

## **Adding Biosemi Integration to Existing Non-EyeLink Experiments: A Quick Tutorial (EB Version 2.2.1)**

This tutorial covers the steps required to add Biosemi EEG support to an existing experiment using version 2.2 or later of SR Research Experiment Builder. This example (Biosemi\_NonEyeLink\_Stroop) is based on the “STROOP” example provided with Experiment Builder. Users who are new to the software are encouraged to re-create the STROOP example by following the step-by-step instructions provided in the Experiment Builder User Manual (“15 Creating Non-EyeLink Experiments: Stroop Effect”). This example illustrates using Experiment Builder for Biosemi experiments without recording eye tracker data. If you are looking for an example that illustrates running experiments with simultaneous EEG and eye tracking recordings, please check out the “Biosemi\_EyeLink\_Simple” example and the accompanying tutorial.

Experiment Builder has built-in functionality to support communication between the Display PC and EEG computer via TTL. The new BIOMETRIC\_TTL action introduced in version 2.2 of Experiment Builder offers more flexibility than the existing SET\_TTL action, and simplifies integration with Biosemi EEG. This example uses the parallel port of the Display PC to send TTL signals, but the BIOMETRIC\_TTL action also supports sending TTL signals through a supported USB device (including the Biosemi USB Trigger Interface), or through the EyeLink Host PC in an EyeLink project.

- 1) The BIOMETRIC\_TTL Control action implements the “Start Recording” and “Stop Recording” options, which can be used to send signals to control the start and stop of the recording for Biosemi EEG. Users will need to configure the “default.cfg” file on the EEG computer to set the values for “PauseOff” and “PauseOn” commands to 254 and 255, respectively.
- 2) The Biometric TTL Control also allows users to easily control the duration of a signal by sending a clearing signal (typically 0x0) shortly after the initial signal (instead of having to use two SET\_TTL actions connected with a Timer trigger).

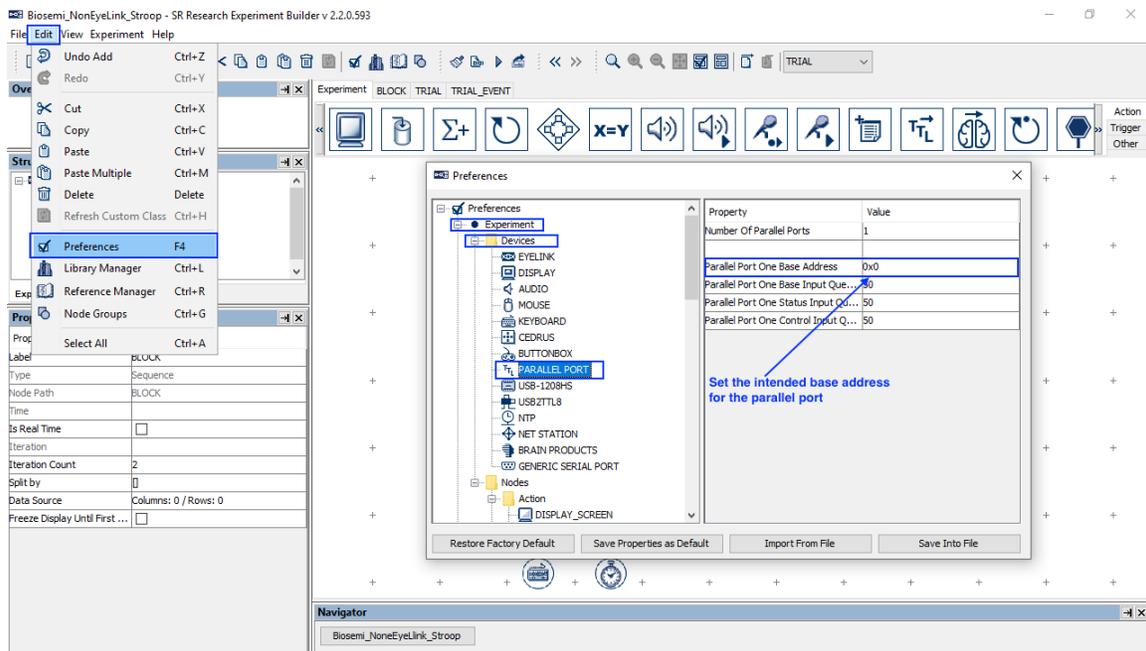
This current tutorial will demonstrate how to unpause and pause EEG recordings and add event markers to an example experiment that mark the critical events that occurred in a trial. Although the discussion is based on the Stroop example, steps covered here can be easily applied to any non-eyetracking experiments programmed with Experiment Builder.

Please report all functionality comments and bugs to [support@sr-research.com](mailto:support@sr-research.com).

# 1 Configuring Experiment Builder Preferences

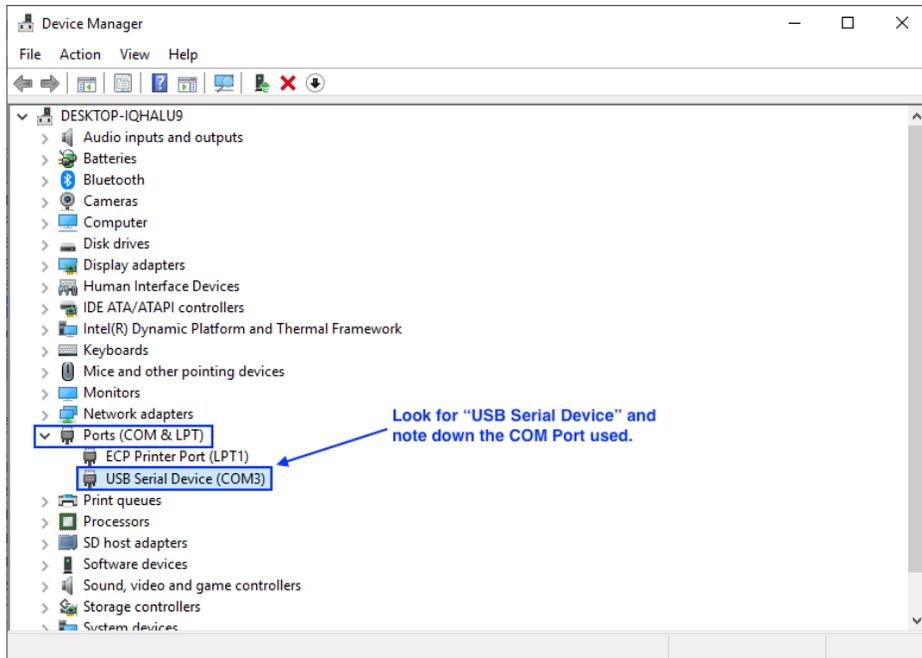
This section illustrates how to configure Experiment Builder to communicate with the Biosemi EEG. In this example, TTL signals are sent through the parallel port on the Display PC.

- 1) Select “Edit -> Preferences” from the application menu bar or press the shortcut key “F4” on Windows.
- 2) Navigate to the “Parallel Port” menu under “Experiment -> Devices” and look for the “Parallel Port One Base Address”. Enter 0x0 in the value field so that Experiment Builder automatically detects the parallel port device installed on the display computer and resolves its base address.

