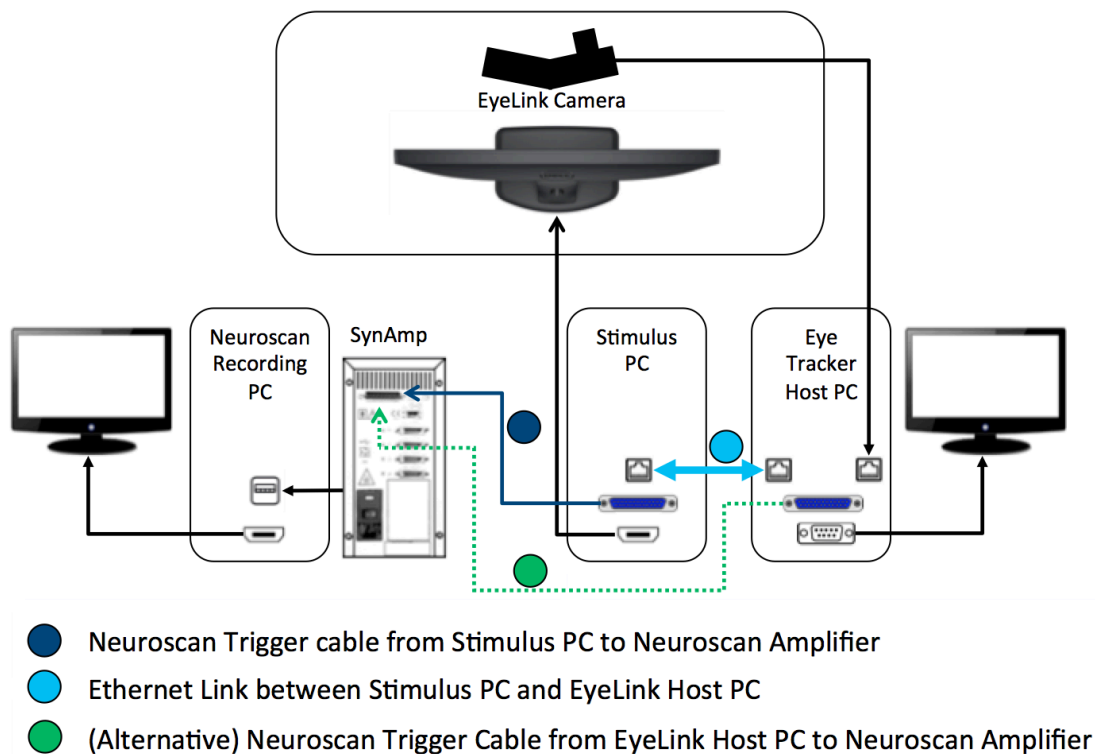


## Adding Neuroscan Integration to Existing EyeLink Experiments: A Quick Tutorial (EB Version 2.2.1)

This tutorial covers the steps required to add Neuroscan EEG support to an existing experiment using version 2.2 or later of SR Research Experiment Builder. This example (Neuroscan\_EyeLink\_Simple) is based on the “SIMPLE” example provided with Experiment Builder. Users who are new to the software are encouraged to re-create the SIMPLE example by following the step-by-step instructions provided in the Experiment Builder User Manual (“14 Creating EyeLink Experiments: The First Example”). This example illustrates creating experiments with simultaneous EEG and eye tracking recordings. If you are looking for an example that illustrates using Experiment Builder to control the Neuroscan EEG without recording eye tracker data, please check out the “Neuroscan\_NonEyeLink\_Stroop” example and the accompanying tutorial.

The following diagram shows an experiment setup for simultaneous EEG and eye tracking recordings.



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 Neuroscan 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, 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 the Neuroscan EEG if running on the Curry software (but not on the older Scan software). Users will need to define the trigger values for the “Start Recording” and “Stop/Pause Recording” event actions in the Curry software (see section 4 “Configuring Trigger Settings for the Neuroscan Curry Software”).
- 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).

