SR Research Experiment Builder
User Manual

Version 2.3.1

Please report all functionality comments and bugs to:
support@sr-research.com

Please cite the Experiment Builder software in your manuscript as:
SR Research Experiment Builder 2.3.1 [Computer software]. (2020).
Mississauga, Ontario, Canada: SR Research Ltd.

An HTML version of this document, which contains extra sections on example projects, can be accessed by pressing F1 or clicking "Help → Content" from the Experiment Builder application, or can be downloaded from https://www.sr-support.com/forums/showthread.php?t=99.

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1 Introduction

SR Research Experiment Builder (SREB) is a visual experiment creation tool for use by Psychologists and Neuroscientists on Windows and macOS. Experiment Builder is designed to be easy to use while maintaining a high degree of flexibility. This unique design combination allows for a wide range of experimental paradigms to be created by someone with little or no programming or scripting expertise. When used in combination with an SR Research EyeLink® eye tracking system, Experiment Builder provides seamless integration into the EyeLink hardware and software platform.

1.1 Features

Experiment Builder provides a comprehensive graphical experiment creation environment and contains functionality that addresses a wide variety of research needs encountered by eye tracking researchers. This functionality allows users to create everything from simple experiments in which each trial shows a static screen of text or picture and then waits for a response from the participant, to highly sophisticated experiments in which complex gaze-contingent event sequences can be scheduled with excellent timing precision.

Experiments are created in the Experiment Builder by dragging and dropping experiment components into a workspace and configuring the properties of the added components. There are two main classes of experiment components in the Experiment Builder: actions and triggers. Actions tell the computer to do something, like displaying a set of graphics on the screen or playing a sound. Triggers define the conditions that must be met before an action can be performed. Examples of triggers are keyboard events and eye (Fixation, Saccade, and Invisible Boundary) events.

The flow of the experiment is achieved by connecting sequentially related components in the workspace in a flow diagram-like fashion. For example, a Display Screen action may be connected to a Keyboard trigger, which is in turn connected to another Display Screen action. This simple Action → Trigger → Action sequence would result in a given set of graphics being displayed until users press a button, at which time a second set of graphics would be displayed. Detailed discussion on the experiment component connection or linking process, including a set of "rules" for linking experiment components together, can be found in Section 6.2 “Experiment Graph: Flow Diagram”.

As a convenient tool for creating eye-tracking experiments, Experiment Builder is fully integrated with EyeLink eye trackers. Performing camera setup, calibration, validation, and drift correction can be achieved by simply inserting the appropriate action in the experiment. A single check box can be enabled to record eye movements for a period of time. Online eye position data (e.g., fixation, saccade, or instantaneous eye sample) can be used to drive display changes in gaze-contingent or gaze-control applications. In addition, users can set eye-tracker preferences and send commands and messages to the EyeLink tracker.

With these capabilities, Experiment Builder allows users to focus on stimulus presentation and data analysis. Recording data collected from experiments created by Experiment Builder is fully integrated with EyeLink Data Viewer. For example, Experiment Builder automatically sends messages to the EDF file when a screen is displayed so that images and/or simple drawings can be used as overlay background in Data Viewer for visualizing gaze data relative to onscreen stimuli. Experiment Builder also allows users to specify condition variables for a trial and to add interest areas to display screens, which may be used in Data Viewer's analysis tools. Finally, the users can send custom messages to the EDF file so that time critical or important events can be marked in the data file and used to guide future analyses.

Experiment Builder also contains a built-in Screen Builder utility that makes the creation of 2D visual displays easier. The Screen Builder is a what-you-see-is-what-you-get ("WYSIWYG") tool, allowing users to create and view 2D visual stimuli right within the Experiment Builder application. The Screen Builder allows various types of graphic resources (movies, images, text, or simple line drawings) to be added to a Display Screen action. The exact properties of the resources can be further modified from a property panel. In addition, Screen Builder supports creation of both static and dynamic displays. In a dynamic display, users can have some resources on the screen move along a pre-specified movement pattern, or make the position of the resources contingent on the current eye or mouse position.

Experiment Builder is highly configurable. Nearly all of the properties of experiment components can be modified. This can be done either by directly entering the parameter values or, more flexibly, by attribute reference and equations (i.e., setting the value of one parameter to the value of another parameter, variable, or data source column). With this dynamic reference capability, a typical experiment requires the users to create a prototype of experiment conditions while leaving all parameter settings (e.g., experiment trial condition labeling, images to be used, text to be shown, positions of the resources) to be handled by a data source. This makes the randomization of trials across participants easier. In addition, attribute reference allows users to access some run-time data so that useful experiment manipulations such as conditional branching, displaying appropriate feedback, and creating new variables can be made.

1.2 How to Use This Manual

This manual is intended for users who are using version 2.3 or later of SR Research Experiment Builder. If you are still using an earlier version of the software, please download the latest version from https://www.sr-support.com/forums/showthread.php?t=9. The latest version of this document can be obtained from https://www.sr-support.com/forums/showthread.php?t=99. (Note: you must be a registered user of https://www.sr-support.com to access these updates and the Experiment Builder usage discussion forum.) If you have feature requests or bug reports, please send an e-mail to support@sr-research.com. If you need a copy of the software license, please contact sales@sr-research.com. If you have questions on using the software, please check out the Examples (Chapters 13, 14, and 15) and "Experiment Builder Project Checklist" sections of the user manual, visit the support forum, or send us an e-mail.

To use Experiment Builder effectively, it might help if you follow Chapter 14 "Creating EyeLink Experiments: The First Example" to re-create the "SIMPLE" example by yourself and get a sense of the life cycle of experiment creation and data collection with Experiment Builder. The following sections of the document should be read carefully as they discuss the basic concepts of Experiment Builder software: Chapter 2 "Experiment Builder Life Cycle", Chapter 6 "Designing an Experiment in Experiment Builder", Chapter 9 "Data Source", and Chapter 10 "References". Following this, take a look at other examples we provided (see the .html version of this document for detailed explanations of the examples) and start reading other sections. Chapter 16 “Experiment Builder Project Checklist” may be used to make sure common problems can be avoided when creating your experiments.

Finally, users are strongly suggested to sign up at SR Research Support site https://www.sr-support.com/. The site contains lots of Experiment Builder related Learning Resources, such as Frequently Asked Questions, Examples, Video Tutorials, Webinars, and Discussion Forum.

1.3 Citing Experiment Builder

Please use the following to cite the Experiment Builder software in your manuscript:
SR Research Experiment Builder 2.3.1 [Computer software]. (2020). Mississauga, Ontario, Canada: SR Research Ltd.

2 Experiment Builder Experiment Life Cycle

The following sequence of steps is required in order to create an experiment with Experiment Builder:

- Experiment Design
- Building and Test-running Experiment
- Deploying Experiment
- Participant Data Set Randomization (optional)
- Data Collection
- Data Analysis

2.1 Experiment Design

Whilst Experiment Builder simplifies many of the tasks required for creating an experiment, a good understanding of experiment design (e.g., blocking, counterbalancing, factorial design, etc.) and experience with the EyeLink system makes the initial use of Experiment Builder easier. In the stage of experiment design, users need to do the following:

1) ***Conceptualizing the Experiment***. Users should have a clear concept of the experiment before creating it. Which variables will be manipulated in the experiment? Within each trial, how is the display presented: a static display or a dynamic display? Can the same display presentation routine be used across all conditions or should a different routine be created for each of the experiment conditions? This allows users to contemplate all of the possible trial types in the experiment, design conditional branching if necessary, and create a data source for providing parameters which change from trial to trial (e.g. image filenames / trial durations etc). Once this is done, study one or more of the sample experiments supplied with Experiment Builder before creating your own project.
2) ***Creating a New Experiment Session***. Start the Experiment Builder application and create a new experiment session. Please read Chapter 4 "Working with Files" for details on experiment creation and file/folder management.
3) ***Adding Experiment Building Blocks to the Graph***. To schedule an array of events in an experiment, users need to add individual building blocks (triggers, actions, sequences, and other components) to the workspace in the Graph Editor Window. Connecting components by arrowed lines, which represent sequence and dependency relationships, forms the experiment flow. Please read Chapter 6 on experimental flow and Chapter 7 on the components of Experiment Builder.
4) ***Modifying Properties of Experiment Components***. Users will need to change the default settings for the actions, triggers, and sequences so that the experiment can be run as intended. For example, if a timer trigger is used, users may change the Duration property of the trigger. If an invisible-boundary trigger is used, the desired triggering location needs to be specified. Similarly, users need to supply data for all actions. For example, if a display screen action is used, users need to add different resources into the screen builder and adjust the layout of the resources in the screen. To change the default settings for triggers, actions, and

subsequences, and make the new values available for future uses, users may make the modification through the preference settings of the Experiment Builder application (see Chapter 17).

5) ***Creating a Data Source***. Experiment Builder allows users to create prototypical trials for the experiment and to supply actual parameters for individual trials from a data source. A data source can be created within Experiment Builder or by loading a text file. The use of a data source makes the creation of experiments more efficient and less error-prone. It also makes the randomization of trial order across participants easier (see Chapter 9 "Data Source" for details).
6) ***Saving the Experiment Session***. After the experiment is generated, don't forget to save the experiment session so that it can be re-opened later on. If you are creating an experiment by modifying one of the example scripts, don't forget to uncheck the Read Only property of the script before saving.

2.2 Building and Test-running Experiment

After the experiment is created, the next step is to see whether there are any errors in the experiment graph (for example, failing to make a connection between items, incomplete data source, wrong data type used, etc). Users can compile the experiment by clicking on "Experiment → Build" menu to build the experiment. Build time errors (in red) or warnings (in orange) will be displayed in the "Output" tab of the Graph Editor Window. In most cases, clicking on the error or warning message will select the experiment component at issue and thus enable users to quickly identify and fix the problem.

Please note that the above build process just checks whether there are obvious mistakes in the experiment graph but does not check for the content and validity of the experiment itself. Therefore, users should test-run the experiment on a couple of participants to see whether the experiment behaves exactly as intended. By clicking on "Experiment → Test Run", the experiment will be executed from within the Experiment Builder application. For an EyeLink experiment, a connection to the tracker PC will be made and users may record some data using mouse simulation, or with an actual participant. The EDF data file should be carefully examined to see whether all of the trial condition variables are properly recorded, whether interest areas and images are shown correctly, whether time-critical and other important messages are recorded for analysis, and so on. For a non-EyeLink experiment, users may rely on a message-log file or results file to debug the experiment.

Important Note: Every time "Experiment → Test Run" is performed, the experiment is rebuilt and all of previous data files in the experiment directory are deleted. Do not use "Experiment → Test Run" for collecting real experiment data; "Experiment → Test Run" is intended for testing purposes only.

2.3 Experiment Deployment

After fixing errors in the experiment graph and checking that the experiment is working as intended, users can then deploy the experiment to a new directory. This will generate a set of folders and files in the intended directory. Please note that the "Experiment → Test Run" step mentioned in the previous section must be used only for the purpose of testing and debugging the experiment graph. To collect experiment data, users must use a deployed version of the experiment as this does not rely on the Experiment Builder application (and also does not require the license key to run). In addition, running the deployed version of an experiment generally has a better timing performance than running it directly from the Experiment Builder application because the computer is not running the Experiment Builder interface at the same time as the experiment. To run an experiment on a different computer, users should copy the entire directory of the deployed version of the experiment to the new experiment computer, assuming the latter is running on the same operating system as the original computer and has the required hardware (e.g., monitor, sound card, response device) for the proper execution of the experiment. If a different operating system is used, the user will need to deploy the original Experiment Builder project again on the new computer. The experiment should be run at least once and results validated on the new computer before starting full data collection from multiple participants.

2.4 Participant Data Set Randomization

As mentioned earlier, users typically first create prototypical trials for the experiment in the software and then supply the actual parameters of individual trials from a data source. In many experiments, users will want to randomize trial order so that the experiment materials are not presented in the same sequence across participants. Randomization of data source can be done with either an internal randomizer or an external randomizer. These two randomization methods are almost identical and therefore users may use the internal randomizer to perform randomization unless complicated counterbalancing or Latin-square designs are needed.

Please note that configuration of the internal randomization settings should be done before deploying the experiment project whereas the external randomization can be done after deploying the experiment project (see Chapter 9 “Data Source”).

2.5 Data Collection

Data can now be collected from the deployed version of the experiment. Double click the executable file in the deployed experiment directory or type in the .exe file name from the command-line prompt. If the experiment uses a data source, and the “Prompt for Dataset File” property of the relevant sequence has been checked, a dialog will be displayed, allowing users to choose the appropriate data source file. In an EyeLink Experiment, users will also be asked to enter an EDF file name. At the End of experiment, an EDF file will be generated for EyeLink recording session and saved in the experiment directory. Optional results file(s) will be created if users have specified them in EyeLink and non-EyeLink experiments.

2.6 Data Analysis

EyeLink Data Files can be conveniently analyzed with EyeLink Data Viewer as experiments created with Experiment Builder are fully integrated with this analysis tool. Experiment Builder sends messages to the data file so that images or simple drawing can be added as overlay background by Data Viewer. Users can also specify trial variables, create interest areas, and send messages for the ease of data analysis. Experiment Builder can also create results files, which contain columnar outputs for selected variables in the experiment. This file can be easily loaded by common statistics packages. This can be useful for non-EyeLink experiments.