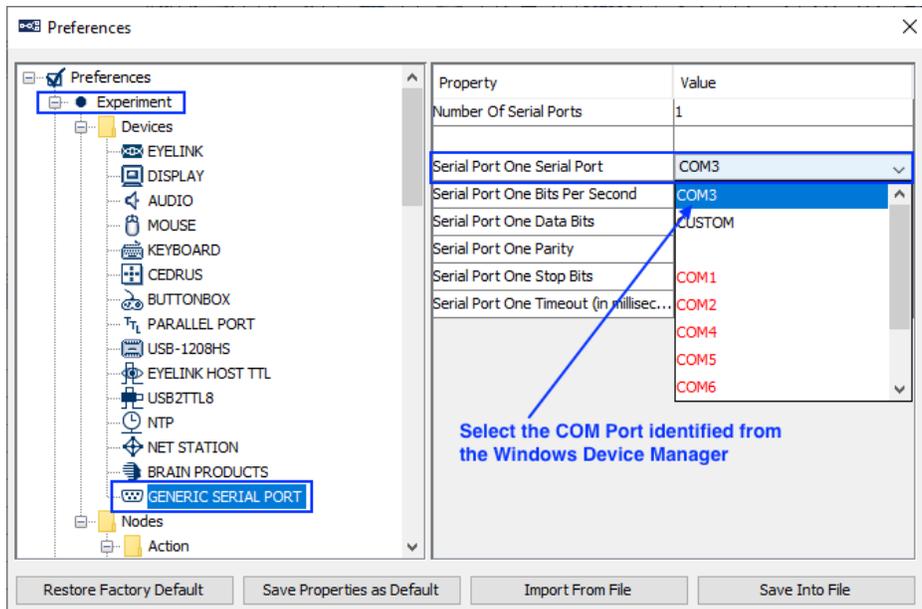


For display computers without a parallel port, users have other options to send TTL signals. For example, the USB-1208 HS by Measurement Computing and the USB2TTL8 by LabHackers are USB-based TTL devices that can be used on both a Mac and Windows PC. Experiment Builder also supports the Biosemi USB Trigger Interface (<https://www.biosemi.com/faq/USB%20Trigger%20interface%20cable.htm>), which can be used on both Windows and Mac OS X.

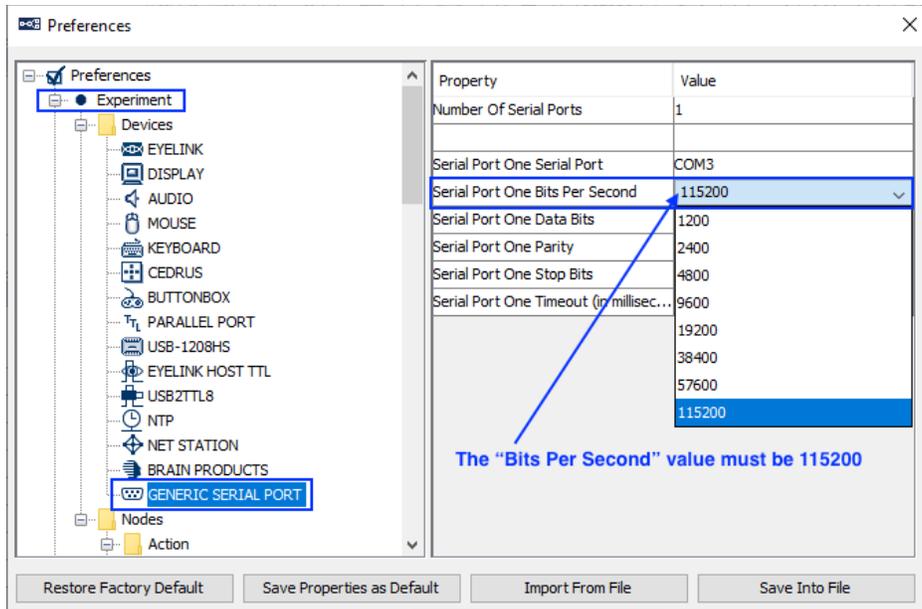
- 1) The COM port that the USB Trigger Interface uses can be found in the “Ports (COM & LPT)” section of the Windows Device Manager. Search the entry “USB Serial Port (COMx)”.



- 2) Go to "Preferences -> Experiment -> Generic Serial Port". For the "Serial Port One Serial Port" field, select the COM port value identified from the Windows Device Manager. On Mac OS X, the COM Port will appear in the format of "/dev/tty.usbserial-\*\*\*".



- 3) The "Serial Port One Bits per Second" field must be set to 115200 for the USB Trigger Interface to work properly.

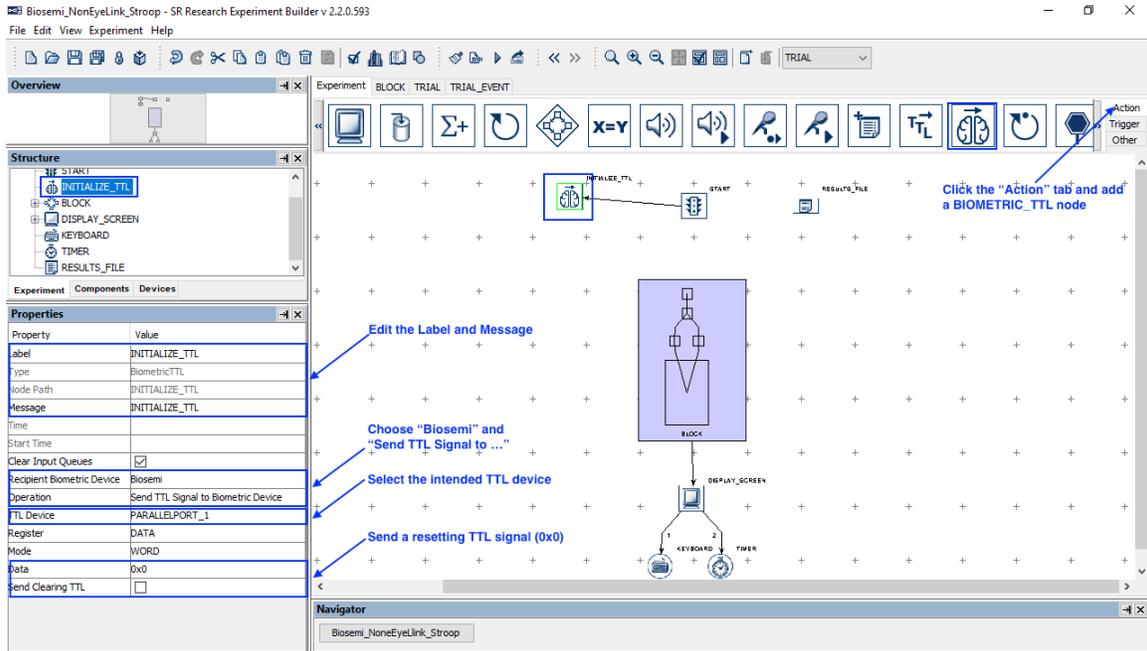


## 2 Setting the Default TTL Value and Controlling EEG Recordings

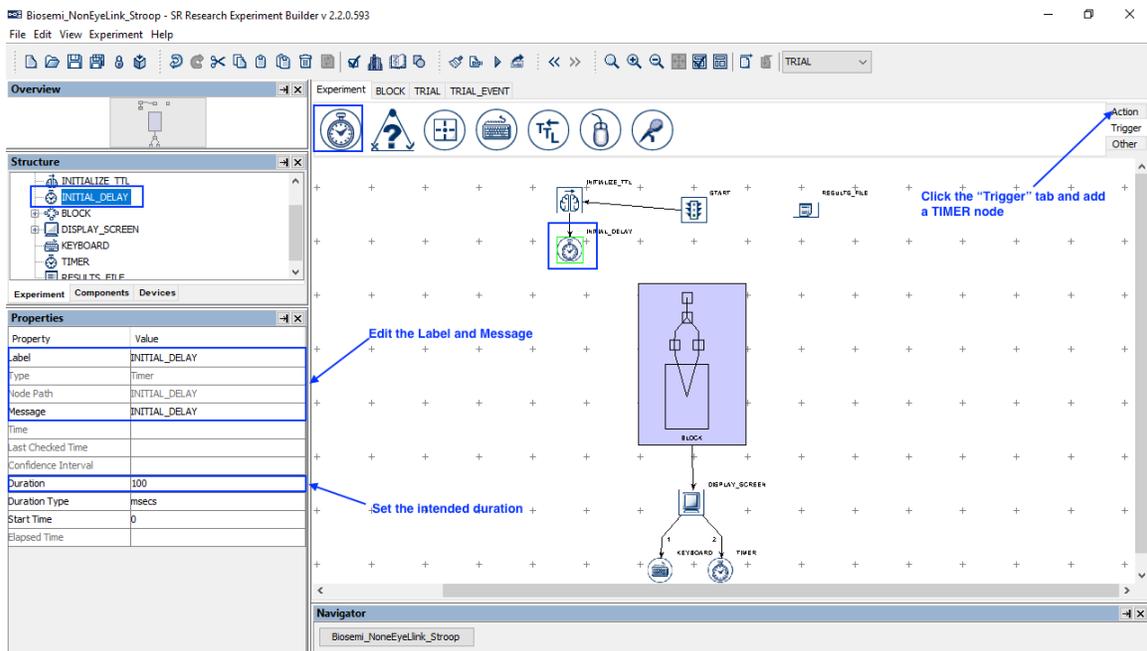
One important aspect of integrating eye tracking and EEG data is to ensure that critical events, such as display screens, and/or participants' responses, are marked in both the Experiment Builder results file and the EEG data file. For the Biosemi EEG system, a default TTL value (typically 0) needs to be set at the beginning of the project. To mark critical events (e.g., stimulus onsets, participant responses) in the EEG data, we can send a brief trigger immediately after the event, then reset the TTL value back to 0 so the EEG can receive the next event marker.