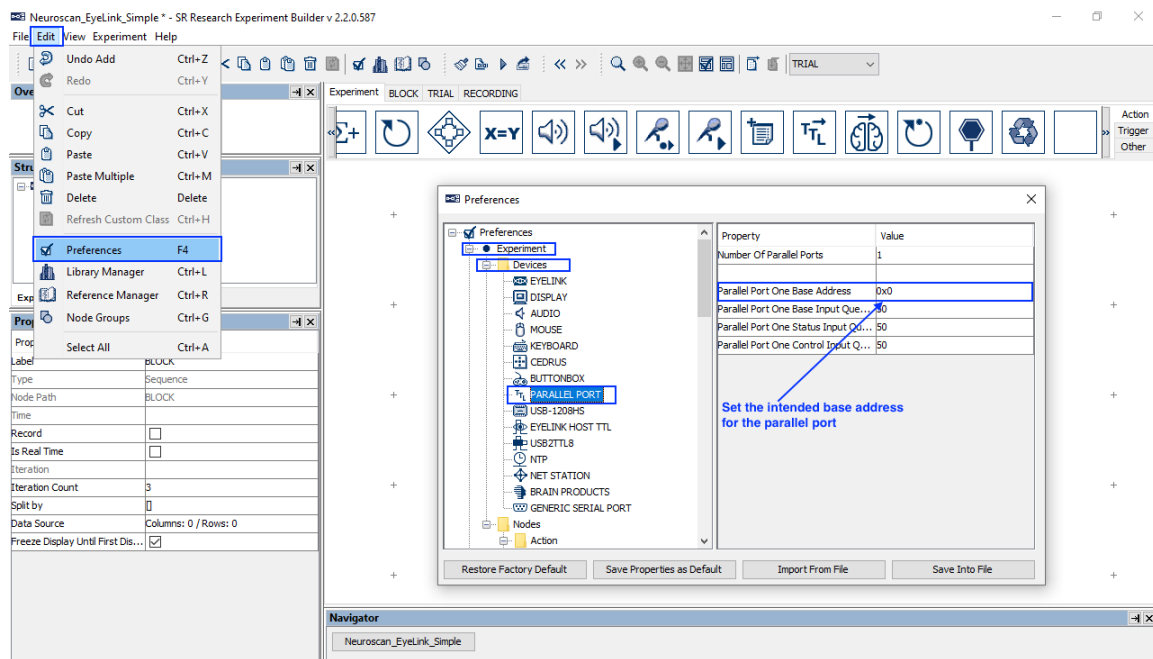
The current tutorial demonstrates how to start and stop EEG recordings and add event markers to an example experiment that mark the critical events that occurred in a trial. Although the discussion is based on the Simple example, steps covered here can be easily applied to any experiments programmed 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 Neuroscan 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.



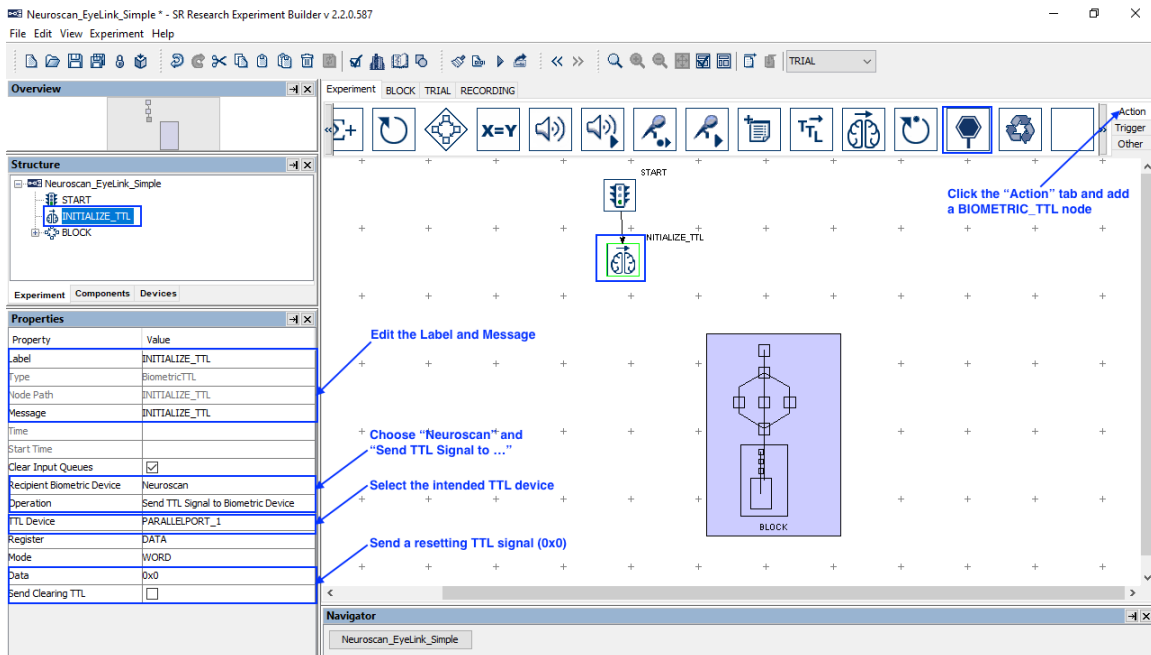
For display computers without a parallel port, users have other options to send TTL signals. For example, the USB-1208 HS by Measurement Computing and the USB2TTL8 by LabHackers are USB-based TTL devices that can be used on both a Mac and Windows PC. In an EyeLink experiment, users may send TTL signals through the devices installed on the EyeLink Host PC (configured through the “EyeLink\_Host\_TTL” Device).