3 Installation

Version 2.3 of Experiment Builder runs on both Windows (32-bit and 64-bit of Windows 7, 8, and 10) and macOS (versions 10.12 – 10.15). The current section covers system requirements for computers used to create and run experiments with Experiment Builder as well as installation and licensing issues.

3.1 Windows PC System Requirements

The computer recommendations for SR Research Experiment Builder are in a large part dependent on the experimental paradigm being run. For example, an experiment that simply displays a single screen of text and waits for a manual response can run on a computer with much lower specifications than an experiment where video presentation is occurring during the trial. We recommend that you buy the best computer you can for running your experiments, even if you do not immediately plan on using all the features of the computer. The following computer specifications are guidelines only. SR Research can be contacted for input on what computer specifications would best match your actual experiment designs.

IMPORTANT: Regardless of the computer used and the experimental design, it is critical to evaluate the timing of the experiment to ensure it operates as expected.

3.1.1 Computer Configuration

This recommended PC configuration should handle any experiment that can be created by SR Research Experiment Builder, including video presentation, saccade-contingent display changes, accurately timed audio presentation, audio recording, and ASIO-based voice key support.

- Recent Intel CPUs with duo-core/multi-core processor
- Windows 10 (32-bit or 64-bit)
- At least 4 GB of memory
- 250 GB or larger hard disk with 7,200 or higher rpm, or solid-state hard drive
- A recent video card with at least 1.0 GB of memory and OpenGL 2.0 support
- Monitor that supports high refresh rate
- ASIO-Compatible Sound Device ***
- Keyboard and Mouse
- Free USB ports (for Experiment Builder key)
- A dedicated Ethernet port to connect the Display PC to the EyeLink Host PC.

*** Any DirectX compatible sound card can be used for hearing calibration and drift correction feedback tones and playing audio files where exact audio timing is not important to the experiment. In cases where accurate audio timing is important, or if the audio recording and/or computer-base voice key features of the software will be used, then a supported ASIO-compliant audio card or USB device must be available in the PC. The following cards have been tested and the results of the ASIO driver tests are listed below. SR Research strongly recommends that you use a card from the table that supports the features required for your experiment.

ASIO-compatible Sound Card	32-bit and 64-bit Windows 10	Format	Notes
Creative Labs Sound Blaster Audigy 5/ RX (SB1550)	Supported	PCI-Express	
Creative Labs Sound Blaster AE-5 (Model SB1740)	Supported	PCI-Express	This card has a 4 ms delay for the for Voice Key triggers.
M-Audio M-Track Air	Supported	USB *	
M-Audio M-Track 2x2M	Supported	USB *	
Steinberg UR22MKII	Supported	USB *	
Roland Rubix 22c	Supported	USB *	

For details on the currently supported and legacy sound card selection and installation, please see section "Installation → System Requirements → ASIO Card Installation" in the html version of this document. This can be accessed by pressing F1 or clicking "Help → Content" when running Experiment Builder software, or downloaded from (https://www.sr-support.com/forums/showthread.php?t=99).

3.1.2 Maximizing the Real-time Performance of the Display PC

If you have options to tweak/reconfigure computer hardware, the following enhancements in particular will improve performance:

- Install more and/or faster RAM
- Upgrade to a better video card
- Use a SSD (Solid State Drive) instead of HDD (Hard Disk Drive)

To maximize the real-time performance of the Display PC, users should do the following:

- Shut down all other applications (browser windows, chat clients, email programs, etc.) prior to running an EyeLink experiment. These applications are listed in the taskbar at the bottom of the screen.
- Shut down any programs (volume controller, Windows Messenger, Google Desktop, etc.) running in the notification area of the taskbar where you usually see the current time displayed (lower-right corner of the screen). In Windows 10, click "Settings → System → Notifications & Actions". Set "Notifications – Get notifications from apps and other senders" to "Off".
- Remove live tiles from the Start menu of Windows 10. Open the Start menu, right-click a tile and select "Unpin from Start". Now do that for every single tile on the right side of the Start menu.
- Make sure no scheduled tasks (e.g., data backup, virus checking, Windows Update) are active.
- Remove unnecessary devices (e.g., flash drive, external hard drive) connected to the computer.
- Scan the computer for virus, spyware, and malware, but make sure to disable the antivirus program when deploying or running experiments.

- Shut down screen-saver management. On Windows 7, click the right mouse button at a blank space on the Display PC desktop and choose "Personalize" from the popup menu. Click the "Screen Saver" icon at the bottom-right corner of the window, and set the screen saver to "None" in the following dialog box. On Windows 10, click "Settings → Personalization → Lock Screen". Click the "Screen Saver Settings" at the bottom of the "Lock Screen" page.
- Choose a high performance power setting. On Windows 7, click "Control Panel → Power options". Choose the "High Performance" option in the "Select a power plan" page. On Windows 10, click "Settings → System → Power and Sleep". Choose "Never" for both the Screen and Sleep dropdown lists. Click the "Additional Power Settings" button. Choose the "High Performance" option in the "Choose or Customize a power plan" page.
- For a computer with multiple Ethernet cards installed, use the Windows Control Panel to temporarily disable all network connections except for the one dedicated for EyeLink connection. Disable wi-fi and Bluetooth when they are not in use.
- If you are using a monitor that uses NVidia G-Sync technology, please disable the G-SYNC feature using Nvidia Control Panel.
    - Right-click on the desktop screen and select Nvidia Control Panel in the menu.
    - Click on the + symbol next to Display.
    - Click on Set up G-SYNC.
    - Uncheck the box next to Enable G-SYNC.

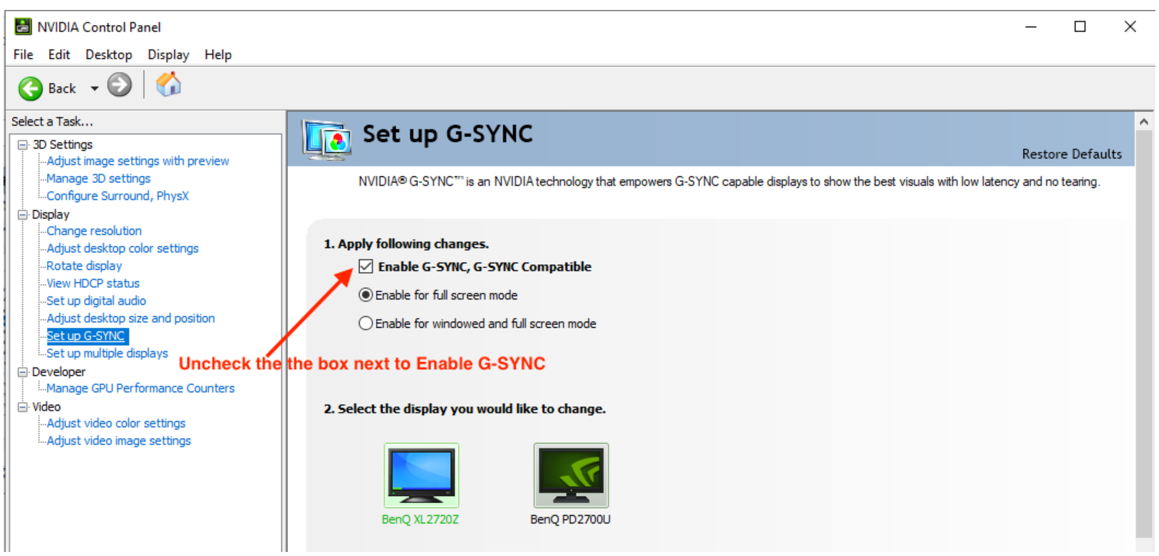


Figure 3-1. Disabling the NVidia G-SYNC option on Windows

- Uninstall any unneeded programs on the PC (e.g., the bloatware and trial software supplied by the manufacturer of the computer). If you are using an NVIDIA video card, make sure the "NVIDIA GeForce Experience" program is not installed.
- Stop some of the unnecessary services running at the background. For example you can stop the Index "Windows Search" process. Press Ctrl + Alt + Del three keys together to start the Task Manager. Click the "Services" tab. Find the

"WSearch" by name, select the service and click the right mouse button, and choose "Stop". Now click the "Processes" tab and review the applications and processes listed. On Windows 10, you can pretty much kill all processes listed in the "Background processes" section except for Cortana and a few Windows processes. If you are using an NVidia video card, make sure the "NVIDIA Backend" or "NvBackend.exe" process is disabled in the Processed list. **WARNING:** Disabling the wrong service could hurt performance, or even cripple Windows. If you do not truly know what you are doing, then it's highly recommended not to do this.

- If you are using a recent NVidia graphics card, please make sure NVIDIA Streamer Service, NVIDIA Streamer Network Service and NVIDIA Streamer User Agent are disabled. Type "services.msc" in the Windows search box to start the Services Window. If you find these services listed in the Services Window, select the process, click the Stop button to disable it for the session, and set the "Start type" to "Disabled".
- Stop all virtual machines if you have them running (e.g., virtual box, hyper-v services, vmware, etc). Make sure that the idling CPU usage of the computer is very low.
- To run the experiment project, go to the deployed folder, and double click the file .exe file in the folder. Click "Yes" in the following "User Account Control" dialog box.
- Please don't collect data by using the "Test Run" option from the Experiment Builder software. Please make sure the Experiment Builder application window(s) is closed before you collect data with your experiment.
- When running experiments with an LCD monitor that supports high refresh rates, use the native screen resolution and the highest refresh rate offered by the monitor.

3.1.3 Host Computer and Display Computer Software Requirements

SR Research Experiment Builder works with EyeLink I, II, 1000, 1000 Plus, and Portable Duo eye trackers.

- EyeLink I users should make sure that version 2.11 of the eyelink.exe file (https://www.sr-support.com/forums/showthread.php?t=45) is installed on the Host PC.
- EyeLink II users should use a recent version (2.0 or later) of eyelink2.exe (https://www.sr-support.com/forums/showthread.php?t=11).
- Any version of EyeLink 1000 host software will be fine, although version 4.56 or later is recommended (https://www.sr-support.com/forums/showthread.php?t=179).
- Any version of EyeLink 1000 Plus host software will be fine, although the latest version is recommended (https://www.sr-support.com/showthread.php?4256).
- Any version of EyeLink Portable Duo host software will be fine, although the latest version is recommended (https://www.sr-support.com/forum/downloads/eyelink-host-software/51697).

- If using EyeLink Data Viewer for data analysis, users should make sure to install the most recent version of the software (https://www.sr-support.com/showthread.php?4434).

3.2 Software Installation and Licensing on Windows

The latest version of Experiment Builder installer can be downloaded from https://www.sr-support.com/forums/showthread.php?t=9. If you have a previous version of Experiment Builder installed on the computer, please choose the "Clean Install" option to remove the existing version of the software and install the new version. By default, Experiment Builder will be installed at "{Windows Drive}:\Program Files (x86)\SR Research\Experiment Builder" for 64-bit Windows or "{Windows Drive}:\Program Files\SR Research\Experiment Builder" for 32-bit Windows. Click ExperimentBuilderW.exe (or "Start → All Programs → SR Research → Experiment Builder") to run the software.

Users can run the Experiment Builder software in demo mode immediately. All of the functionality of the licensed copy of Experiment Builder is available in the demo mode except that experiments created with a demo version of the software will not re-open using a fully-licensed version of the software. An "UNLICENSED DEMO VERSION" watermark will be drawn on every display screen in an experiment that is created with the demo version of the software.

To run Experiment Builder in a fully licensed mode, users need to purchase a license for the software. This can be either a software license code that needs to be activated online or a USB key connected to the computer on which the Experiment Builder software is installed. If this is the first time that the license has been used on the Display PC, you will need to install the HASP driver.

3.2.1 For Standard Installation (Applicable to Most Users)

The following installation instructions are applicable to users who use a standalone USB license key that supports a single-PC license.

1. Install the Experiment Builder software. Double click the sreb_2.*.exe installer and proceed, keeping all the default settings. You may see the following dialog box (Figure 3-2) if this is the first time Experiment Builder is installed on the PC. This is a confirmation whether you want to install device driver for USB-1208HS DAQ box. You may choose either "Install" or "Don't Install" to proceed.

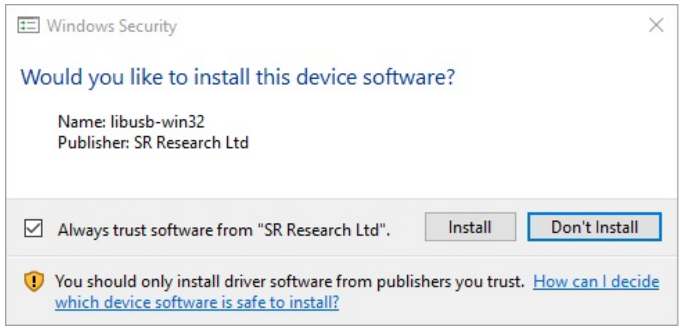


Figure 3-2. Driver Installation for USB-1208 HS DAQ.

2. If this is the first time that the USB license key has been used on the computer, install the standalone HASP key driver. First plug the license key into the Display PC. Then install the driver by clicking "Start → All Programs → SR Research → Install HASP Driver", or by double clicking on "hdd32.exe" in the "C:\Program Files (x86)\SR Research\Common" folder.
3. Open the License Manager utility (Start → All Programs → SR Research → License Manager) to check the licensing status for the Experiment Builder software.