Biosemi EEG systems allow the user to start and stop the EEG recording by sending TTL triggers from Experiment Builder—please see section 4 for information on how to configure the EEG computer to use TTL signals to trigger EEG recording. In this example, we send a single Start Recording command at the beginning of the experiment, and a single Stop Recording at the end of the experiment. Users may also choose to start and stop the EEG recording multiple times within the project, for instance, by sending the start and stop commands at the beginning and end of each block of trials, or more rarely at the beginning and end of each individual trial. Make sure to include a short (1000 msec) delay after sending a Start Recording command, or before sending a Stop Recording command, to ensure the recording has stabilized.

- 1) Go to the topmost layer of the experiment.
- 2) Select the “Action” tab of the Component Toolbox and add a BIOMETRIC\_TTL action. Set the Label and Message of the action to “INITIALIZE\_TTL”. Set the “Recipient Biometric Device” to “Biosemi”, and set the “Operation” to “Send TTL Signal to Biometric Device”. Use the TTL Device as discussed in section 1 – in this example, we are going to use the parallel port on the Display PC (“PARALLELPORT\_1”; if another device is chosen, a prompt will allow the user to set that as the default TTL Device for all Biometric TTL nodes). Set the Register to “DATA”, set the Data to “0x0”, and uncheck the “Send Clearing TTL” box. If using the Biosemi USB Trigger Interface, set the "TTL Device" to "SERIAL\_PORT\_ONE". Now connect the START node to the INITIALIZE\_TTL node.

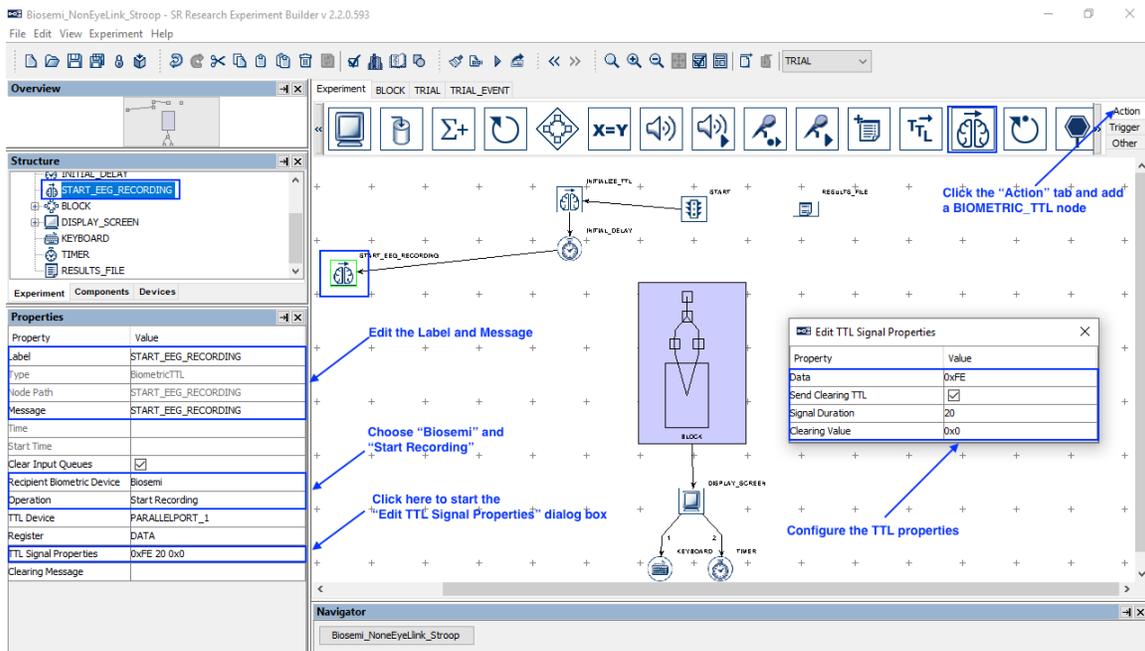


- 3) Select the “Trigger” tab of the Component Toolbox and add a TIMER node to the graph. Edit the “Label” and “Message” properties of the node to “INITIAL\_DELAY”. Set the “Duration” to be 100 (msecs). Draw a connection from the INITIALIZE\_TTL node to the TIMER node.

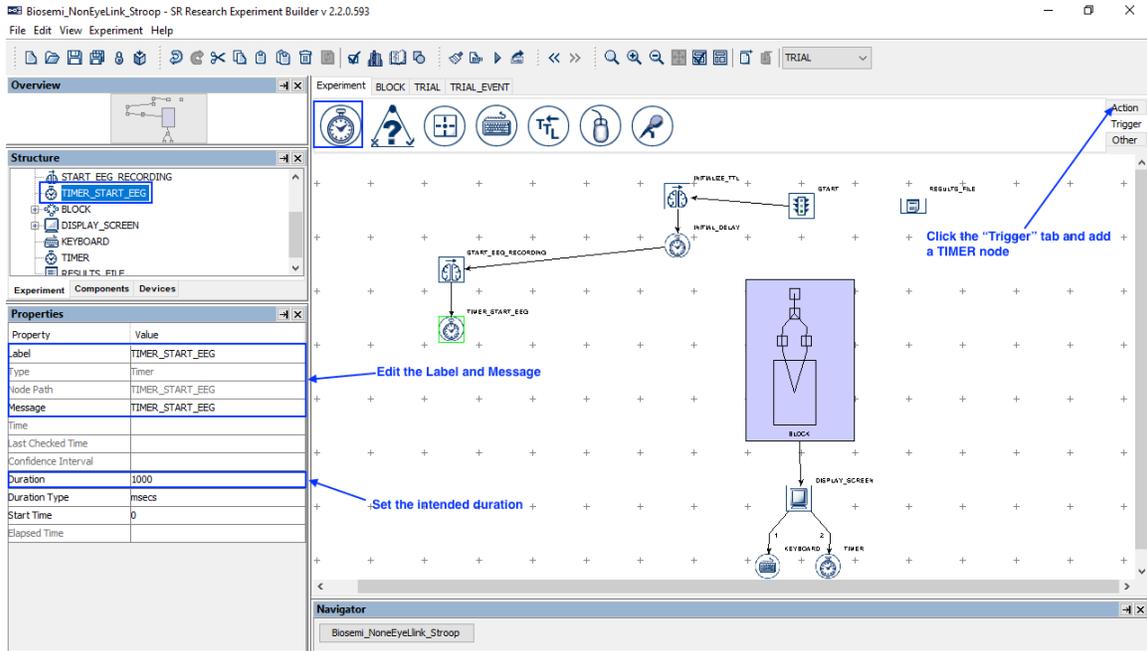


- 4) At the beginning of the experiment, the EEG recording is started. Select the “Action” tab of the Component Toolbox and add a BIOMETRIC\_TTL node to the graph. Edit the “Label” and “Message” properties of the node to “START\_EEG\_RECORDING”. Set the “Recipient Biometric Device” to