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

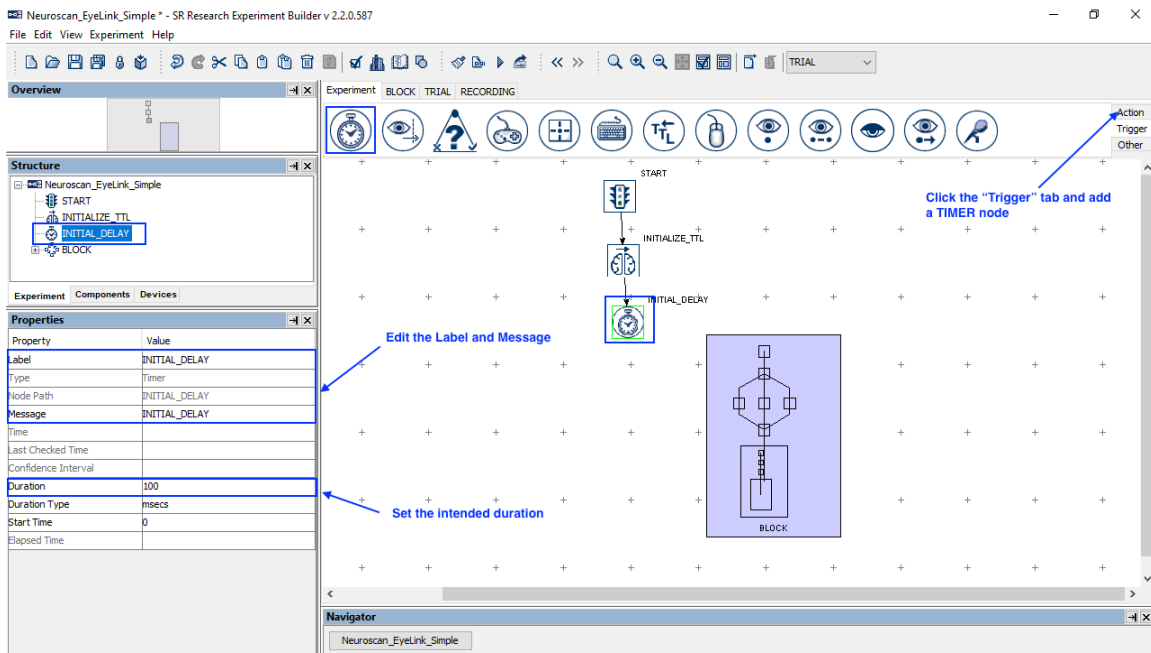
One important aspect of integrating eye tracking and EEG data is to ensure that critical events, such as display screens, and/or participants' responses, are marked in both the Experiment Builder results file and the EEG data file. For the Neuroscan EEG system, a default TTL value (typically 0) needs 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.

Neuroscan EEG systems running the latest Curry software 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 “Neuroscan”, and set the “Operation” to “Send TTL Signal to Biometric Device”. Set the TTL Device—in this example, we 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. Now connect the START node to the INITIALIZE\_TTL node.

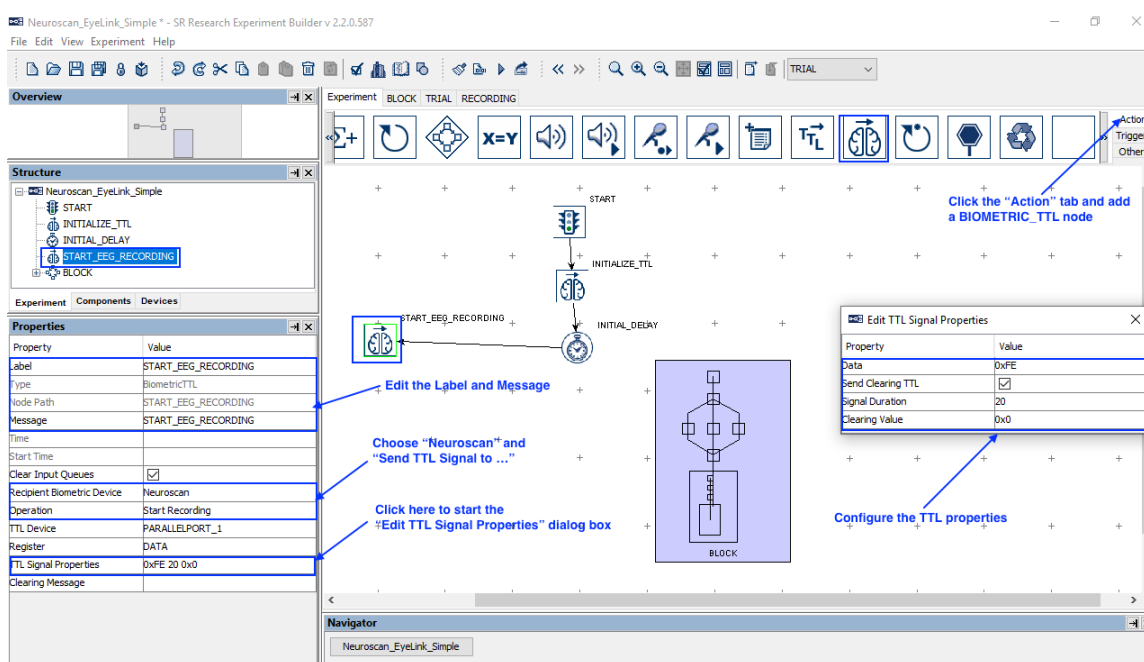


- 3) Select the “Trigger” tab of the Component Toolbox and add a TIMER node to the graph. Edit the “Label” and “Message” properties of the node to “INITIAL\_DELAY”. Set the “Duration” to be 100 (msecs). Draw a connection from the INITIALIZE\_TTL node to the TIMER node.