3.2.2 For Installation Using Network Licensing

The following is applicable to users who have purchased a network license, i.e., a shared license for several computers on a network that are running Exeriment Builder at the same time. (The following instructions work for license keys received from SR Research after November 2019. If using an earlier license key, please contact SR Research at support@sr-research.com.)

On both the Server and Client Computers, install Experiment Builder and the HASP driver as discussed in section 3.2.1. (Even you have previously installed a HASP key driver, please install the latest version of the HASP key driver included with the Experiment Builder software for the network licensing to work properly.) Please make sure that the server and client computers are running and able to find each other in the network; contact your system administrator if the computers cannot see each other in the same network group. Now plug in the network license key to the Server Computer; it should glow when detected. For each of the Client Computers, start the License Manager (Start -> All Programs -> SR Research -> License Manager) and click "File -> Enable Net Key" in the menu.

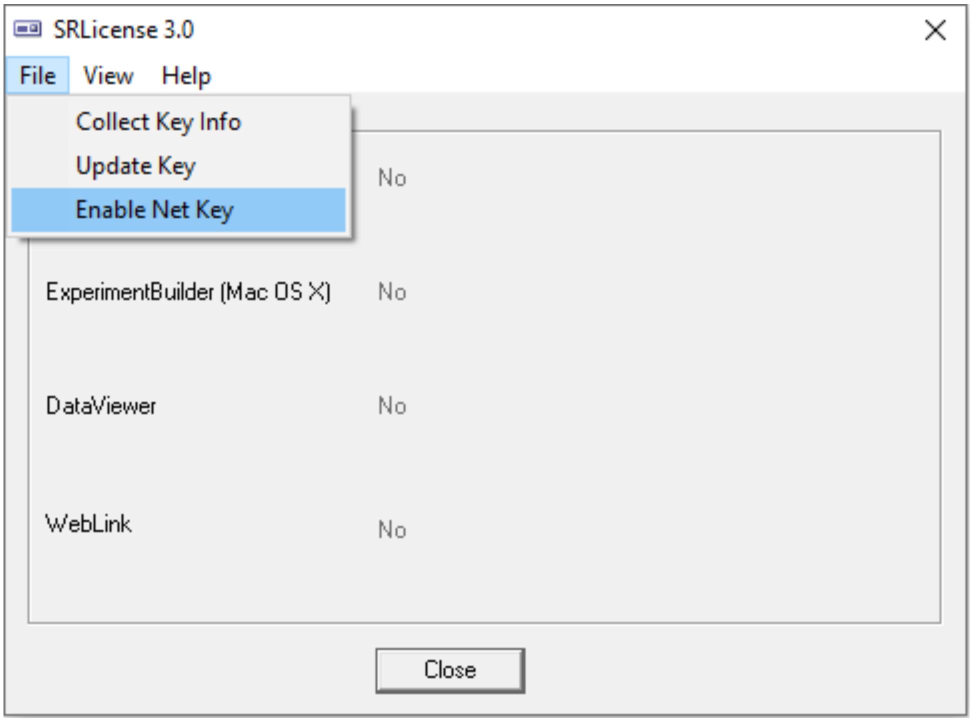


Figure 3-3. Enabling Network License Key Detection on Windows

3.3 Software Installation and Licensing on macOS

SR Research Experiment Builder runs on most recent Intel-based Macs (software version macOS 10.12 – 10.15). The computer recommendations are in a large part dependent on the experimental paradigm being run; it is always suggested to get the best computer you can for running your experiments, even if you do not immediately plan on using all the features of the computer.

3.3.1 Experiment Builder Installation

The latest version of Experiment Builder installer can be downloaded from https://www.sr-support.com/forums/showthread.php?t=9. If you have a previous version of Experiment Builder installed on the computer, please uninstall it first by removing the "/Applications/ExperimentBuilder" folder to Trash. Now click the dmg installer of the software. Select the "ExperimentBuilder" folder in the package, and drag and drop it into the "Applications" folder (see Figure 3-4). The software is now installed at "/Applications/ExperimentBuilder". Click "ExperimentBuilder.app" to run the software. The examples can be found in the "~/Documents/ExperimentBuilder Examples" folder.

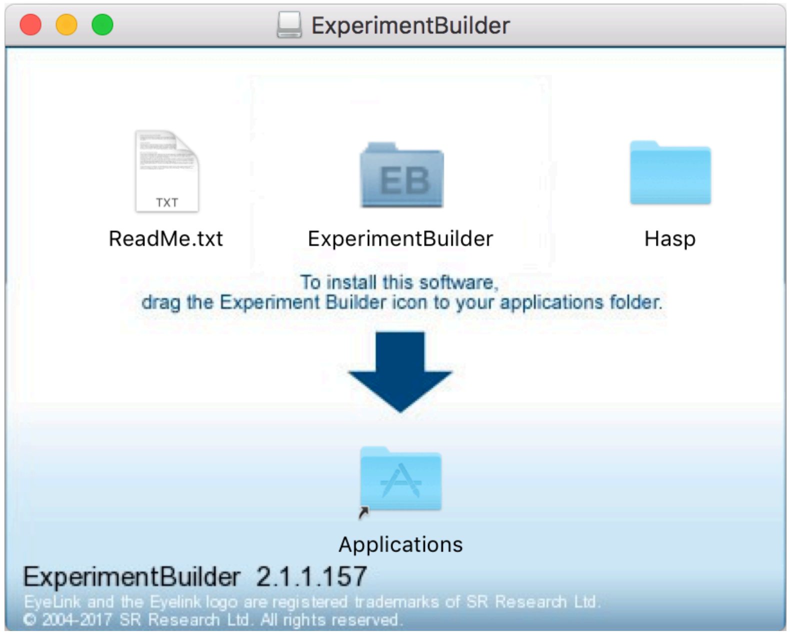


Figure 3-4. Installing Experiment Builder on macOS

If you see the error message “ExperimentBuilder is damaged and can’t be opened” when you try installing the software, please click the Apple logo in the top-left corner and select “System Preferences”, then go to “Security & Privacy” and under the General tab make sure “Allow apps downloaded from:" is set to “Anywhere” (you may need to click the padlock to make changes).

If you are using the recent macOS, you may be prompted to download legacy Java 6 from this link: https://support.apple.com/kb/DL1572?locale=en_GB and install it.

3.3.2 Other Software Installation

SR Research Experiment Builder works with EyeLink I, II, 1000, 1000 Plus, and Portable Duo eye trackers.

- EyeLink I users should make sure that version 2.11 of the eyelink.exe file (https://www.sr-support.com/forums/showthread.php?t=45) runs on the Host PC.
- EyeLink II users should use a recent version (2.0 or later) of eyelink2.exe (https://www.sr-support.com/forums/showthread.php?t=11).
- Any version of EyeLink 1000 host software will be fine, although version 4.56 or later is recommended (https://www.sr-support.com/forums/showthread.php?t=179).
- Any version of EyeLink 1000 Plus host software will be fine, although the latest version is recommended (https://www.sr-support.com/showthread.php?4256).
- Any version of EyeLink Portable Duo host software will be fine, although the latest version is recommended (https://www.sr-support.com/forum/downloads/eyelink-host-software/51697).

- If using EyeLink Data Viewer for data analysis, you should get the most recent version of the software (https://www.sr-support.com/showthread.php?4434).

3.3.3 HASP Driver Installation and Licensing

Users can run Experiment Builder in demo mode immediately for 30 days from the first installation of the software on the computer. All of the functionality of the licensed copy of Experiment Builder is available in the demo mode except that Experiments created with a demo version of the software will not re-open using a fully-licensed version of the software. An "UNLICENSED DEMO VERSION" watermark will be drawn on every display screen in an experiment that is created with the demo version of the software.

To run Experiment Builder in a fully licensed mode, users need to purchase a license for the software. This can be either a software license code that needs to be activated online or a USB key connected to the computer on which the Experiment Builder software is installed. If this is the first time that the license key has been used on your Mac, you will need to install the driver for the HASP key. The driver installer can be found in the "Hasp" folder after unpacking the Experiment Builder installer .dmg (see Figure 3-4). Double click the "HDD_MacOSX.dmg" file and then run the "Install Sentinel Runtime Environment" application with the default settings. If the driver installation is successful and the USB license key is attached to the computer, the licene key should glow.

If your key is not licensed for the Experiment Builder software, contact sales@sr-research.com to purchase a license for the software. If your key is already licensed for the Windows version of the software, please contact support@sr-research.com for instructions on updating the license for the Mac version remotely.

If using a network license key, please make sure a Windows PC is used to host the license key. Please make sure that the server and client computers are running and able to find each other in the network; contact your system administrator if the computers cannot see each other in the same network group. To receive network licensing on Mac, please start the LicenseManager in the "/Applications/ExperimentBuilder" folder, and click "File -> Enable Net Key".

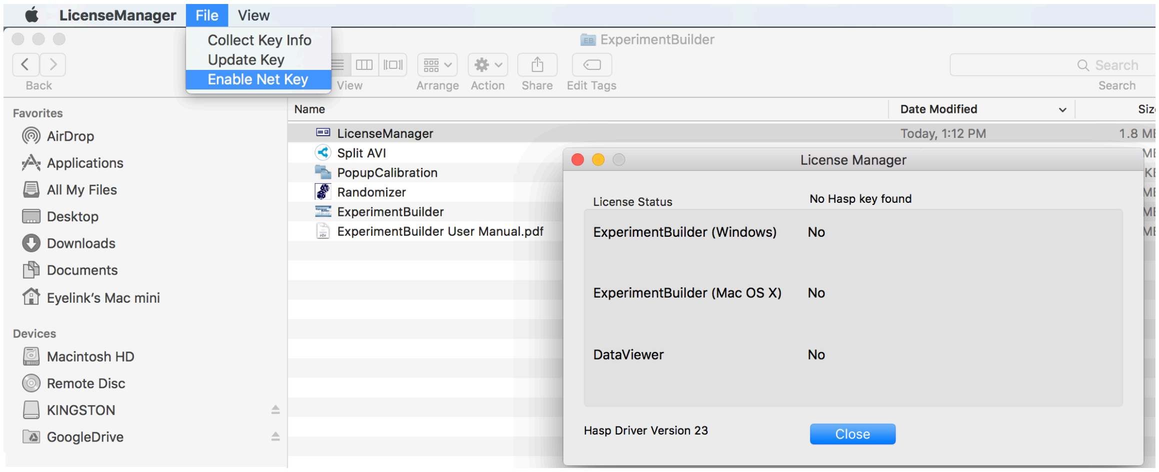


Figure 3-5. Enabling Network License Key Detection on Mac OS

4 Working with Files

Experiment Builder can be used to create, build/test run, and deploy experiments on either Windows (Windows 7, 8, or 10) or macOS (versions 10.12 – 10.15). Each experiment creation session generates a binary file (graph.ebd), which contains the graphic layout of the experiment, and a set of supporting files and directories for preference settings, image loading, etc. With these files, the experiment creation session can be reopened later for review or modification. After the experiment is built, users can deploy the experiment to a new directory. This will generate a set of files so that the experiment can be run on a different computer without relying on the Experiment Builder application.

4.1 Creating a New Project

To create a new experiment project, from the application menu bar, choose (see Figure 4-1):

File → New

Tip: A new experiment project can also be created by clicking on the "New Experiment" button ( ) on the application toolbar, or by pressing the shortcut keys Ctrl+N on Windows or Command ⌘+N on macOS.

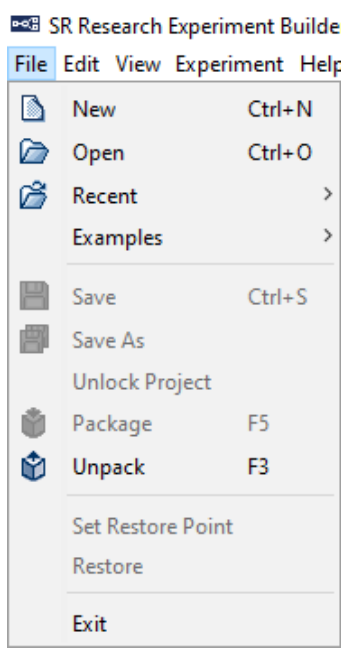


Figure 4-1. File Menu.

This will bring up a "New Project" dialog (see Figure 4-2), prompting for the experiment project name and a directory in which the experiment project should be saved. Enter the name for the experiment in the "Project Name" edit box. Click the "…" button to the right of the "Project Location" field to browse to the directory where the experiment files should be saved; if you are manually entering the "Project Location" field, please make sure that the intended directory already exists. In both cases, please make sure you have writing permission for the selected directory. If your intended project is an EyeLink experiment, make sure to check the "EyeLink Experiment" box and choose the appropriate tracker version from the dropdown list.

Note: Please avoid using non-ASCII characters in the project name or directory path as this may cause runtime problems. The experiment project name must start with a letter between 'a' and 'z' or 'A' and 'Z' and may contain letters, digits, and the underscore character. If there is any space in the filename, this will be replaced by an underscore. An "Invalid Value" or "invalid label format" error dialog box will be displayed if the format of session label is invalid.