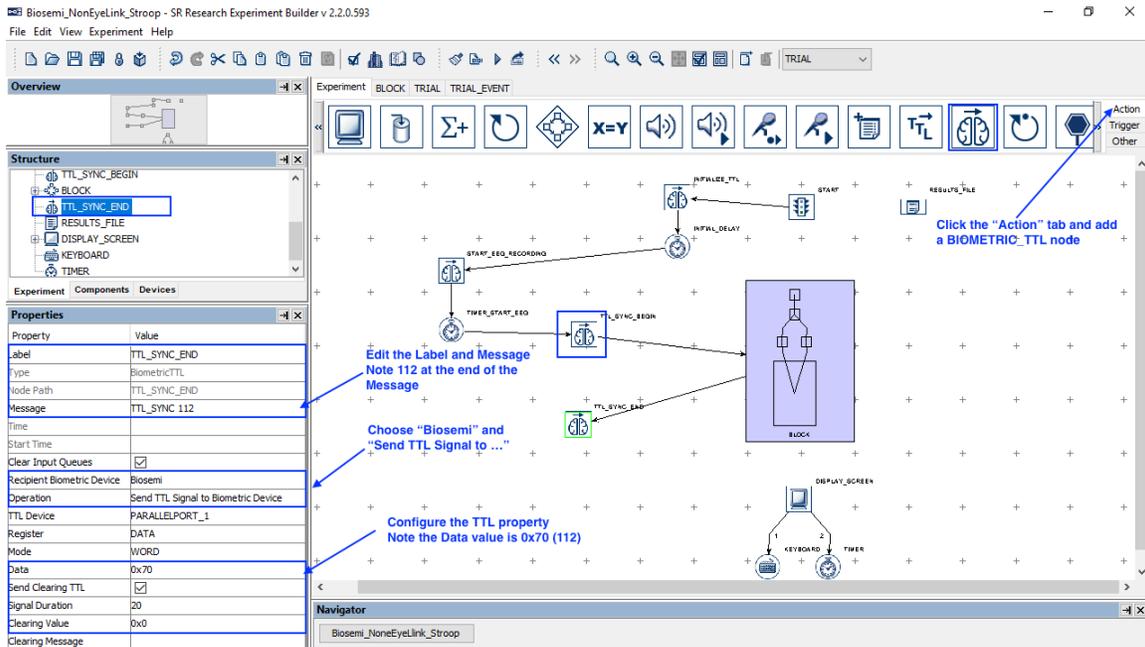
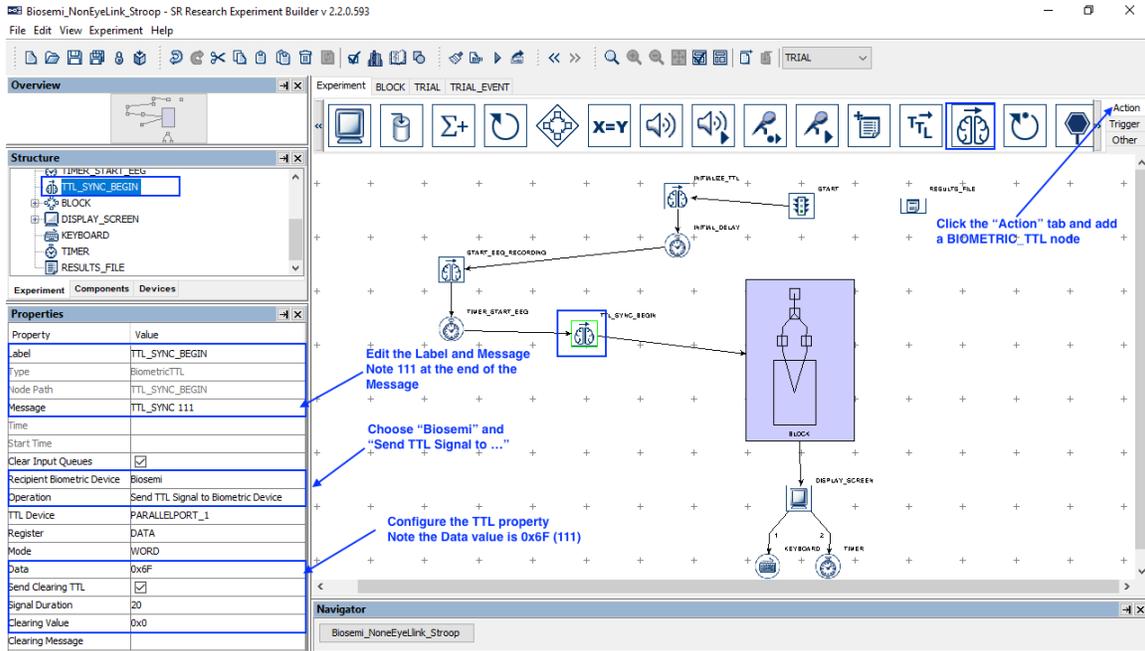
“Biosemi”. Set the “Operation” to “Start Recording”. Keep the same TTL Device and Register as in the previous BIOMETRIC\_TTL action. By default the “TTL Signal Properties” is set to “0xFE 20 0x0”. Click the value field to bring up the “Edit TTL Signal Properties” dialog box to review the settings. The “Data” is set to “0xFE” (254 in decimal)—this is the unique trigger value that will be specified for “PauseOff” in Section 4 (e.g., “254” or the hex code “0xFE”). The “Send Clearing TTL” box is checked, the Signal Duration is set to 20 (ms) and a clearing value of 0x0 is used. Note that the duration required here depends on the sampling frequency used for the EEG recording and will need to be at least one sample period. A 20 msec pulse duration is typically appropriate to use for most recordings but consult your EEG system’s User Manual for the desired duration. If using the Biosemi USB Trigger Interface, set the “TTL Device” to “SERIAL\_PORT\_ONE”. Since the Biosemi USB Trigger Interface automatically sends a clearing signal in 8 milliseconds, please uncheck the “Send Clearing TTL” box. Draw a connection from the INITIAL\_DELAY Timer node to START\_EEG\_RECORDING.



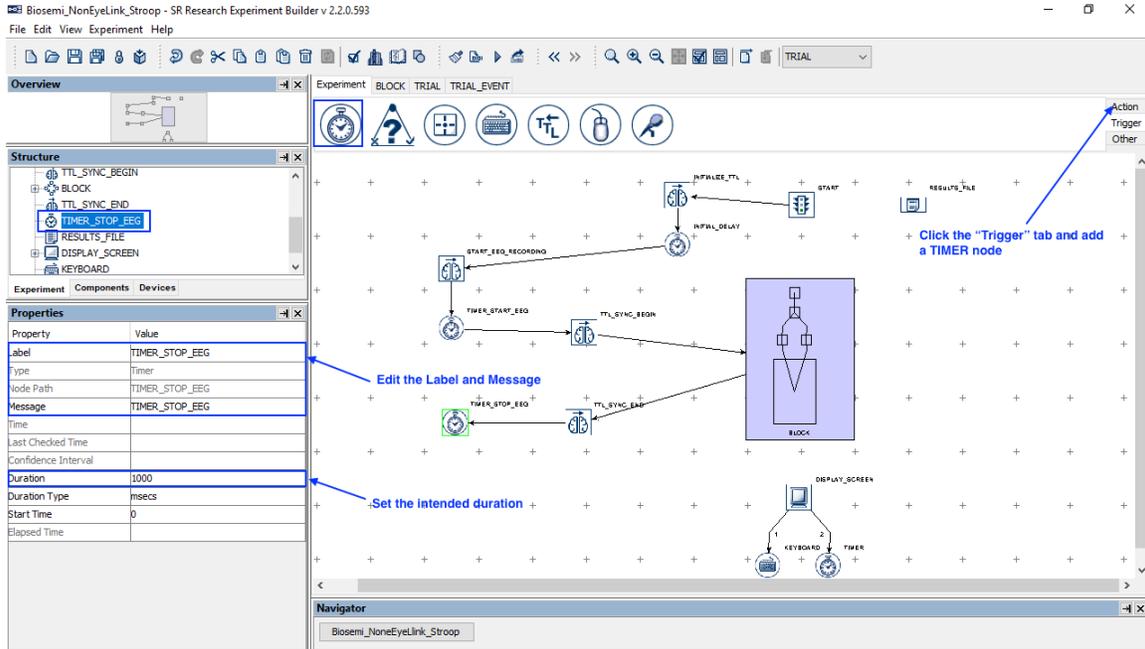
- Now that the TTL signal has been sent, we will add a delay of 1000 milliseconds to ensure the recording has stabilized. Select the “Trigger” tab of the Component Toolbox and add a TIMER node to the graph. Edit the “Label” and “Message” properties of the node to “TIMER\_START\_EEG”. Set the “Duration” to be 1000 (msecs). Draw a connection from the START\_EEG\_RECORDING node to the TIMER\_START\_EEG node.