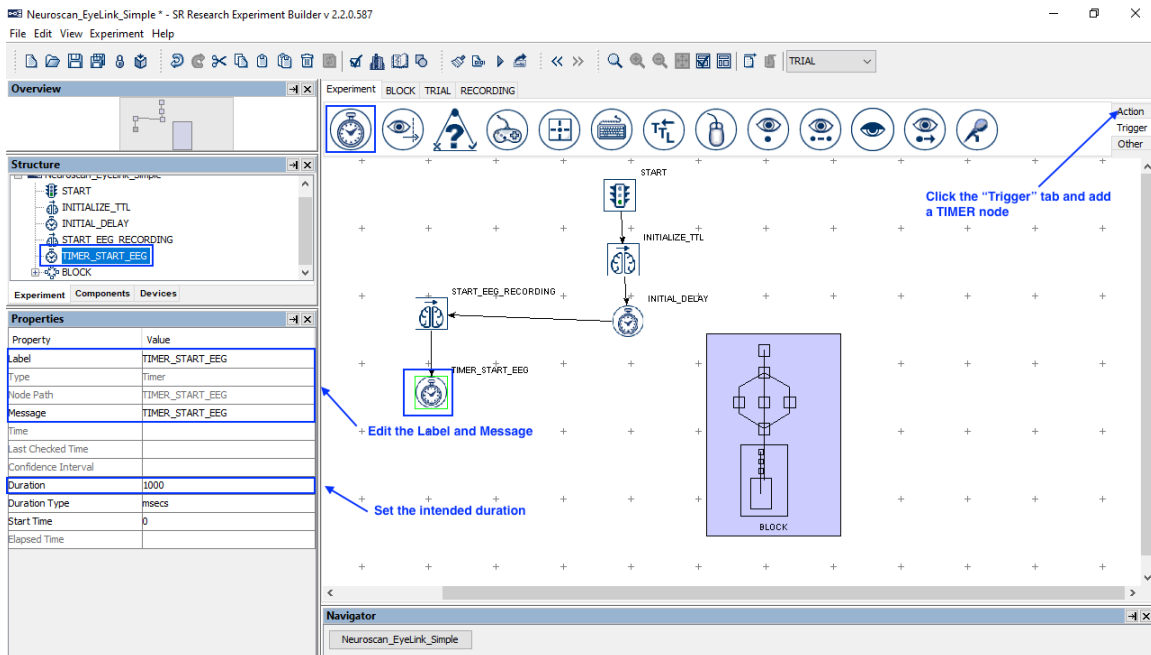


- 4) At the beginning of the experiment, the EEG recording will be started. Select the “Action” tab of the Component Toolbox and add a BIOMETRIC\_TTL node to the graph. Edit the “Label” and “Message” properties of the node to “START\_EEG\_RECORDING”. Set the “Recipient Biometric Device” to

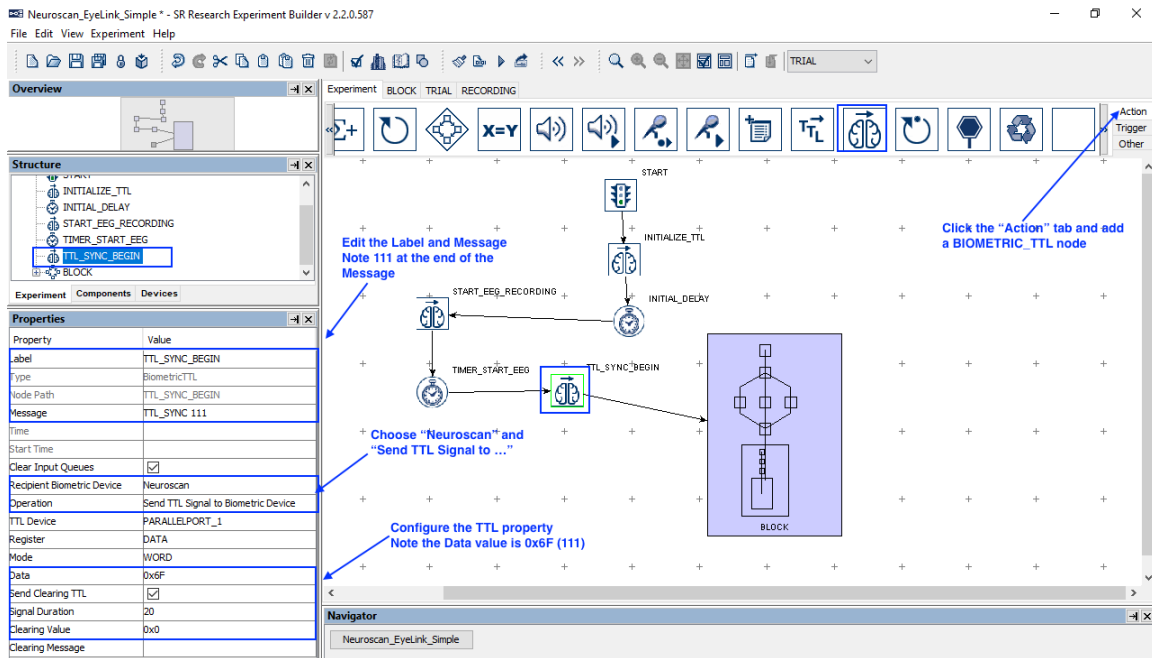
“Neuroscan”. Set the “Operation” to “Start Recording”. Keep the same TTL Device and Register as in the previous BIOMETRIC\_TTL action. By default the “TTL Signal Properties” is set to “0xFE 20 0x0”. Click the value field to bring up the “Edit TTL Signal Properties” dialog box to review the settings. The “Data” is set to “0xFE” (254 in decimal)—this is the unique trigger value that will be specified for “PauseOff” in Section 4. 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 milliseconds pulse duration is typically appropriate, but consult your EEG system’s User Manual for the desired duration. Draw a connection from the INITIAL\_DELAY node to START\_EEG\_RECORDING.