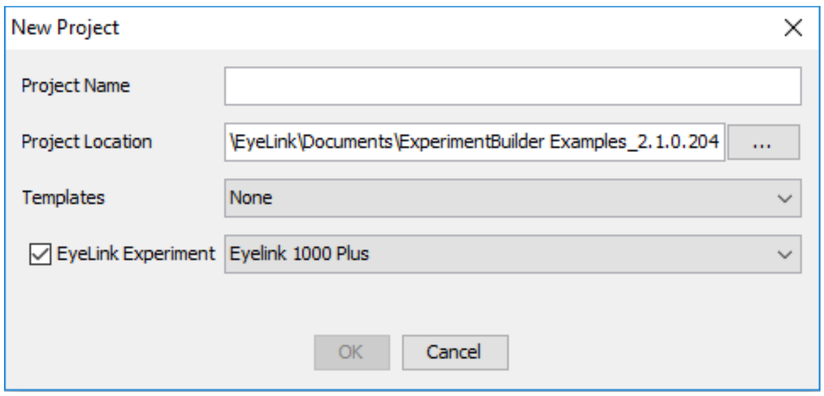


Figure 4-2. Dialog for Creating a New Project.

After the experiment is generated, the following files and folders are created.

```
Experiment
       |--- [datasets]
       |--- [library]
              |--- [audio]
              |--- [customClass]
              |--- [images]
              |--- [datasource]
              |--- [interestAreaSet]
              |--- [movementPattern]
              |--- [video]
       |--- [myfiles]
       |--- [runtime]
              |--- [images]
       |--- graph.ebd
       |--- Preferences.properties
```

- *graph.ebd*: This file contains the experiment graph. Double-click this file to open the experiment project.
- *Preferences.properties*: This file contains the preference settings for the current experiment project.
- *datasets*: This is the directory where the data source file is located.
- *library*: This is the folder where the image, audio, interest area set, and video files are stored.
- *runtime*: This folder contains all of the runtime image. Starting version 2.3, the Data Viewer integration files (image drawing list and interest area set files) are now placed in the results\{session name} folder.
- *myfiles*: This directory (and all files and subdirectories within it) will not be deleted or cleaned by the build process, so this is where users may store any additional files related to the project (randomized data sets, test EDF files, etc). Files in this directory will be included in the packed project and copied to the deployed folder.

Note: In Windows 7, 8, or 10, a new project should be created at a directory with user read/write permission (e.g., at "C:\Users\{User Name}"). Similarly, you should deploy your experiments to the user account directory.

Note: The above files and folders are created and maintained by Experiment Builder. **Users should not attempt to modify these files and folders or store important files in the experiment project folder except within the "myfiles" directory.** Experiment Builder will overwrite any manual changes made to the experiment project directory (except "myfiles").

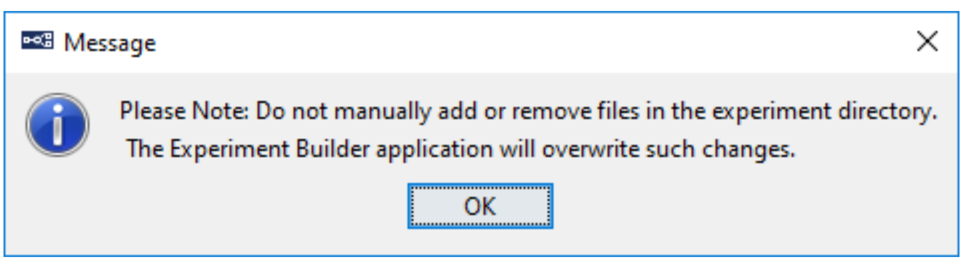


Figure 4-3. Warning Messages after Experiment Creation.

4.2 Saving a Project

An experiment project can be saved by choosing from the application menu bar:

File → Save

Tip: The experiment creation session can also be saved by clicking on the Save button on the application tool bar, or by pressing the shortcut keys Ctrl+S on Windows or Command ⌘+S on macOS.

If there is any change to the experiment project, the previous experiment graph is saved as "graph.ebd.bak" in the experiment directory.

4.3 Saving an Existing Project to a Different Directory

To save an experiment project with a different project name and/or in a different directory,

1) From the application menu bar, choose:
   File → Save As
2) In the Save As dialog box, click the "…" button to the right of "Project Location" to browse to the directory where the project should be saved.
3) Enter the new project name in the Project Name edit box.
4) Click the OK button.

Tip: The project can also be saved by clicking the "Save As" button on the application tool bar.

4.4 Opening an Existing Project

To open an existing experiment project from the Experiment Builder application,

1) From the application menu bar, choose:
   File → Open
2) In the "Open" dialog box, browse to the directory of experiment and select the "graph.ebd" file (see Figure 4-4).

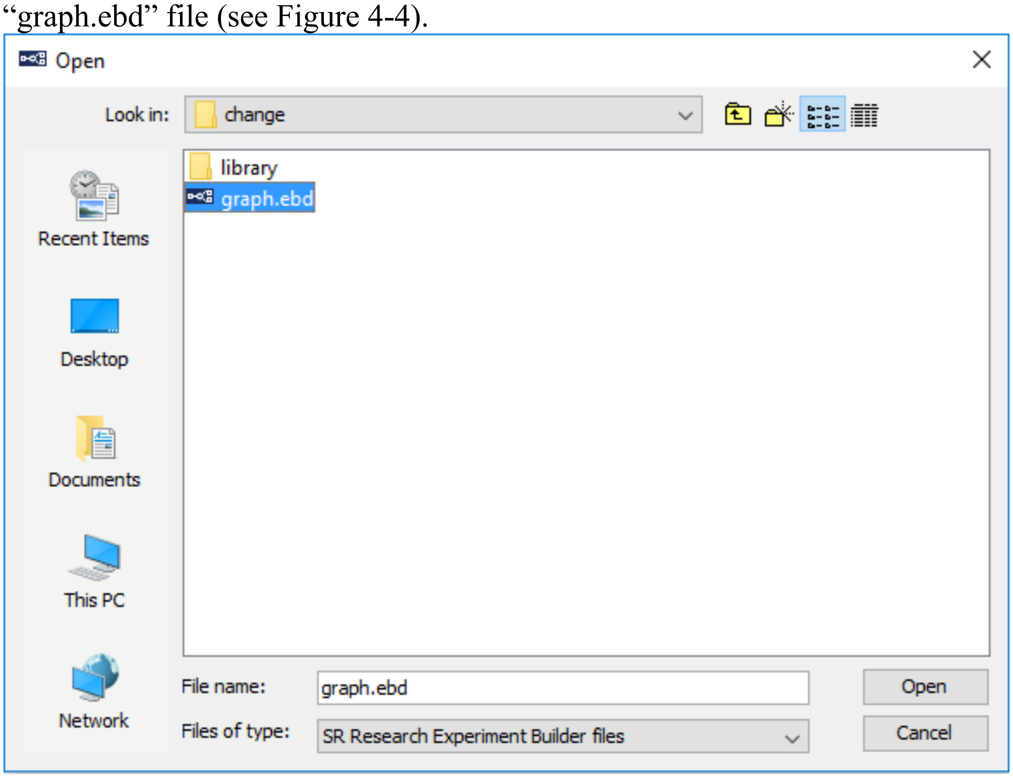


Figure 4-4. Open an Experiment Builder Project.

3) Click the “Open” button.

Note: If an experiment is already open in the current project, the “Open” operation will first bring up a “Save Confirmation” dialog box so that users can either save the current session (“YES”), abandon the current session (“NO”), or stay in the current session (“CANCEL”; see Figure 4-5).

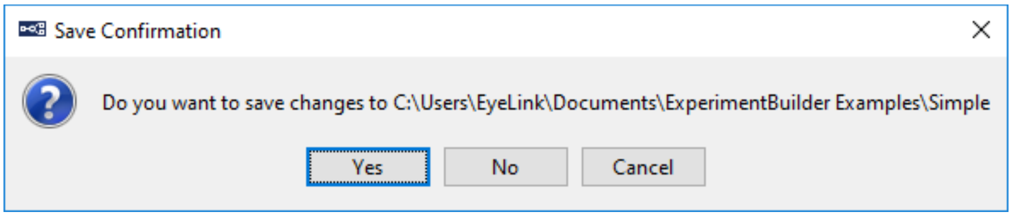


Figure 4-5. Save Confirmation When Opening a New Project.

Tip: A saved experiment project can also be opened by clicking the Open button on the application toolbar, or pressing the shortcut keys Ctrl+O on Windows or Command ⌘+O on macOS.

Note: Users can also open an existing experiment project with Windows Explorer, or Finder in macOS, by going to the directory where the experiment project is contained and double clicking on the *graph.ebd* file.

Note: If you are opening a project created with version 1.x of Experiment Builder on a Windows 8 or 10 computer, you will see the following warning message (see Figure 4-6). This is the expected behavior as DirectDraw graphics is no longer supported in version 2.3; Expeirment Builder uses the OpenGL graphics on both Windows and macOS.

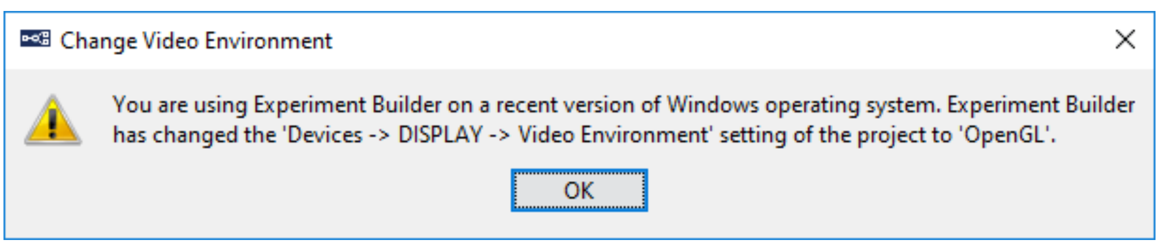


Figure 4-6. Change in Video Environment When Opening a New Project.

4.5 Reopening a Recent Experiment Project

Experiment Builder keeps a history of five recently opened experiment projects. To reopen a recent experiment project:

1) From the application menu bar, choose:
   File → Recent

2) Choose the project to open from the list of recent experiment projects. (see Figure 4-7).

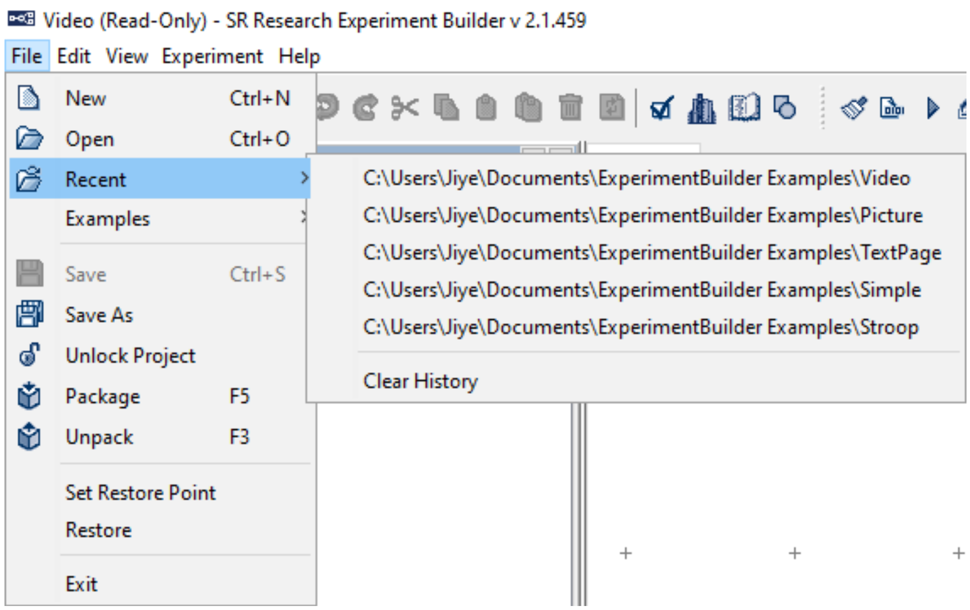


Figure 4-7. Reopening Recent Experiment Projects.

A "File Not Found" error will be displayed if the intended experiment project has been moved, renamed, or deleted. To clear the list of recent projects, click the "Clear History" menu.

4.6 Lock/Unlock a Project

If you open a locked Experiment Builder project, you will notice that there is a "(Read-Only)" string in the titlebar of the experiment project. With a locked project, the "Save" button in the application toolbar is grayed out when you try to save modifications to the experiment graph. The Add, Delete, and Rename buttons in the Library Manager are also disabled. To unlock a locked project, click the "File → Unlock Project" option on the application menu, or click the ( ) button on the application toolbar (see Figure 4-8). To lock a project, click the "File → Lock Project" option on the application menu, or click the ( ) button on the application toolbar.