- 6) To help align the Experiment Builder events and EEG data, we will send a pair of synchronization pulses to the EEG recorder, one at the beginning of the experiment, and one at the end. The same events will be marked as Messages in the messages.txt file. Select the “Action” tab of the Component Toolbox and add a BIOMETRIC\_TTL action. Set the Label of the action to “TTL\_SYNC\_BEGIN” and the message of the action to “TTL\_SYNC 111”. The “111” at the end of the message corresponds to the TTL value that will be sent. Set the “Recipient Biometric Device” to “Biosemi”. Set the “Operation” to “Send TTL Signal to Biometric Device”. Set the “Data” to “0x6F” (111 in decimal). The “Send Clearing TTL” box is checked, the Signal Duration is set to 20 (ms) and a clearing value of 0x0 is used. Draw a connection from the TTL\_SYNC\_BEGIN node to the BLOCK sequence.



Component Toolbox and add a TIMER node to the graph. Edit the “Label” and “Message” properties of the node to “TIMER\_STOP\_EEG”. Set the “Duration” to 1000 (msecs). Draw a connection from the TTL\_SYNC\_END node to the TIMER\_STOP\_EEG node.



- 9) Select the “Action” tab of the Component Toolbox and add a BIOMETRIC\_TTL node to the graph. Edit the “Label” and “Message” properties of the node to “STOP\_EEG\_RECORDING”, and set the “Operation” to “Stop Recording”. When the Operation is set to Stop Recording, the “TTL Signal Properties” will be set to “0xFF 20 0x0”—the data 0xFF (255) will be specified for “PauseOn” in Section 4 . Draw a connection from TIMER\_STOP\_EEG to STOP\_EEG\_RECORDING, and from STOP\_EEG\_RECORDING to DISPLAY\_SCREEN.

Biosemi\_NonEyeLink\_Stroop - SR Research Experiment Builder v 2.2.0.593

File Edit View Experiment Help

Overview Experiment BLOCK TRIAL TRIAL\_EVENT

Structure

- TRIAL\_INDEX
- RT
- RESPONSE
- TTL\_SYNC\_BID
- TIMER\_STOP\_EEG
- STOP\_EEG\_RECORDING**
- DISPLAY\_SCREEN

Properties

Property	Value
Label	STOP_EEG_RECORDING
Type	BiometricTTL
Node Path	STOP_EEG_RECORDING
Message	STOP_EEG_RECORDING
Time	
Start Time	
Clear Input Queues	<input checked="" type="checkbox"/>
Recipient Biometric Device	Biosemi
Operation	Stop Recording
TTL Device	PARALLELPORT_1
Register	DATA
TTL Signal Properties	0xFF 20 0x0
Clearing Message	

Click the "Action" tab and add a BIOMETRIC\_TTL node

Edit the Label and Message

Choose "Biosemi" and "Stop Recording"

Click here to start the "Edit TTL Signal Properties" dialog box

Configure the TTL properties

Property	Value
Data	0xFF
Send Clearing TTL	<input checked="" type="checkbox"/>
Signal Duration	20
Clearing Value	0x0

Navigator

Biosemi\_NonEyeLink\_Stroop

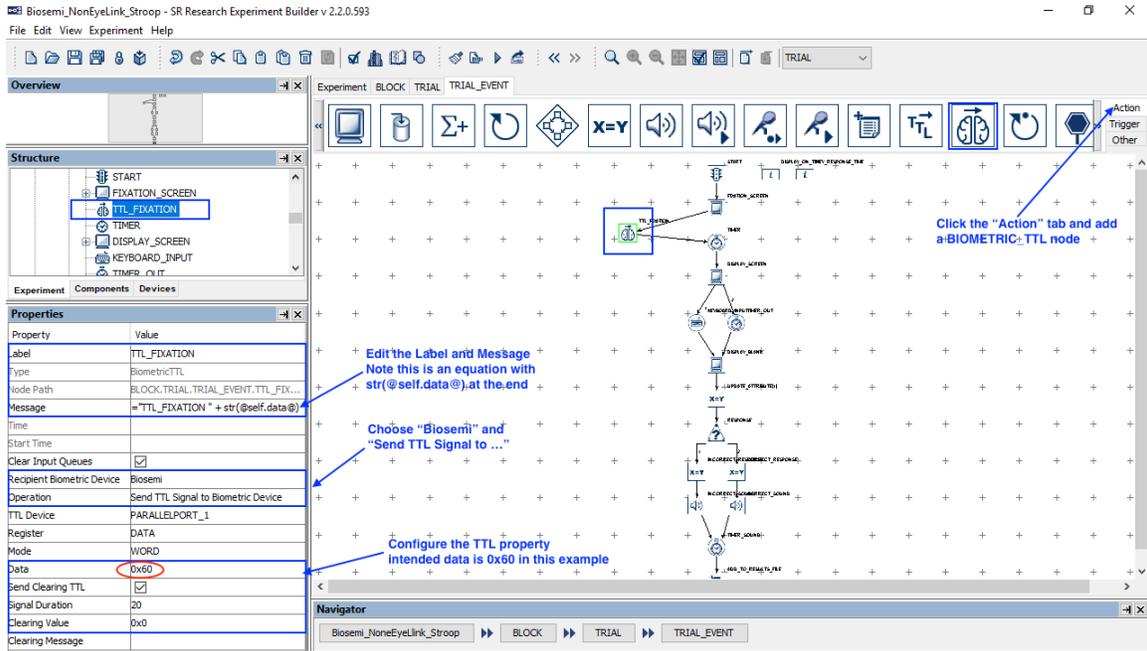
### 3 Sending Event Markers to EEG Recordings

To make sure events recorded in Experiment Builder are synchronized with the EEG data collected by the Biosemi EEG, users can send TTL signals from Experiment Builder to mark the critical events in the experiment such as display and audio stimulus onsets, participant responses, etc. In this example, we will illustrate how to use a BIOMETRIC\_TTL action to mark the onset of the DISPLAY\_SCREEN actions and send the participant's response data to the EEG data stream. It is important to set the "Data" property of the BIOMETRIC\_TTL actions to a unique value for each type of critical event. Users may sometimes also use the TTL signal to encode the trial condition information. Note that the values that can be used for the "Data" property may be dependent on the allowable values that can be set based on the EEG system being used. For the purposes of this example, we will use the hex value 0x60 (96 in decimal) for the DISPLAY\_SCREEN, 0x61 (97) for the TIMER, 0x62 (98) for the EL\_BUTTON, 0x63 (99) for the EL\_KEYBOARD, and 0x64 (100) for the DISPLAY\_BLANK. To simplify data alignment between the EEG and EyeLink recordings, the unique trigger value should also be written to the Message text of the BIOMETRIC\_TTL actions.