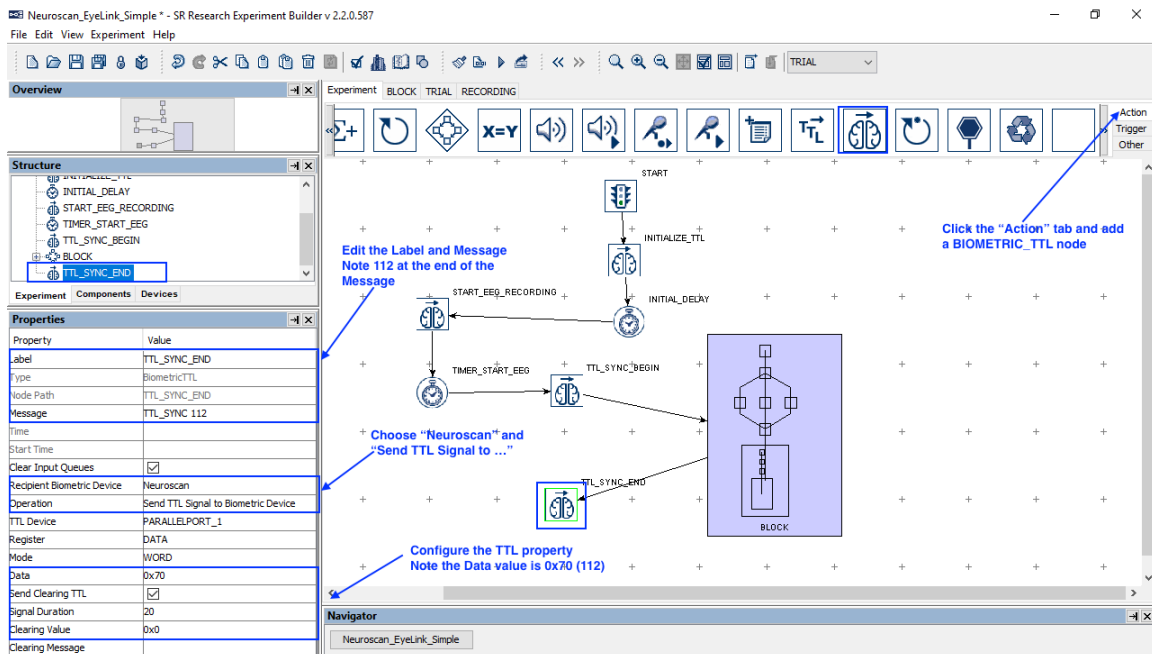
- 5) Now that the TTL signal has been sent, we will add a delay to ensure the recording has stabilized. Select the “Trigger” tab of the Component Toolbox and add a TIMER node to the graph. Edit the “Label” and “Message” properties of the node to “TIMER\_START\_EEG”. Set the “Duration” to be 1000 msec. (This recording stabilization period is added to be consistent with other examples, but is completely optional for Neuroscan EEG systems—users can set a shorter TIMER duration or choose to remove the TIMER trigger altogether.) Draw a connection from the START\_EEG\_RECORDING node to the TIMER\_START\_EEG node, and from the TIMER\_START\_EEG node to TRIAL sequence.



- 6) To help align the eye tracking 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 EyeLink Data 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 "Neuroscan". 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.