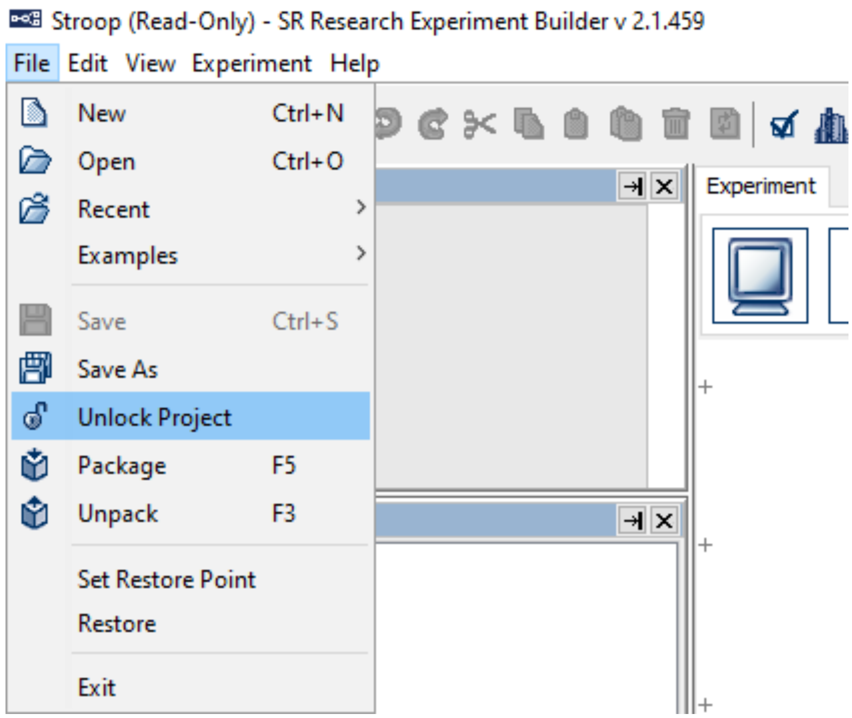


Figure 4-8. Unlock a Locked Project.

4.7 Packaging an Experiment

Experiment packaging is very useful if you want to send another Experiment Builder user an experiment you have created so they can modify the experiment in Experiment Builder. Users can pack up the current experiment project by clicking

File → Package

from the application File menu.

This will zip up the experiment directory and save the zip file at a selected location. The created .ebz file contains only the files necessary to rebuild and run the experiment (*graph.ebd*, *Preferences.properties*, the *library* directory, and the *myfiles* directory if it has any contents). The packed project can be unpacked by Experiment Builder.

Tip: The experiment can also be packaged up by clicking the "Package" button on the application tool bar or pressing F5 on Windows or Ctrl+Shift+P on macOS.

4.8 Unpacking an Experiment

The packed experiment project can be unpacked by clicking "File → Unpack" from the application File menu. In the following dialog, users should select the packed project (source) and specify a directory to which the project should be unpacked (Destination;

see Figure 4-9). By default, the destination directory will be the folder where the .ebz file is located.

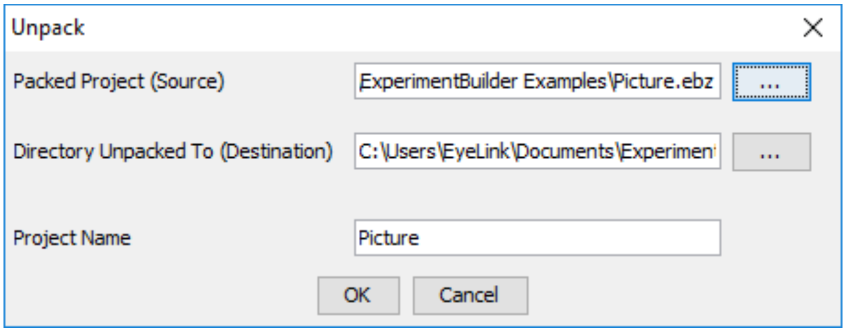


Figure 4-9. Unpacking an Experiment Project.

Tip: A packed project can also be unpacked by pressing F3 on Windows or Ctrl+Shift+U on macOS.

Note: Users can also unpack a project by simply double-clicking on the .ebz file.

4.9 Building an Experiment

After creating the experiment, users need to compile the experiment to make sure there are no errors in the experiment graph. To do that, from the application menu bar, choose (see Figure 4-10):

Experiment → Build

Tip: Building an experiment can also be performed by clicking on the "Build" button on the application tool bar or pressing F9 on Windows or Ctrl+Shift+B on macOS.

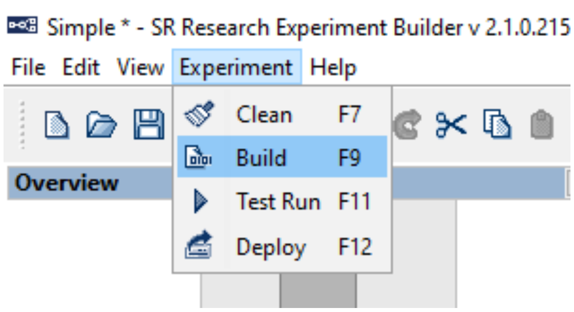


Figure 4-10. Experiment Menu.

4.10 Cleaning an Experiment

Sometimes users may want to clean up the experiment projects. This is especially important when users have changed the images or other screen resources used for the experiment. To clean the project, from the application menu bar, choose:

Experiment → Clean

Tip: Cleaning an experiment can also be performed by clicking on the "Clean" button ( ) on the application tool bar or by pressing shortcut key F7 on Windows or Ctrl+Shift+C on macOS.

4.11 Test-running an Experiment from EB Application

To check whether the experiment works, users may test run the experiment from the Experiment Builder application. To perform a Test Run, from the application menu bar, choose:

Experiment → Test Run

This will create a "Results" directory containing the data collected from the test run session. Note that the test run is not intended for real data collection and should only be used when you are testing your experiment. Each time you test run, the results folder is created again, and existing results will be lost.

Tip: Test running an experiment can also be performed by clicking on the "Test Run" button on the application tool bar or pressing the shortcut key F11 on Windows or Ctrl+Shift+R on macOS.

Note: If the experiment is tested under dummy mode, a warning dialog box "You are running in dummy mode! Some eye tracking functionality will not be available" will be displayed at the beginning of the experiment, and a warning dialog "No EDF file is created for dummy mode session" will be displayed at the end.

4.12 Deploying an Experiment

To deploy a built experiment so that it can be run for data collection without relying on the Experiment Builder application, choose from the application menu bar:

Experiment → Deploy

In the Deploy dialog box, click the "…" button to the right of "Project Location" to browse to the directory where the deployed project should be saved. The project will be saved into a new subdirectory named for the entered File Name. This experiment subdirectory contains all of the required files generated. Please note that non-ASCII characters are not allowed in a deployment path (e.g., deploying a project to a folder that contains Chinese characters will fail). Users can cancel the deploy process by pressing the "Cancel" button.

Tip: Deploying an experiment can also be performed by clicking on the "Deploy" button on the application tool bar or pressing shortcut key F12 on Windows or Ctrl+Shift+D on macOS.

Tip: For the ease of reconstructing the original experiment project, a "source" folder will also be created in the deployed project. Depending on the Build/Deploy preference settings, this folder contains either the packed experiment project or only the graph.ebd and Preferences.properties files.

Note: Users may deploy the experiment on one computer and then copy and execute the project on a different computer. Please make sure the deploy computer and the test computer have the same operating system installed and the test computer has the required hardware (e.g., monitor, sound card, response device) for the proper execution of the experiment. For example, an experiment deployed on a Windows XP computer will not run on a display computer with Windows 7 installed, as the dependency files are different between two operating systems. Similarly, experiment deployed on macOS will not run on the Windows computers and vice versa. Other runtime errors can occur if the two computers have different settings in the Cedrus driver, I/O driver, video card driver, audio device, etc.

4.13 Running an Experiment for Data Collection

To run the experiment for data collection from the deployed folder, simply double click the executable file in the deployed directory, or from your computer desktop, click "Start → All Programs → Accessories → Command Prompt". Go to the deployed experiment directory by typing "cd {experiment path}" on the command prompt and type the {experiment}.exe file name to start the experiment. Running the experiment from the command line prompt also allows users to pass additional parameters to the program. Some of the useful command line options are:

- -session= <your edf or session name >
  If the "-session" option is used, the software will not prompt for a session name via a dialog box at the beginning of the experiment. The session name pass along the "-session=" option must be within eight characters (consisting only of letters, numbers, and the underscore character).
- -ui=[GUI|CONSOLE|NONE]
  The "-ui" option allows to disable the file transferring dialog box at the end of the session. If -ui=GUI the graphical progress bar is popped up (default); if -ui=CONSOLE, progress updates of the file transfer are printed to the console; if -ui=NONE no progress messages are brought to the users. For example, for an experiment named "simple_deployed", you can pass the "-ui=NONE" to disable the files transfer progress bar.
  simple_deployed -session=myTest -ui=NONE
- The actual parameters passed along the command line can be retrieved through the "Command Line Arguments" property of the Experiment node.

Running the deployed version of the experiment doesn't require a license key plugged to the computer. If the experiment needs to be run on a different machine with similar or better computer specifications, users should first copy the entire directory of the deployed version of the experiment to that computer. To make the experiment transfer easier (given the large number of files involved), users may first zip up the {Experiment Name} folder (keeping the directory structure) and then unzip the file on the target computer.

Users should also pay attention to the following details:

- For accurate display drawing, the dots-per-inch (DPI) resolution of the display PC that is used to run the experiment must match that of the development PC which is used to create the experiments. To check the DPI settings, click the right mouse button at a blank space on the Display PC desktop to open a dialog box for display properties settings. On Windows 7, click the "Make text and other items larger or smaller" link at the bottom of the page. Choose “Smaller – 100% (default)” option on the next screen. On Windows 10, users should use the default 100% display scaling. Click “Start menu -> Settings -> System -> Display”. Set the “Scale and Layout” to 100% (if you don’t see this option on your version of Windows, search for other similar options like “Change the size of text, apps and other items" in Display Settings).

- If the deployed experiment shows video clips, please make sure that codec used to test run the video experiment is also installed on the deployment computer as well; otherwise, the deployed experiment will not run.

Important: Please check out section 3.1.2 on steps that should be taken to maximize the real-time performance of the deployment computer.

Finally, when an experiment is in progress, please avoid hitting the Windows logo key on the keyboard so that the experiment will not be aborted for failing to lock the experiment graphics window. You may check out Section 7.10.6.4 for instructions to disable the Windows Logo Keys.

4.14 Converting Projects Between Windows and macOS

Experiment projects saved on the Windows operating systems can be opened with the same version or a newer version of the software on macOS, and vice versa. There are some exceptions on the transferability between the two families of operating systems.

- Audio playback and recording is done through the OS X driver on macOS. When converting a project created on Windows with audio playing (either through DirectX or ASIO driver) or recording (through the ASIO driver), the audio device will be reset to OS X. Conversely, the audio device will be reset to the ASIO driver when converting a Mac version of the experiment project with audio recording or playing.
- The two versions of the software may exhibit different levels of compatibility when playing video clips with .avi file extension. Specially, Experiment Builder

uses the ffmpeg video loader by default to play.avi files on macOS, and uses the vfw (video-for-windows) loader by default on Windows (though users can choose to use the ffmpeg video loader).
- USB1208-HS works on Windows 7 and 10, but not on macOS. The TTL device of an Experiment Builder project created in Windows using the parallel port will be reset to USB2TTL8 when opened in macOS.
- Some of the fonts may be missing when converting from the other operating system. Single-line texts or multi-line texts of the same font size will look smaller (by a factor of about 1.33) on macOS than on Windows due to different default DPI values used across the two operating systems.

4.15 Running Experiments in EB 2.3

Experiment Builder 2.3 updated the version of Python that is used to run experiments (from 2.3 to 2.7). This software update introduces some incompatibility with experiment projects created with an earlier version of Experiment Builder.

- Experiment Builder 2.3 supports both 32-bit and 64-bit Windows 7 and 10 while earlier operating systems such as Windows XP and Vista are not supported.
- Experiment Builder 2.3 adds support for recent versions of macOS (Sierra, High Sierra, Mojave, and Catalina); however, earlier versions of macOS (El Capitan and earlier) will not be supported.
- Please note that inconsistency in visual stimulus presentation timing/delayed stimulus onset has been observed in recent macOS. While users can use macOS to develop and debug experiments, they are advised to use Windows for actual data collection if display timing is critical.
- In both Windows and macOS, Experiment Builder uses the OpenGL graphics library for visual stimulus presentation in EB 2.3; DirectDraw graphics are no longer supported in Windows. Users will see the following error when running an experiment in DirectDraw graphics - "ERROR: error: 2512 Direct Draw is not supported in this version. Please switch 'Video Environment' to 'OpenGL' by going to Edit -> Preferences -> Experiments -> Devices -> DISPLAY. DISPLAY".
- Running deployed experiments from non-admin accounts in Windows now requires user name and password for an administrative account. The option of removing .manifest file used in the earlier version of the software is no longer available as the deployed exe now uses an embedded manifest.
- USB1208-HS works in Windows 7 and 10, but not on macOS. The TTL device of a project created in Windows using parallel port will be reset to USB2TTL8 when opened the project in macOS.
- Cedrus response pad works in both 32-bit and 64-bit Windows, but not in macOS.
- Support for using multiple keyboards or mice doesn't work in macOS.

- In version 2.3, the Drift Correction and Camera Setup actions will simply be skipped when running the experiment in the Dummy Mode without an actual connection to the eye tracker.
- Users will see a “No module named Image” error when opening an experiment that uses the Image module (“import Image”) in custom class. This error can be fixed by using the following line to the Custom class instead of “import Image”:

  ```
  import PIL.Image
  ```

  or

  ```
  from PIL import Image
  ```
- If accessing the link samples and events from eye tracker in custom class, users should check the “Force Enable Link Data” option in the EyeLink Device. Please also make sure the following code is called at the beginning of the trial to reset the link buffer.

  ```
  pylink.getEYELINK().resetAllDataBuffer(5000)
  ```

  Failing to do so will result in an error “Error: eyelinkAllData buffer is not initialized. Call resetAllDataBuffer to initialize eyelinkAllData”.