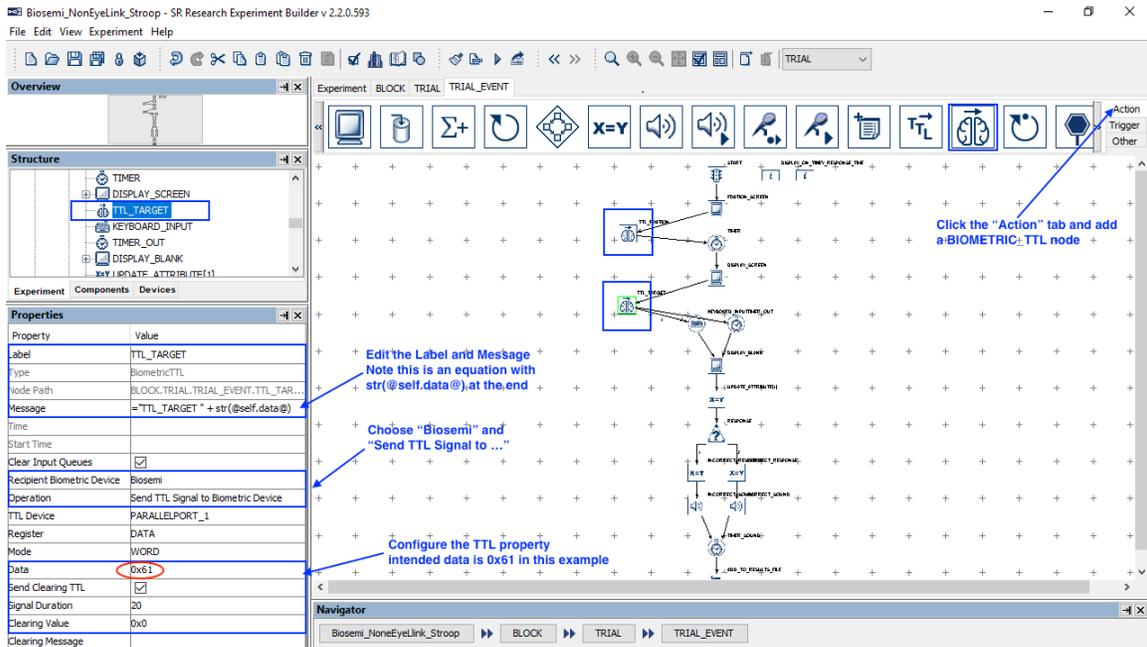
**Please note the Biosemi USB interface has 8-ms pulse duration, and therefore users don't need to send a clearing signal if it is used as the TTL device.**

- 1) Double click the innermost TRIAL\_EVENT sequence to show events in the trial.
- 2) Select the "Action" tab of the Component Toolbox and add a BIOMETRIC\_TTL action. Set the Label and message of the action to '="TTL\_FIXATION" + str(@self.data@)' (note that the expression must begin with an "="). The reference str(@self.data@) will record the TTL value in the message text. Set the "Recipient Biometric Device" to "Biosemi", and set the "Operation" to "Send TTL Signal to Biometric Device". Keep the same TTL Device as in other Biometric TTL actions discussed previously. Set the "Data" to 0x60. Check the "Send Clearing TTL" box, and set the Signal Duration to 20 (ms) and clearing value to 0x0. Draw a connection from the FIXATION\_SCREEN action to the newly added TTL\_FIXATION node. From the TTL\_FIXATION node, draw connections to the TIMER node.

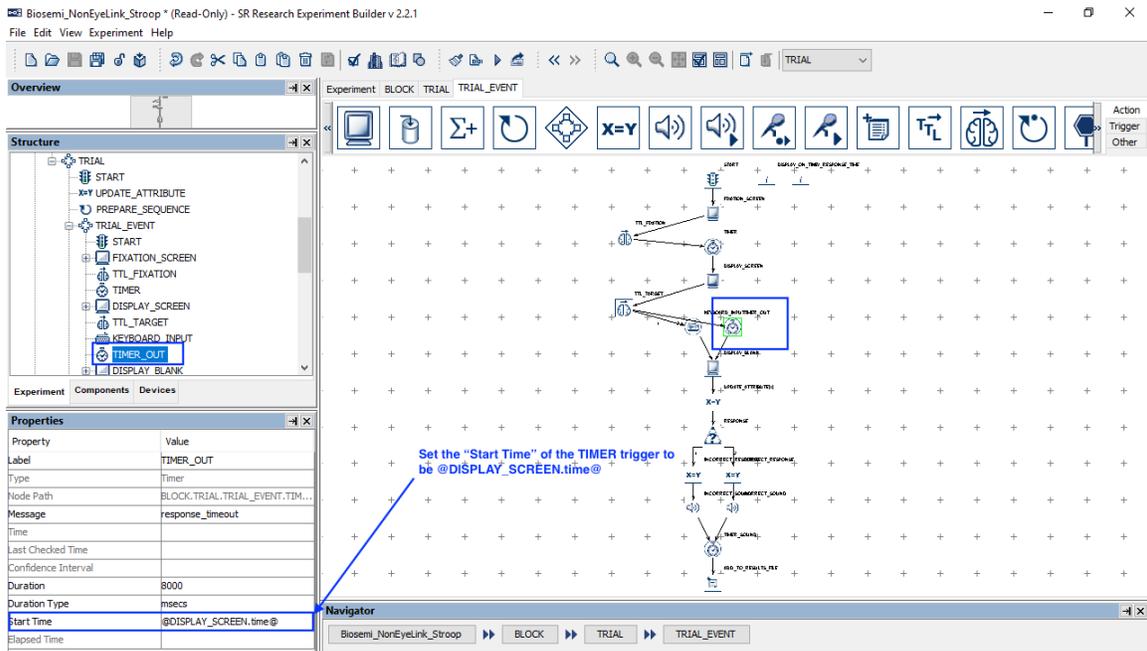
**Important! For proper data alignment between the behavioral data and EEG recordings, please make sure the "Message" field of the BIOMETRIC\_TTL action contains a uniquely identifiable string with the TTL value at the end of the text. Please also make sure the BIOMETRIC\_TTL node is placed immediately after the event you want to mark in the EEG data.**



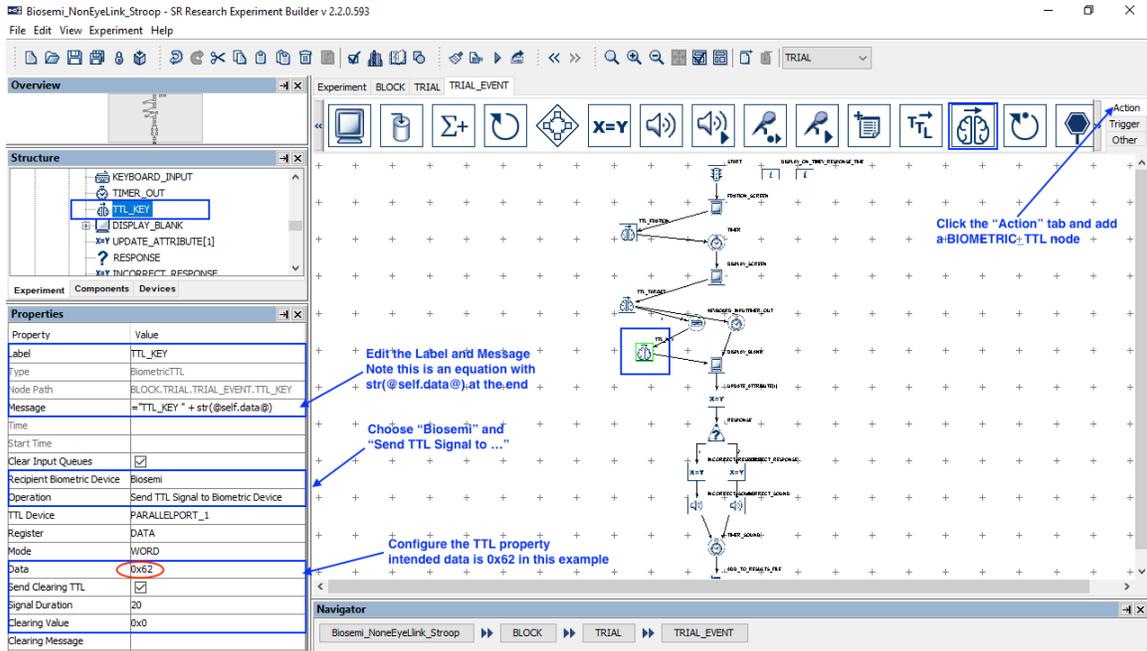
- 3) Now send a TTL signal following on the onset of the target display. Select the "Action" tab of the Component Toolbox and add a BIOMETRIC\_TTL action. Set the message of the action to = "TTL\_TARGET" + str(@self.data@). Use the exactly same properties as in the above-mentioned TTL\_FIXATION except that the "Data" will now be 0x61. Draw a connection from the DISPLAY\_SCREEN action to the TTL\_TARGET node. From the TTL\_TARGET node, draw connections to the KEYBOARD\_INPUT and TIMEOUT nodes.