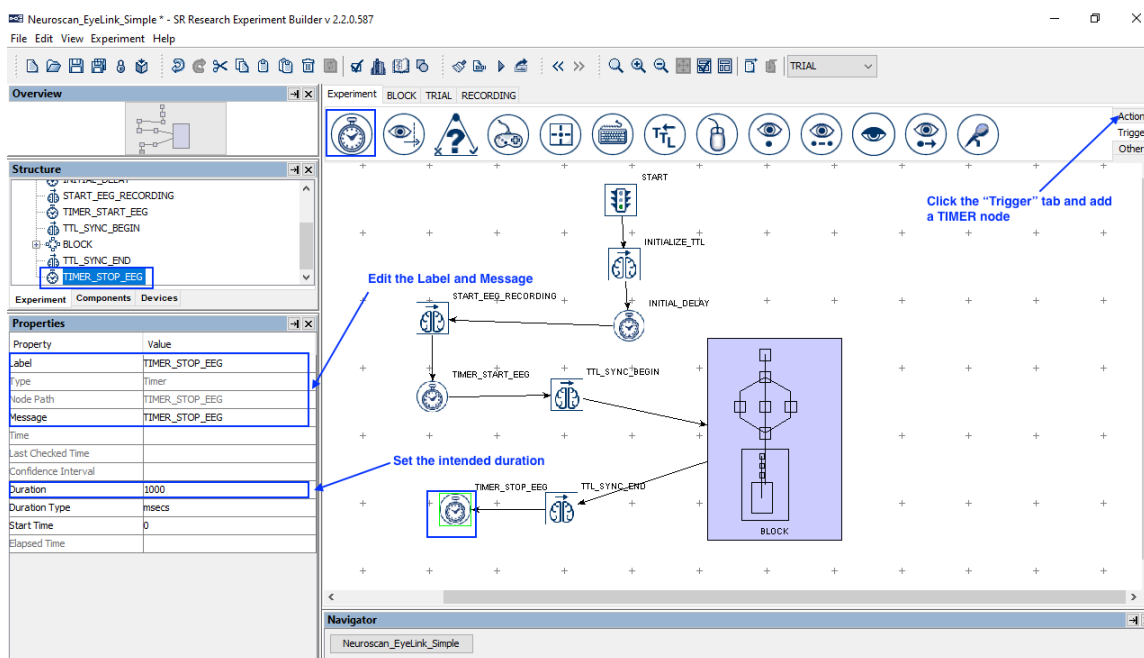
- 7) A sync signal will also be sent at the end of the experiment. Select the “Action” tab of the Component Toolbox and add a BIOMETRIC\_TTL action. Set the Label of the action to “TTL\_SYNC\_END” and the message of the action to “TTL\_SYNC 112”—as before, the “112” corresponds to the TTL value that will be sent from this action. Set the Data to “0x70” (112). 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 BLOCK sequence.



- 8) Before we stop the EEG recording, we will first add a delay to ensure that the



recording has finished processing. 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\_STOP\_EEG”. Set the “Duration” to 1000 msec. (This recording stabilization period is added to be consistent with other examples, but is completely optional for Neuroscan EEG systems—users can set a shorter TIMER duration or choose to remove the TIMER trigger altogether.) 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” is set 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 “Stop/Pause Recording” event action in Section 4 (e.g., “255” or the hex code “0xFF”). Draw a connection from TIMER\_STOP\_EEG to STOP\_EEG\_RECORDING.

Neuroscan\_EyeLink\_Simple - SR Research Experiment Builder v 2.2.0.587

File Edit View Experiment Help

Overview Experiment BLOCK TRIAL RECORDING

Structure

- NETWORKING
  - TIMER
  - BL\_BUTTON
  - DISPLAY\_BLANK
  - TTL\_SYNC\_END
  - TIMER\_STOP\_EEG
  - STOP\_EEG\_RECORDING

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	Neuroscan
Operation	Stop Recording
TTL Device	PARALLELPORT_1
Register	DATA
TTL Signal Properties	0xFF 20 0x0
Clearing Message	

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

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

Edit the Label and Message

Choose "Neuroscan" and "Stop Recording"

Configure the TTL properties

Edit TTL Signal Properties

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

Diagram showing the flow of the experiment: START -> INITIALIZE\_TTL -> INITIAL\_DELAY -> START\_EEG\_RECORDING -> TIMER\_START\_EEG -> TTL\_SYNC\_BEGIN -> BLOCK -> TTL\_SYNC\_END -> TIMER\_STOP\_EEG -> STOP\_EEG\_RECORDING.

Navigator

Neuroscan\_EyeLink\_Simple

### 3 Sending Event Markers to EEG Recordings

To make sure events recorded in Experiment Builder are synchronized with the data collected by the Neuroscan 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.

- 1) Double click the innermost RECORDING sequence to show events in the trial.
- 2) Select the "Action" tab of the Component Toolbox and add a BIOMETRIC\_TTL action. Set the Message of the action to '= "TTL\_DISPLAY" + 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 "Neuroscan", 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 DISPLAY\_SCREEN action to the newly added TTL\_DISPLAY node. From the TTL\_DISPLAY node, draw connections to the TIMER, EL\_BUTTON, and EL\_KEYBOARD nodes.