5 Experiment Builder Graphical User Interface

Experiment Builder uses a desktop framework that contains all the windows of the application. The following figure shows a typical graphical user interface (GUI) users will see in an experiment creation session. Below the menu and toolbar, the Experiment Builder desktop is divided into two areas: the Project Explorer Window on the left and the Graph Editor Window on the right. The Project Explorer Window lists all of the experiment nodes in a hierarchical fashion and allows users to select the nodes for review or modification. The Graph Editor Window allows users to create the experiment graph by dragging individual building blocks and making connections between components to form experiment flow.

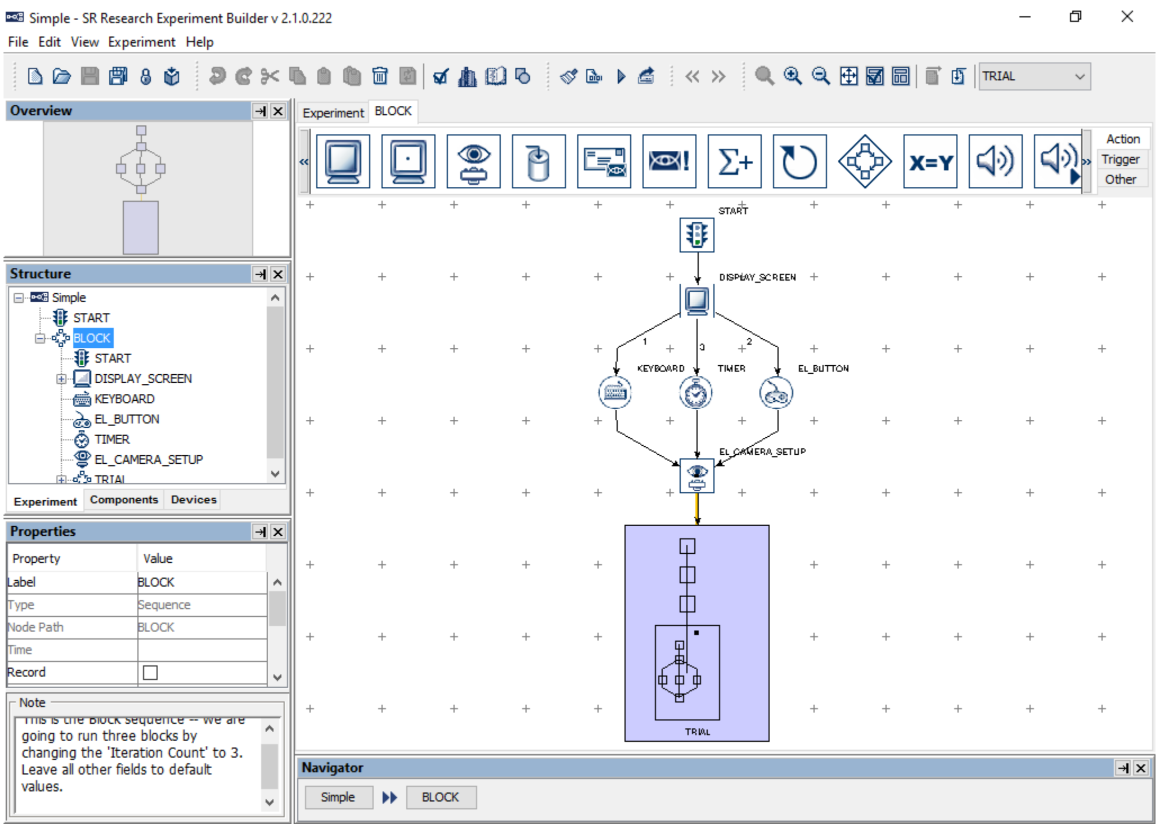


Figure 5-1. Sample Experiment Builder Interface.

5.1 Project Explorer Window

The Project Explorer Window allows users to select experiment nodes to be viewed, to modify the selected node's properties, and to configure default devices (e.g., eye tracker, display, audio driver, parallel port, and Cedrus Input settings). This window has four individual panels: Overview, Structure, Property, and Connections panels. Each of the individual sections can either be a docked ( ) panel of the Project Explorer Window or a free-floating ( ) window. In addition, each of the panels can be hidden or made visible from the "View" menu (see Figure 5-2).

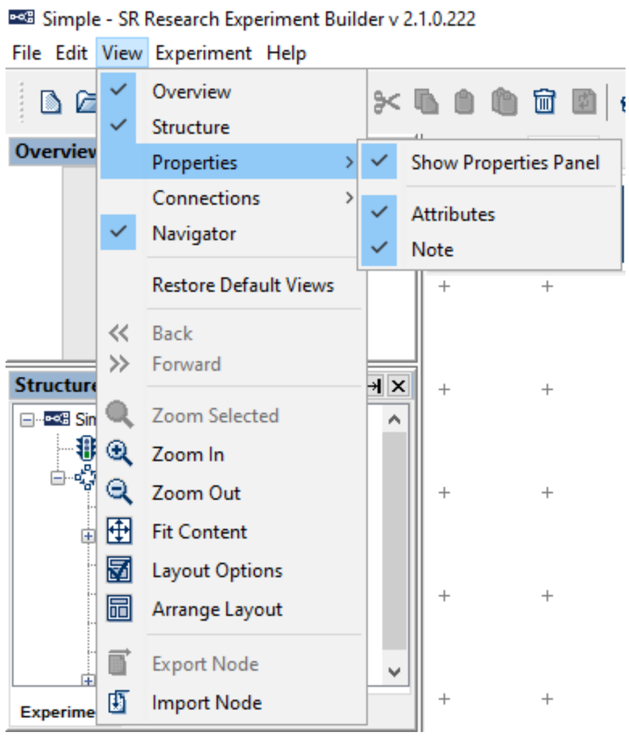


Figure 5-2. The View Menu.

The Overview panel (on the top) shows the graph layout of all components in the current level of experiment and highlights the currently selected node. The part of the graph within the shaded box is currently visible in the workspace of the Graph Editor Window. Users can choose to work on a different part of the graph by clicking on the shaded box and dragging it over to the intended region.

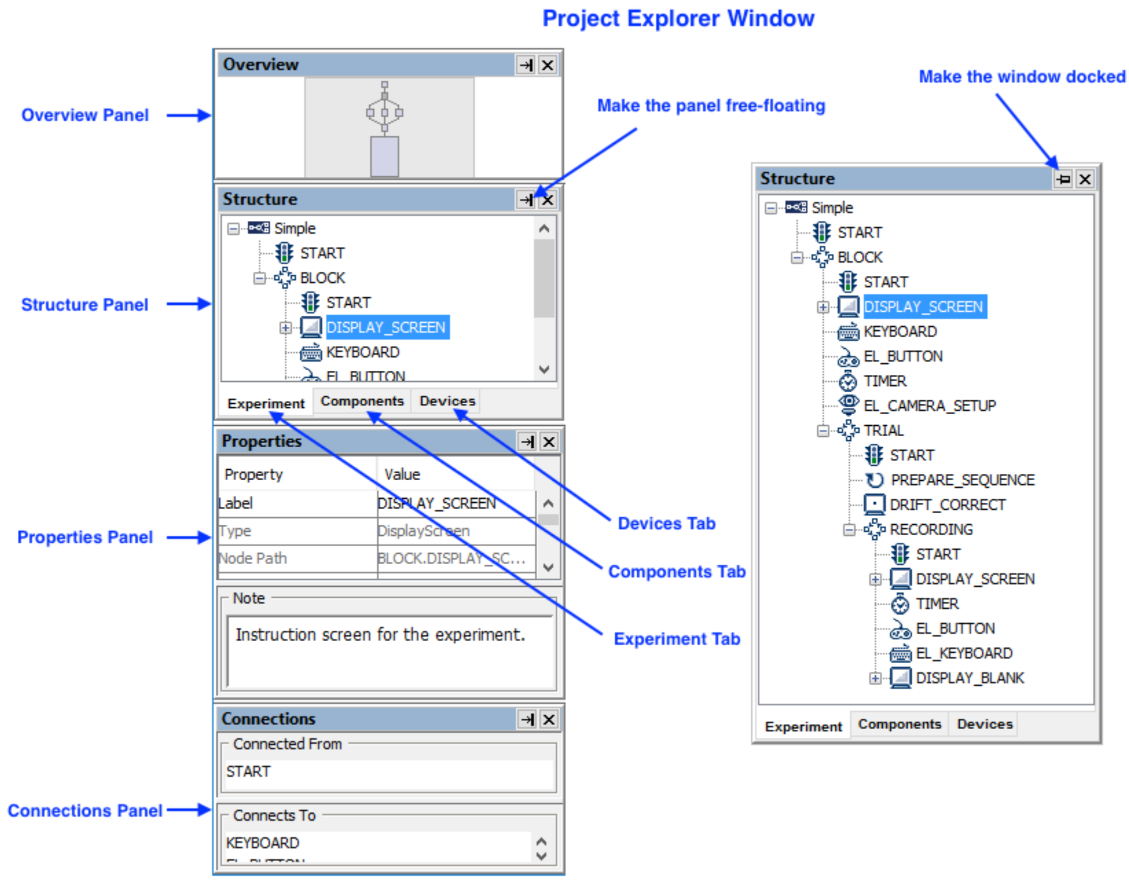


Figure 5-3. Components of the Project Explorer Window.

The Structure panel (in the middle) lists the nodes used in the experiment. This panel has three tabs: Experiment, Components, and Devices. The Experiment Tab (left panel, Figure 5-4) contains a hierarchical representation of the Experiment -- all component nodes are listed under the sequence in which they are contained. The Components Tab (middle panel, Figure 5-4) lists the nodes by type (triggers, actions, or other components). Similar to the interface used by Windows Explorer, if certain types of components are used, the folder containing those components can be opened (⊞) or closed (⊟). The Devices Tab (right panel, Figure 5-4) allows users to configure default settings for the EyeLink tracker, experiment display and other devices (see section 17 on Preferences settings).

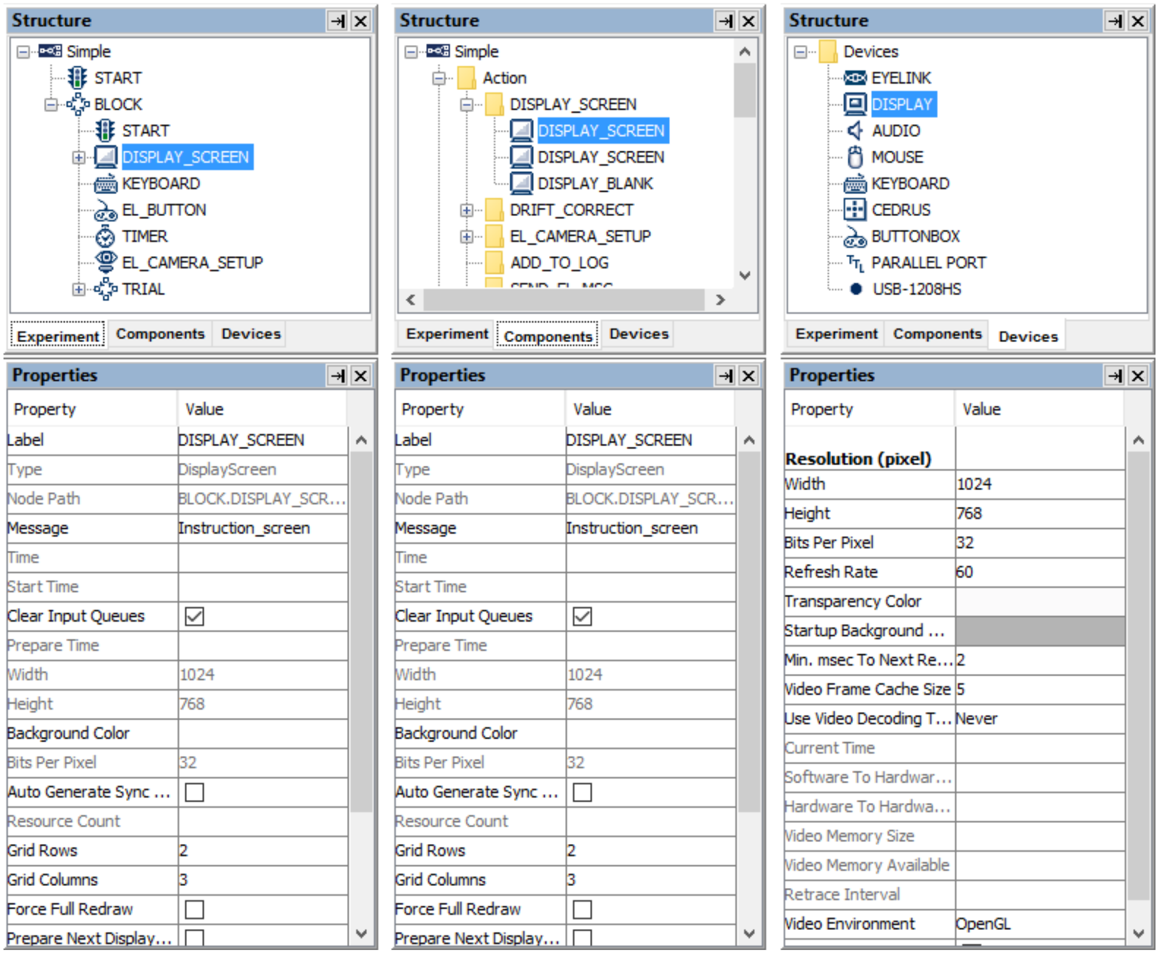


Figure 5-4. Different Tabs of the Structure Panel.

