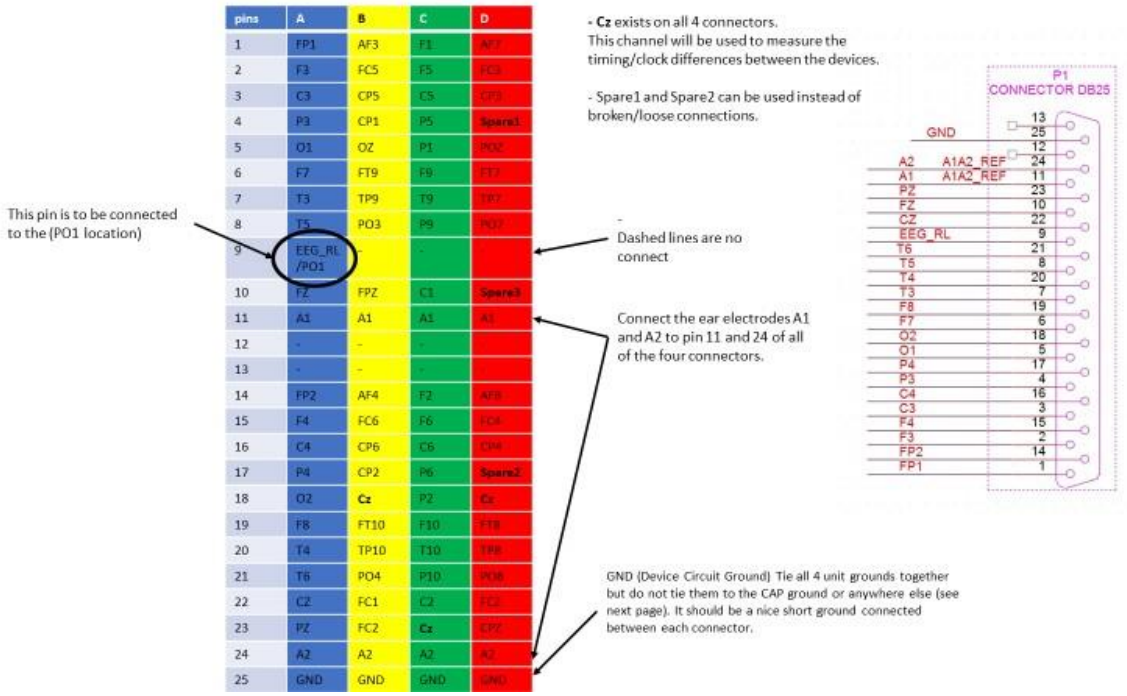
NeuroField ERP stores all the component images in the "figures" folder located in the same folder where you placed your .ERP file. Navigate to that folder and inspect each of the images. The acceptance criteria is that the component is at least a 85% or more match to the brain database and not at match of any of the other artifacts listed in the ICLABEL list. Like most programs, ICLABEL is very good at categorizing data, but can make mistakes which is why you must visually inspect the data as well.