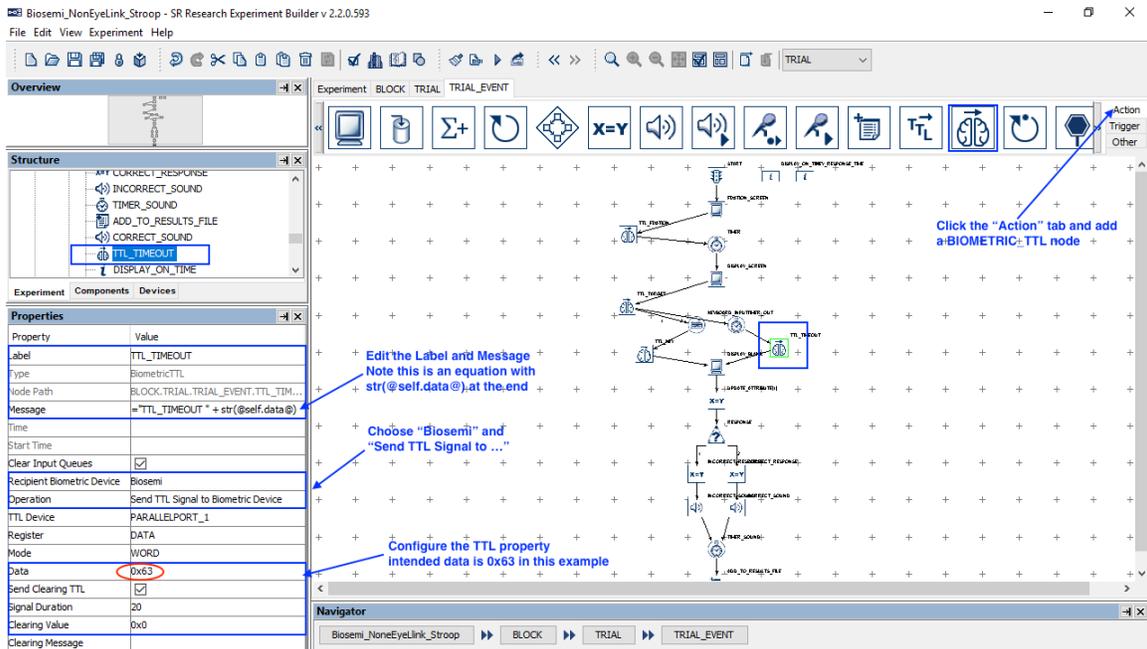
- 4) For the TIMER trigger that follows the TTL\_FIXATION node, set the Start Time to be @FIXATION\_SCREEN.time@ instead of the default value of 0, and for the TIMER\_OUT trigger that follows TTL\_TARGET, set the Start Time value to @DISPLAY\_SCREEN.time@. This ensures that the elapsed time of the Timer triggers start at the onset of the Display Screen actions—if left at the default time of 0, the elapsed time would be measured from when the BIOMETRIC\_TTL action returns (after the clearing signal is sent).



- 5) Next, send a TTL signal following each of the possible response methods. Let's start with the keyboard response. Select the "Action" tab of the Component Toolbox and add a BIOMETRIC\_TTL action. Set the Message of the action to ="TTL\_KEY" + str(@self.data@). Use the same property settings as in the previous BIOMETRIC\_TTL actions except that the "Data" will be 0x62. Draw a connection from the KEYBOARD\_INPUT to TTL\_KEY, and from TTL\_KEY to DISPLAY\_BLANK.



- 6) Now select the "Action" tab of the Component Toolbox and add a BIOMETRIC\_TTL action. Set the Message of the action to = "TTL\_TIMEOUT" + str(@self.data@). Use the same TTL settings except that the "Data" is set to 0x63. Draw a connection from the TIMEOUT to TTL\_TIMEOUT.



- 7) Finally, send a TTL signal when the feedback audio is played. Select the "Action" tab of the Component Toolbox and add a BIOMETRIC\_TTL action. Set the Message of the action to = "TTL\_FEEDBACK" + str(@self.data@), and "Data" to 0x64. Draw a connection from the INCORRECT\_SOUND and

CORRECT\_SOUND nodes to TTL\_FEEDBACK, and from TTL\_FEEDBACK to TIMER\_SOUND.

Biosemi\_NonEyeLink\_Stroop - SR Research Experiment Builder v 2.2.0.593

File Edit View Experiment Help

Overview Experiment BLOCK TRIAL TRIAL\_EVENT

Structure

- INCORRECT\_RESPONSE
- INCORRECT\_SOUND
- TTL\_FEEDBACK
- TIMER\_SOUND
- ADD\_TO\_RESULTS\_FILE
- CORRECT\_SOUND
- TTL\_TIMEOUT

Properties

Property	Value
Label	TTL_FEEDBACK
Type	BiometricTTL
Node Path	BLOCK.TRIAL.TRIAL_EVENT.TTL_FEE...
Message	= TTL_FEEDBACK + str(@self.data@)
Time	
Start Time	
Clear Input Queues	<input checked="" type="checkbox"/>
Recipient Biometric Device	Biosemi
Operation	Send TTL Signal to Biometric Device
TTL Device	PARALLELPORT_1
Register	DATA
Mode	WORD
Data	0x64
Send Clearing TTL	<input checked="" type="checkbox"/>
Signal Duration	20
Clearing Value	0x0
Clearing Message	

Click the "Action" tab and add a BIOMETRIC\_TTL node

Edit the Label and Message  
Note this is an equation with str(@self.data@) at the end

Choose "Biosemi" and "Send TTL Signal to ..."