The Properties panel (at the bottom) displays properties of the selected item in the Structure panel. Users can review the current property values and make modifications if necessary. If a property field is grayed out (e.g., the "Time" property of the DISPLAY_SCREEN action), the value of the property cannot be directly modified, but may be referred to. All the other properties may be modified directly (see section 7.5 "Editing Properties of a Node").

The Note section of a properties panel allows users to add comments to the node.

The Connections panel lists all of the nodes that are connected to the current node. The "Connected From" section lists all of the nodes that target the current node, and the "Connects To" section lists all of the nodes that receive a connection from the current node.

5.2 Graph Editor Window

The Graph Editor Window provides an interface through which the experiment can be created graphically. This window is divided into four sections: the Component Toolbox, Work Space, Editor Selection Tabs, and Navigator (see Figure 5-5).

The Component Toolbox contains the basic building blocks of the experiment graph and allows users to select a desired component to be added into the experiment. The experiment components are grouped under three categories: Trigger (including timer, invisible boundary, conditional, EyeLink button, Cedrus Input, TTL, keyboard, mouse, voice key, fixation, saccade, blink, and sample velocity triggers), Action (display screen, perform camera setup, perform drift correction, send EyeLink message, log experiment data, send EyeLink command, update variable attribute, prepare sequence, add to results file, add to accumulator, send TTL signal, play/record sound, control sound playing/recording, terminate experiment, recycle data line, reset node, Net Station control, Brain Products control, as well as a NULL action), and Other (variable, results file, accumulator, and custom class).

The Work Space provides the graphical environment in which the experiment is generated. In an empty sequence, the Work Space area contains a START node to which actions and triggers can be connected. Users can drag selected experiment elements from the Component Toolbox and drop them into the work space, then make connections to and from other components. Users can select individual items in the Work Space to edit their properties.

The Editor Selection Tabs and Navigator provide convenient shortcuts for selecting a display screen or an experiment sequence to work on. When an experiment involves several different layers of sequences (for example Blocks → Trials → Trial Recording), the Navigator at the bottom of the graph editor window indicates the current layer the user is working on. Users can switch to work on a higher-level layer by clicking one of buttons in the Navigator corresponding to the higher-level sequences. All sequences and display screens opened in the experiment, as well as the project output screen, are listed as individual Editor Selection Tabs above the Component Toolbox for direct access. To dismiss Editor Selection Tabs, right-click a tab, then select either “Close” to close just that tab, or “Close Others” to close all except the clicked tab and the top-level “Experiment” tab.

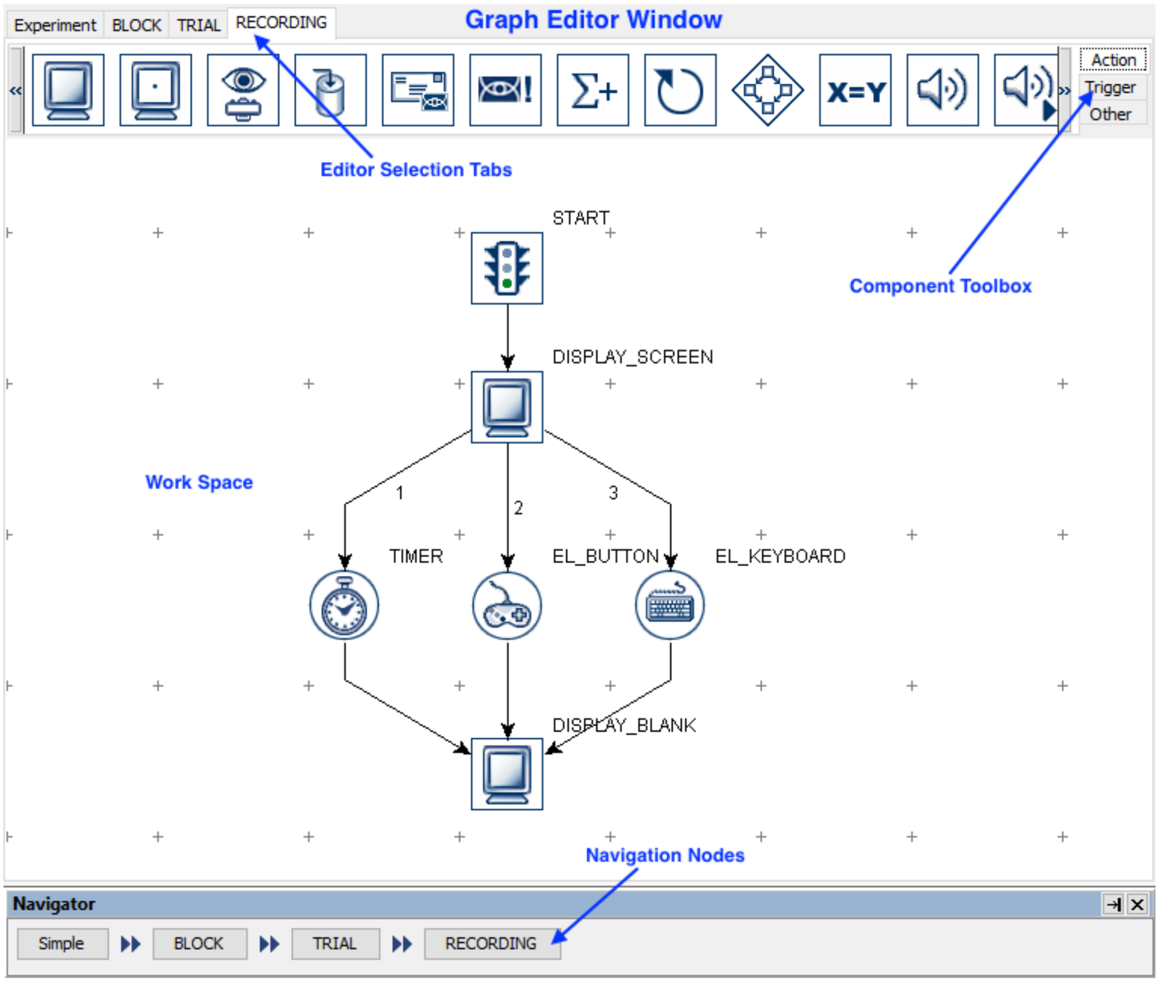


Figure 5-5. Components of the Graph Editor Window.

5.3 Application Menu Bar and Toolbar

The Experiment Builder application menu bar and toolbar contain a list of common operations. Most of the operations can also be performed by keyboard shortcuts or by using buttons on the application toolbar.

5.3.1 File Menu and Tool Buttons

Commands that affect creating, opening, saving, packaging, or closing the Experiment Builder sessions are located here (see Chapter 4 for details).

Operation	**Shortcut (Windows)**	**Shortcut (macOS)**	**Function**
New	Ctrl + N	⌘ + N	Creates a new experiment project.
Open	Ctrl + O	⌘ + O	Opens an existing experiment project.
Recent			Reopens a recent Experiment Builder project.
Save	Ctrl + S	⌘ + S	Saves the current experiment project.
Save As			Saves the experiment project to a different directory.

Lock Unlock Project			Click the closed icon to lock a currently unlocked project, or the open icon to unlock a currently locked project.
Package	F5	Ctrl + Shift + P	Used to compress the experiment project into an .ebz file for file sharing, etc.
Unpack	F3	Ctrl + Shift + U	Used to extract the experiment project from a compressed .ebz file.
Set Restore Point			Sets a restore point for the project so that users can revert the project's state to that point in time.
Restore			Reverts the project's state to that of a previous point in time.
Exit		⌘ Q (under "Experiment Builder" menu)	Closes the Experiment Builder application.

5.3.2 Edit Menu and Tool Buttons

The Edit menu contains commands such as copy, paste, cut, delete, and undo. It also contains tools for resource library management, node group organization, and preference settings (see Chapter 17).

Operation	**Shortcut (Windows)**	**Shortcut (macOS)**	**Function**
Undo	Ctrl + Z	⌘ + Z	Undoes the last action performed.
Redo	Ctrl + Y	⌘ + Y	Redoes or repeats an action.
Cut	Ctrl + X	⌘ + X	Removes a selection from the project and places it into the clipboard.
Copy	Ctrl + C	⌘ + C	Puts a copy of a selection to the clipboard.
Paste	Ctrl + V	⌘ + V	Inserts the previously copied item from the clipboard to the current position.
Paste Multiple	Ctrl + M	⌘ + M	Inserts several copies of the previously copied item from the clipboard to the current position.
Delete	Delete	⌘ + Delete	Removes the selection from the current location.
Refresh Custom Class	Ctrl + H		Refreshes the Custom Class files (i. e., reparses the contents of the files). This tool is useful to users who use an external editor to edit the content of custom classes.
Preferences	F4	⌘ + ,	Shows a list of preference settings for Experiment Builder.
Library Manager	Ctrl + L	⌘ + L	Used to load in image, audio, interest area set, video, custom class, or movement pattern files.
Reference Manager	Ctrl + R	⌘ + R	Tabulates the source, property, and value of each reference used in the experiment graph (see section 10.5).
Node Groups	Ctrl + G	⌘ + G	Allows users to rearrange the layout of the components in the component toolbox.

Select All	Ctrl+ A	⌘ + A	Selects the entire contents of the active window.

5.3.3 View Menu

The View menu contains commands that display or hide panels in the Project Explorer Window, or change the layout of the experiment graph.

Operation	Function
Overview	Display the Overview panel.
Structure	Display the Structure panel.
Properties	Display the 'Attributes' and/or 'Note' sections of the Properties Panel.
Connections	Display the 'Connects To' and/or 'Connected From' sections of the Connections Panel.
Navigator	Display the "Navigator" panel in the Graph Editor Window.
Restore Default Views	Restore the default layout of the windows and panels.
Back	Go back to the previously selected/viewed node.
Forward	Move forward to a previously selected/viewed node.
Zoom Selected	When one or more components in the graph are selected, zoom in on the selected items.
Zoom In	Zoom in towards the center of the work space.
Zoom Out	Zoom out so that more items can be displayed in the work space.
Fit Content	Zoom in or out so all the components in the work space are displayed.
Layout Options	Configure the layout of components when "Arrange Layout" is applied.
Arrange Layout	Rearrange the graph components in an orderly manner.
Export Node	Export the selected node(s) to an .ebo file so they can be shared.
Import Node	Import nodes from an .ebo file into the current experiment project.

5.3.4 Experiment Menu and Tool Buttons

The Experiment Menu contains commands that are used to compile and run the experiment, clean up the experiment project, and to create a deployed version of the experiment (see Chapter 4 for details).

Operation	Shortcut (Windows)	Shortcut (macOS)	Function
Clean	F7	Ctrl + Shift + C	Used to clean up the experiment project.
Build	F9	Ctrl + Shift + B	Used to compile the experiment.
Test Run	F11	Ctrl + Shift + R	Used to test run the experiment from the Experiment Builder application.
Deploy	F12	Ctrl + Shift + D	Used to generate deploy code so that the experiment can be executed as a standalone program.

5.3.5 Help Menu

The Help menu contains the Experiment Builder Help document as well as licensing and product release information (see Chapter 3 for details).

Operation	Shortcut (Windows)	Shortcut (macOS)	Function

Contents	F1		Displays the online help (htlm version of this document) of the Experiment Builder application.
About			Displays the release information for this copy of the software.
License			Displays license information for this copy of Experiment Builder

6 Designing an Experiment in Experiment Builder

This chapter introduces the general concepts of experiment design in Experiment Builder: hierarchical organization of events in an experiment, flow diagram, and attribute referencing. It also provides an overview of Experiment Builder components (triggers, actions, sequences, and other nodes) and linking rules for the experiment graph.

6.1 Hierarchical Organization of Experiments

One of the important concepts in SR Research Experiment Builder is the hierarchical organization of events in an experiment. A typical experiment can be dissected into several levels along a hierarchy of Experiment → Blocks → Trials → Trial Runtime / Recording. All of the events within each level of this hierarchy can be conveniently wrapped in a loop (called a Sequence in Experiment Builder). This allows the whole sequence to be connected to other objects as a unit and be repeated several times in a row.

The following figure illustrates a common high-level EyeLink experiment architecture. To create an experiment, users need to create several nested sequences, add a list of actions and triggers to each sequence, and make necessary connections between components to form the experiment flow. In this example, the top-most level of the experiment (Experiment Sequence) contains a greeting message or instruction screen followed by a sequence representing blocks of trials (Block Sequence), and then a goodbye or debriefing message at the end of the experiment. Within each repetition of the Block Sequence, users first perform camera adjustments, calibration and validation, and then run several trials (Trial Sequence). Every iteration of the Trial Sequence starts with pre-recording preparations (e.g., preloading image, audio, video resources, clearing trigger data, sending some simple drawing graphics to the tracker screen, flushing log file) and drift correction followed by the trial recording (Recording Sequence), and finally displaying feedback information if necessary. The Recording Sequence is responsible for collecting the eye data and is where visual and auditory stimuli are presented. Response collection from the participant is also performed in the Recording Sequence.