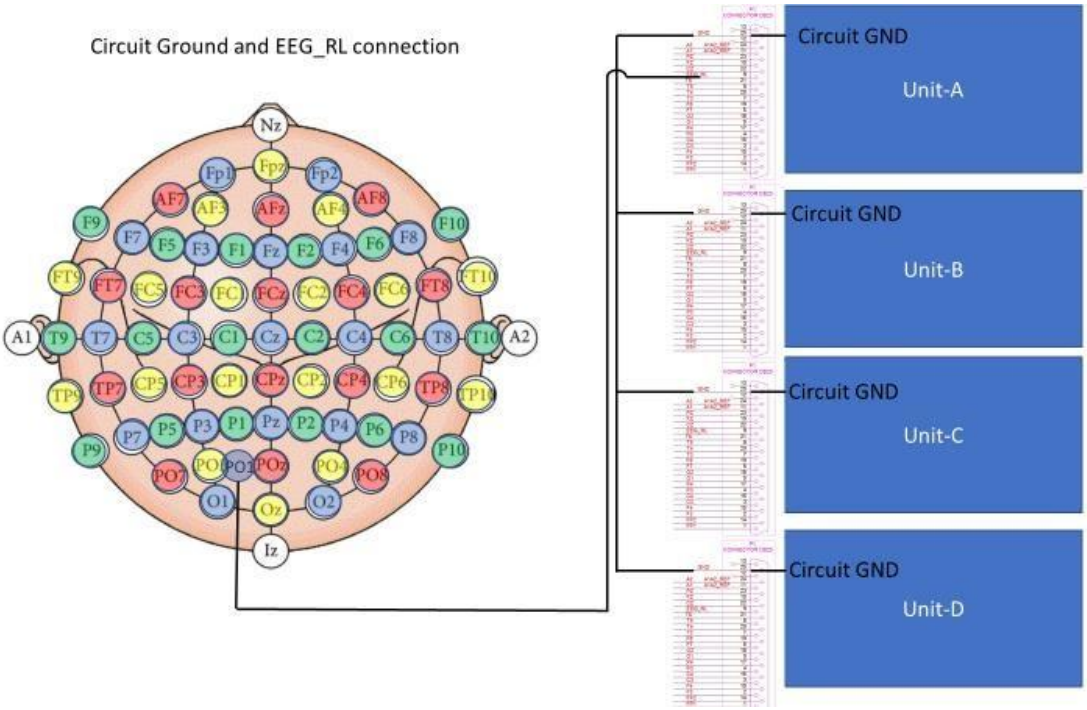
To remove a component simply click in the text box and delete it. To keep it do nothing and leave it there. When you are done click ok. NeuroField ERP now has all of the data it needs to create your ERP data and images. You will now be treated a series of images that pop up on the screen representing the outcomes from your ERP test. All of the images will be saved in the same folder where you placed your .ERP file. Learning how to interpret this data and utilize it is beyond the scope of this manual. Please visit www.schoolofneurotherapy.com to sign up for classes and learn more about the complex world of EEG!!

Appendix A

NeuroField ERP is capable of connecting to a Q20 or Q21, so you can record 19 channels of EEG. You can run up to four Q20 or Q21 amplifiers at the same time for a total of 72 channels. This will require a specialized cap that must be custom made. Contact NeuroField, Inc to obtain more information about specialized 38 or greater channel configurations.




pins
A
B
C
D
- Cz exists on all 4 connectors.
This channel will be used to measure the timing/clock differences between the devices.
- Spare1 and Spare2 can be used instead of broken/loose connections.
This pin is to be connected to the (PO1 location)
EEG_RL /PO1
Dashed lines are no connect
Connect the ear electrodes A1 and A2 to pin 11 and 24 of all of the four connectors.
GND (Device Circuit Ground) Tie all 4 unit grounds together but do not tie them to the CAP ground or anywhere else (see next page). It should be a nice short ground connected between each connector.
P1
CONNECTOR DB25
GND
A2
A1A2_REF
A1
A1A2_REF
PZ
FZ
CZ
EEG_RL
T6
T5
T4
T3
F8
F7
O2
O1
P4
P3
C4
C3
F4
F3
FP2
FP1


Circuit Ground and EEG_RL connection
Nz
Fp1
Fpz
Fp2
AF7
AF3
AFz
AF4
AF8
F9
F7
F5
F3
F1
Fz
F2
F4
F6
F8
F10
FT9
FT7
FC5
FC3
FC1
FC2
FC4
FC6
FT8
FT10
A1
T9
T7
C5
C3
C1
Cz
C2
C4
C6
T8
T10
A2
TP9
TP7
CP5
CP3
CP1
CPz
CP2
CP4
CP6
TP8
TP10
P9
P7
P5
P3
P1
Pz
P2
P4
P6
P8
P10
PO7
PO3
POz
PO4
PO8
O1
Oz
O2
Iz
Circuit GND
Unit-A
Circuit GND
Unit-B
Circuit GND
Unit-C
Circuit GND
Unit-D