**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.**

Neuroscan\_EyeLink\_Simple \* - SR Research Experiment Builder v 2.2.0.587

File Edit View Experiment Help

Overview

Structure

- START
- DISPLAY\_SCREEN
- TTL\_DISPLAY
- TIMER
- EL\_BUTTON
- EL\_KEYBOARD
- DISPLAY\_BLANK

Properties

Property	Value
Label	TTL_DISPLAY
Type	BiometricTTL
Node Path	BLOCK.TRIAL.RECORDING.TTL_DISP...
Message	=TTL_DISPLAY * + str(@self.data@)
Time	
Start Time	
Clear Input Queues	<input checked="" type="checkbox"/>
Recipient Biometric Device	Neuroscan
Operation	Send TTL Signal to Biometric Device
TTL Device	PARALLELPORT_1
Register	DATA
Mode	WORD
Data	0x60
Send Clearing TTL	<input checked="" type="checkbox"/>
Signal Duration	20
Clearing Value	0x0
Clearing Message	

Experiment BLOCK TRIAL RECORDING

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 "Neuroscan" and "Send TTL Signal to ..."

Configure the TTL property  
intended data is 0x60 in this example

Navigator

Neuroscan\_EyeLink\_Simple BLOCK TRIAL RECORDING

- 3) For the TIMER trigger that follows the TTL\_DISPLAY node, set the Start Time to be @DISPLAY\_SCREEN.time@ instead of the default value of 0. With this change, the elapse time of the TIMER trigger starts at the onset of the DISPLAY\_SCREEN action instead of the return of the BIOMETRIC\_TTL action (after the clearing signal is sent).

Neuroscan\_EyeLink\_Simple \* (Read-Only) - SR Research Experiment Builder v 2.2.1

File Edit View Experiment Help

Overview

Structure

- START
- PREPARE\_SEQUENCE
- DRIFT\_CORRECT
- RECORDING
- START
- DISPLAY\_SCREEN
- TTL\_DISPLAY
- TIMER
- EL\_BUTTON
- EL\_KEYBOARD
- DISPLAY\_BLANK

Properties

Property	Value
Label	TIMER
Type	Timer
Node Path	BLOCK.TRIAL.RECORDING.TIMER
Message	timeout
Time	
Last Checked Time	
Confidence Interval	
Duration	10000
Duration Type	msecs
Start Time	@DISPLAY_SCREEN.time@
Elapsed Time	

Experiment BLOCK TRIAL RECORDING

Set the "Start Time" of the TIMER trigger to be @DISPLAY\_SCREEN.time@

Navigator

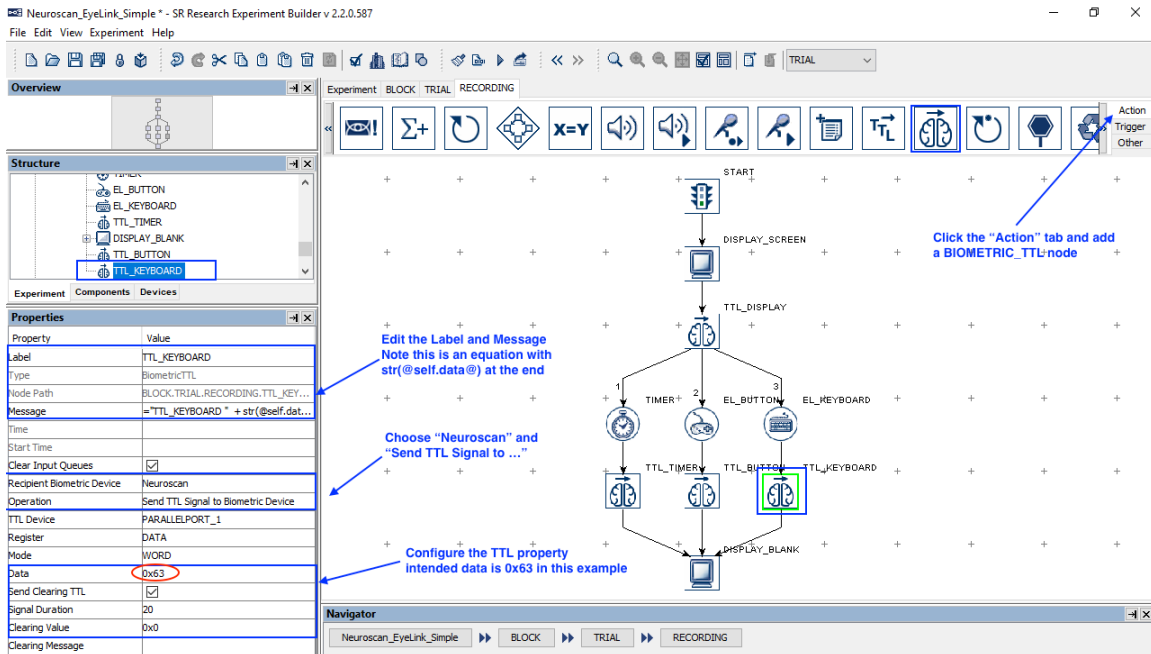
Neuroscan\_EyeLink\_Simple BLOCK TRIAL RECORDING

- 4) Next, send a TTL signal following each of the possible response methods. Let's start with the TIMER trigger. Select the "Action" tab of the Component Toolbox and add a BIOMETRIC\_TTL action. Set the Message of the action to

=“TTL\_TIMER” + str(@self.data@). Use the same property settings as in the previous BIOMETRIC\_TTL actions except that the “Data” will be 0x61. Draw a connection from the TIMER node to TTL\_TIMER, and from TTL\_TIMER to DISPLAY\_BLANK.