Configure the TTL property  
intended data is 0x64 in this example

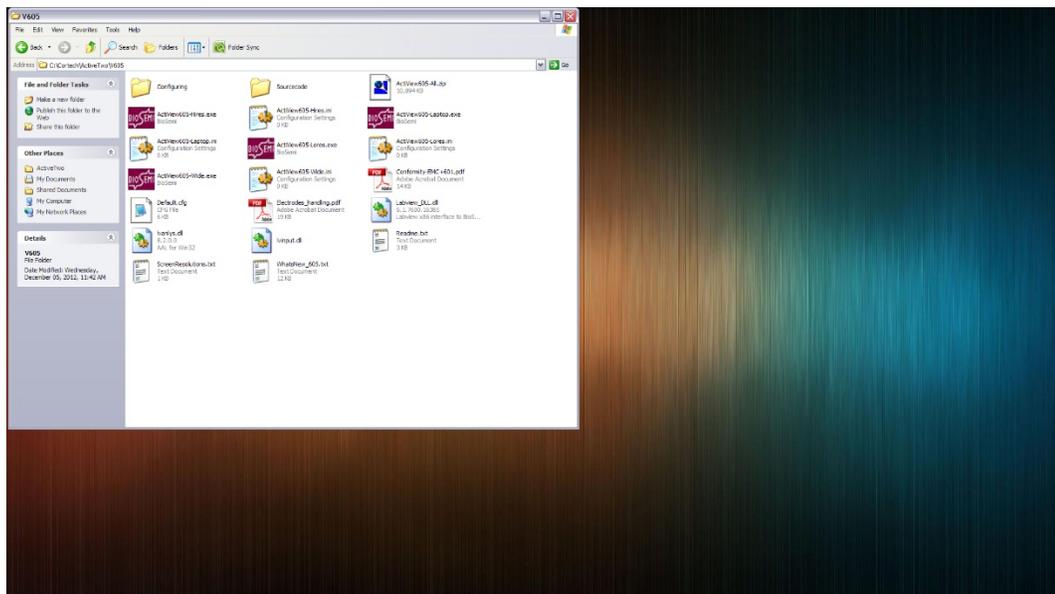
Navigator

Biosemi\_NonEyeLink\_Stroop >> BLOCK >> TRIAL >> TRIAL\_EVENT

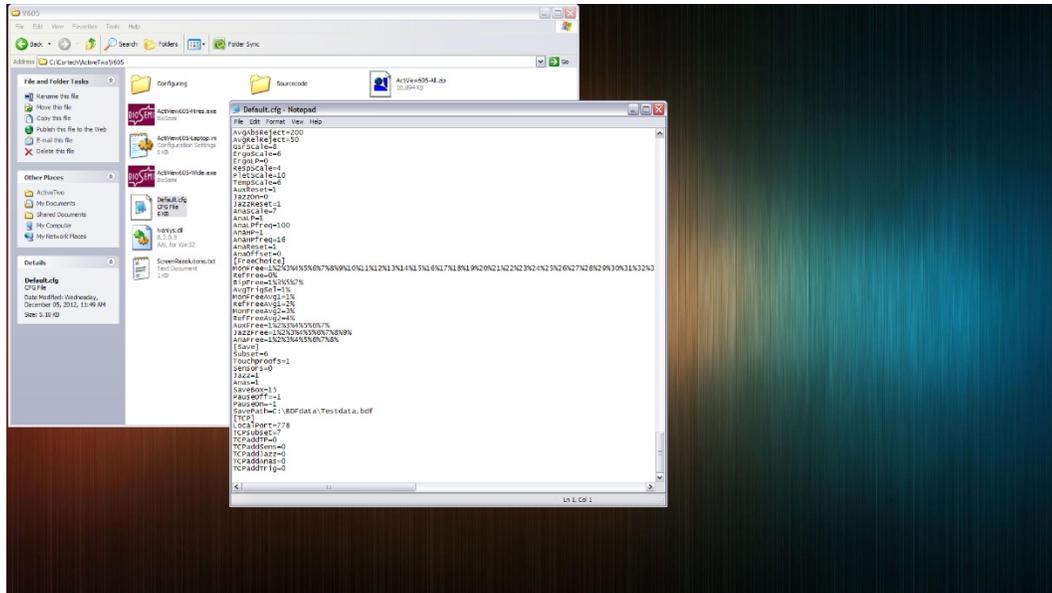
## 4 Configuring Trigger Settings for the Biosemi Computer

For some EEG systems, trigger commands can be sent or received in order to start and stop the EEG recording (or to “pause” the EEG file) to ensure that unnecessary information is not being recorded. The following section covers how to enable this functionality on the BioSemi Active Two EEG system by editing the system’s default configuration file.

- 1) On the EEG computer, navigate to the installation folder and open the file “default.cfg” with a text editor, such as Notepad or Wordpad.



- 2) Scroll to the end of the file and find the “PauseOff” and “PauseOn” settings. By default, they are set to -1, which means that the pause/unpause functionality is disabled.

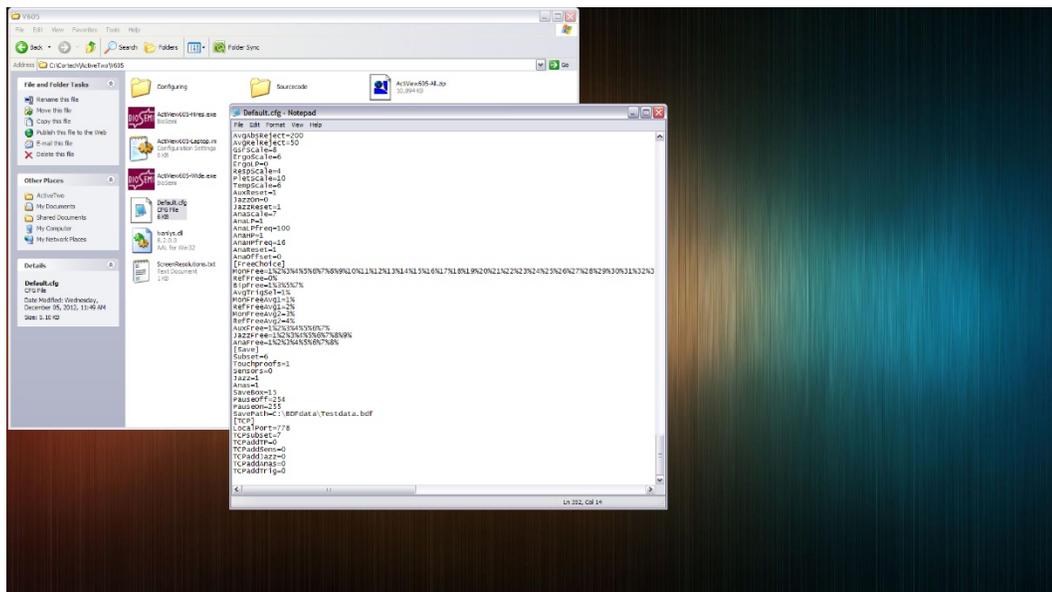


- 3) To enable the pause function, change the PauseOff and PauseOn triggers from -1 to 254 and 255. The values should be entered as follows:

PauseOff=254

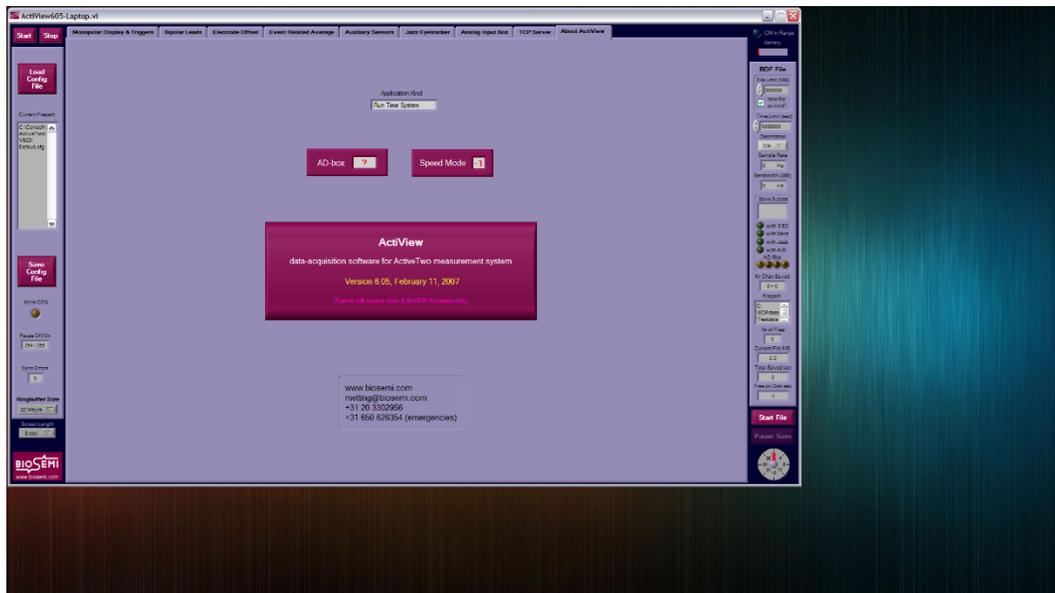
PauseOn=255

While this example uses the values 254 and 255, the PauseOff and PauseOn commands may be assigned any two unique values within the pin configuration (typically 0-255) that will not be used elsewhere in your experiment. Whatever two values used here will not be usable for any other functionality apart from pausing and unpausing the EEG recording



- 4) Save the file under the same name, “default.cfg”, and exit from the text editor.

- 5) In order to check that these triggers have been enabled, load BioSemi ActiView on the EEG PC, and under the “About ActiView” tab, the new trigger values for PauseOff and PauseOn should be displayed on the bottom left sidebar.



The EEG computer should now be set up to receive these trigger commands from the Display PC in order to start and stop the EEG recording. Note that the above triggers only control the pausing of the EEG data file during the experiment. The experimenter will still need to manually start a new data file at the beginning of data collection.