- Now select the “Action” tab of the Component Toolbox and add a BIOMETRIC\_TTL action. Set the Message of the action to =“TTL\_BUTTON” + str(@self.data@). Use the same TTL settings except that the “Data” is set to 0x62. Draw a connection from the EL\_BUTTON to DISPLAY\_BLANK.

- 6) Select the “Action” tab of the Component Toolbox and add a BIOMETRIC\_TTL action. Set the Message of the action to =“TTL\_KEYBOARD” + str(@self.data@). Use the same TTL settings except that the “Data” is set to 0x63. Draw a connection from the EL\_KEYBOARD to DISPLAY\_BLANK.



- 7) Finally, send a TTL signal when the end-of-trial blank screen is displayed. Select the “Action” tab of the Component Toolbox and add a BIOMETRIC\_TTL action. Set the Message of the action to =“TTL\_BLANK” + str(@self.data@), and “Data” to 0x64. Draw a connection from the DISPLAY\_BLANK node to TTL\_BLANK.

Neuroscan\_EyeLink\_Simple - SR Research Experiment Builder v 2.2.0.587

File Edit View Experiment Help

Overview Experiment BLOCK TRIAL RECORDING

Structure

- TIMER
- EL\_BUTTON
- TTL\_TIMER
- DISPLAY\_BLANK
- TTL\_BLANK

Properties

Property	Value
Label	TTL_BLANK
Type	BiometricTTL
Node Path	BLOCK.TRIAL.RECORDING.TTL_BLANK
Message	"TTL_BLANK" + str(@self.data@)
Time	
Start Time	
Clear Input Queues	<input checked="" type="checkbox"/>
Recipient Biometric Device	Neuroscan
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 "Neuroscan" and "Send TTL Signal to ..."

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

Navigator

Neuroscan\_EyeLink\_Simple BLOCK TRIAL RECORDING

## 4 Configuring Trigger Settings for the Neuroscan Curry Software

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 Neuroscan EEG system when running on the Curry software (this is not supported on the older SCAN software).

To edit event codes in the Curry software:

- 1) Click on the Amplifier Control button and then click on the Advanced button.

The screenshot shows the 'Amplifier Control' dialog box in the Neuroscan Curry software. The 'Amplifier' dropdown is set to 'Simulator'. The 'Configuration' dropdown is empty. The 'Sample Rate' is set to '250 Hz'. The 'Recording' status shows '419.4 GB (>10 days) receiving data'. The file path is '\*DT\Acquisition\Acquisition \*\$.dat'. Below the file path are several icons: a green play button, a blue square with a white circle, a green square with a white circle, a red circle, a blue square, and a speech bubble. A blue 'Advanced' button is located below the icons. The 'Impedance Settings' section includes 'Min [kΩ]' (0.0), 'Max [kΩ]' (100.0), 'Color Scale' (a color bar), 'Bad channel threshold [kΩ]' (100.0), and 'Channels' with checkboxes for 'Monopolar' and 'Bipolar'. There are 'Quick Imp. Test' and 'Deselect bad' buttons. The 'Misc. Settings' section includes 'Simulator Speed' (1), 'Pre-Recording Time [s]' (0), 'Split File At [MB]' (500), and 'Const. Baseline Correction' (unchecked) with a 'Get' button. At the bottom are 'Trigger Settings' and 'Re-Synchronize' buttons, and a 'Custom Amplifier Settings' button.



- 2) Click on the Trigger Settings button to open the Trigger Settings dialog window.
- 3) Under “Event Actions”, check the “Start Recording” and “Stop / Pause Recording” boxes, and then enter the intended trigger value. For the purposes of this example, set the trigger value to the following:

Start Recording = 254

Stop/Pause Recording = 255

Trigger Settings

Mode

☐ Cedrus StimTracker
☐ Cedrus StimTracker MagLink
☒ Other

Stimulus

Binary
Decimal
Count

Current:
0 0 0 0 0 0 0 0
0

Accept:
☒ ☒ ☒ ☒ ☒ ☒ ☒ ☒
255

Last valid:
0 0 0 0 0 0 0 0
☐ Invert
0
0

Response

Binary
Decimal
Count

Current:
0 0 0 0 0 0 0 0
0

Accept:
☒ ☒ ☒ ☒ ☒ ☒ ☒ ☒
255

Last valid:
0 0 0 0 0 0 0 0
☒ Invert
0
0

Method:
Mark Onset

Event Actions

Define Actions that are executed when certain events are received:

☐ Start Recording:
Stimulus
1

☐ Stop / Pause Recording:
Stimulus
1

☐ Split File:
Stimulus
1

☐ Quick Impedance Test:
Stimulus
1

☐ Disconnect Amplifier:
Stimulus
1

Miscellaneous

Refractory Period [ms]:
2

Align StimTracker Events [ms]:
0

☐ Record Event Duration

☐ Auto-Create Events:
Stimulus
10

☒ Show Events
Interval [ms]:
1000

☒ Record Events

Reset
OK

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.