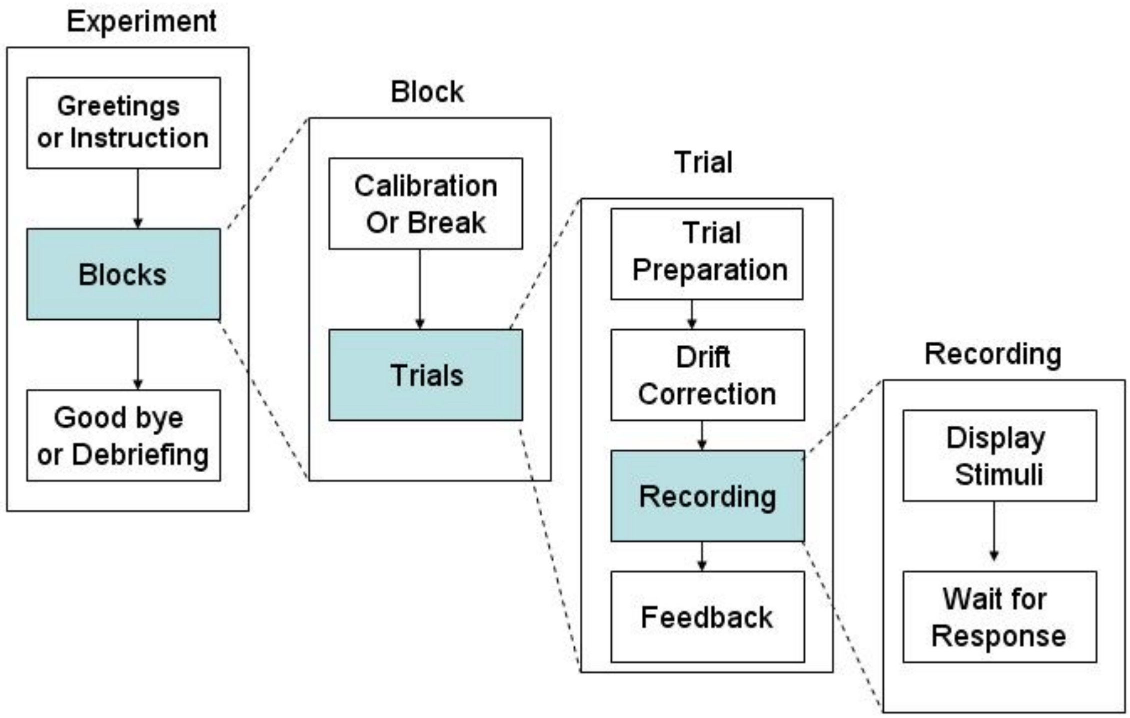


Figure 6-1. Hierarchical Organization of Events in an Experiment.

6.2 Experiment Graph: Flow Diagram

Experiment Builder uses an intuitive flow diagram interface for experiment creation - the whole experiment generated can be called a graph. Users can drag and drop experiment components into the work space of the Graph Editor Window. These experiment components include triggers and actions that represent individual events and preconditions in the experiment. An Action tells the computer to do something (e.g., display a screen or play an audio clip), whereas a Trigger represents some preconditions that must be met for the experiment to continue past that point. Experiment components are connected to each other using arrowed lines that represent sequence and dependency relationships (i.e., X must be done before Y can be done). The connection of experiment components forms the flow of the experiment. The following figure illustrates a very simple experiment sequence with gaze-contingent manipulation.

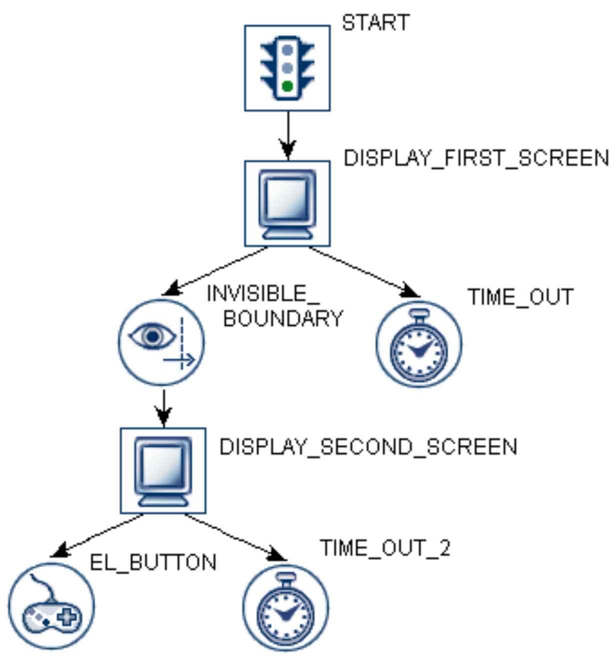


Figure 6-2. Sample Experiment Sequence.

In this example, the experiment sequence starts with a DISPLAY_FIRST_SCREEN action, which draws graphics to the computer display. Now the sequence constantly monitors two Triggers until one of the Triggers is satisfied: an INVISIBLE_BOUNDARY trigger and a TIME_OUT. The INVISIBLE_BOUNDARY is triggered if the participant's gaze falls within a pre-specified region of the screen whereas the TIME_OUT is triggered if a specified amount of time (e.g., 30000 milliseconds) has passed since DISPLAY_FIRST_SCREEN was drawn.

If TIME_OUT is triggered, the sequence ends since the TIME_OUT Trigger does not connect to any subsequent experiment components. However if INVISIBLE_BOUNDARY is triggered, DISPLAY_SECOND_SCREEN action is performed and new graphics are drawn to the computer screen.

Now the sequence monitors two new Triggers: a TIME_OUT_2 trigger and an EL_BUTTON trigger. The EL_BUTTON trigger fires if the participant presses a button on the EyeLink button box. TIME_OUT_2 is triggered if a pre-specified duration has elapsed since the second display was drawn. The sequence ends when either of the triggers (EL_BUTTON and TIME_OUT_2) becomes true.

Important: Note that in the above example, once the DISPLAY_SECOND_SCREEN Action has been performed the TIME_OUT and INVISIBLE_BOUNDARY Triggers are no longer monitored; only the Triggers connected to the last processed Action are monitored.

6.2.1 Adding Components to an Experiment

To add individual components to the workspace of the Graph Editor, first choose the corresponding node group of the Components Toolbox by clicking on the Trigger, Action, or Other tab. Left-click on the icon of the desired component and drag the selected item to the desired location in the work space, then release the mouse button. For a description of any component, simply hover the mouse cursor over the icon

6.2.2 Linking Experiment Components

The flow of an experiment sequence moves from the default "START" node to one or several triggers or actions and then to other triggers or actions, and so on. This requires users to connect two nodes with arrowed line to establish a directional or dependency relationship between a "Source" node and a "Target" node.

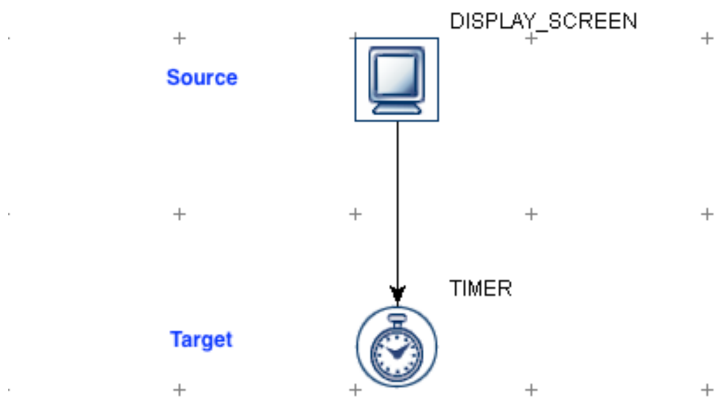


Figure 6-3. Connecting Between Source and Target Components.

To make a connection from a Source node to a Target node, left-click on the Source node and drag the mouse to the Target node, then release the mouse button. To cancel a connecting operation in progress, press the "ESC" key. To remove a connection between two experiment nodes, click the connecting line until it is highlighted in yellow, and then press the "Delete" key on a Windows keyboard (Command ⌘ + Delete together on macOS) or select the button on the application tool bar.

6.2.3 Linking Rules

The connection between a Source node and a Target node is governed by a set of rules:

1) A node cannot be connected to itself.
2) You cannot connect from the source node to the target node more than once.
3) The START node cannot be a Target (i.e., it cannot receive a connection from other nodes in a graph). The START node can target to an action, trigger, or sequence.
4) A Source node cannot have more than one Target Action; unless it is a Conditional Trigger in which case each conditional branch cannot Target more than one Action node.
5) A Source node can target many Trigger nodes.
6) A Source node cannot target a Trigger node and an Action node at the same time.
7) A Sequence node cannot target a Trigger node.

8) A Target trigger node cannot receive connections from multiple source trigger nodes.
9) A Source node cannot target multiple Sequence nodes. That is, the current version of Experiment Builder does not support parallel processing.
10) A Drift Correct Action or Camera Setup Action cannot target any Trigger.
11) Storage space elements (Accumulator, Variable, and Results File) cannot be Source or Target Nodes (i.e., never directly connected to other nodes).
12) Certain node types, such as Fixation, Saccade, Invisible Boundary, and Sample Velocity Triggers, can only be added to a sequence that has the "Record" checkbox ticked.
13) Drift Correct and Camera Setup Actions cannot be added to a sequence that has the "Record" checkbox enabled.
14) A Trigger cannot be the target of an action and a trigger at the same time.

6.3 Actions

Action nodes instruct the computer to do something, for example, to display a screen or play a sound. One or multiple actions can be added to a sequence, depending on the complexity of the experiment. For example, a recording sequence showing a static page of text may just require a single display screen action whereas an experiment studying change detection necessitates several display screen actions to present alternating screens at a fixed interval. SR Research Experiment Builder supports a set of actions listed in the following table.

	Display Screen	Used to show a set of 2D graphics on the computer screen. Please follow Chapter 8 “Screen Builder” to modify the content of the screen.
	Camera Setup	Displays the EyeLink camera setup screen for the experimenter to perform camera setup, calibration, and validation.
	Drift Correction	Performs an EyeLink drift correction by using a fixation point at a known position to correct for small drifts in the calculation of gaze position that can build up over time. This is particularly useful when using the pupil-only mode of EyeLink. On the recent versions of eye trackers (e.g., EyeLink 1000, 1000 Plus, Portable Duo), a drift check will be performed instead, in which no correction is applied to the gaze data.
	EyeLink Command	Sends a text command to the EyeLink tracker through the Ethernet link for on-line tracker configuration and control.
	EyeLink Message	Writes a text message to the EyeLink eye tracker. The text is millisecond time stamped and is inserted into the EyeLink EDF file.
	Add to Log File	Allows users to add text to a log file for experiment debugging.
	Prepare Sequence	Performs preparatory operations for a sequence (e.g., preloading image or audio files, drawing feedback graphics on the Host PC, and re-initializing trigger settings) to ensure real-time performance and better recording feedback.
	Add to Accumulator	Adds a number to an Accumulator object.
	Add to Results File	Used to output data to a tab-delimited Results File.

	Update Attribute	Updates the value of a Variable or an attribute of an experiment component.
	Send TTL Signal	Sends a TTL signal via the parallel port or other data ports.
	Reset Node	Allows users to pick a node in the experiment and reset its data.
	Terminate Experiment	Used to terminate the experiment project programmatically.
	Recycle Data Line	Instructs the experiment sequencer to run the current data source line again at a later time.
	Play Sound	Plays a .WAV audio file.
	Play Sound Control	Stops, pauses, or unpauses a specified Play Sound action
	Record Sound	Records audio to a .WAV file. Only supported with an ASIO-compatible sound card in Windows or in macOS.
	Record Sound Control	Stop, pause, unpause, or abort the current sound being recorded. Only supported with an ASIO-compatible sound card in Windows or in macOS.
	Execute	Executes a method defined in a Custom Class Resource.
	Null Action	A dummy action used primarily for the purpose of controlling experiment flow and cleaning cached trigger data.
	ResponsePixx LED Control	An action used to turn on/off the LEDs on the ResponsePixx Button box.
	Biometric TTL	Sends TTL signals to biometric devices, and controls start/stop recording for selected devices
	Net Station Control	Controls Net Station recording operations and sends events to Net Station.
	Brain Products Control	Controls Brain Products EEG recordings and sends event markers to the BrainVision Recorder.

6.4 Triggers

A Trigger is some condition that must be met for the experiment flow to continue past that point. Triggers are used by Experiment Builder to control the transition from one Action to another, or to end a sequence itself. For example, in a simple reaction-time experiment, following the onset of the stimulus display a speeded response from the keyboard or a button box can be used as a trigger to end the trial. In a change-detection experiment, the time delay serves as a trigger to make the transition from one display screen to another (and therefore controls the exposure duration of a display screen). In a gaze-control experiment, a trigger for display change can be elicited when the eye enters or leaves a pre-specified invisible boundary. Experiment Builder supports the following set of triggers:

	Timer	Fires when a specified amount of time elapses. Timers can be used to add a delay between actions and/or triggers, and to control the maximum amount of time a node can last.
	Keyboard	Fires when a specified key is pressed.
	Mouse	Fires when a mouse button is pressed and / or when the mouse cursor falls within a specified region of the screen.

	TTL	Checks TTL input to the input ports (e.g., parallel port or USB 1208HS box) of the display computer and fires when a specified TTL signal is received.
	Cedrus Button	Fires when a specified button on the Cedrus response pad is pressed.
	EyeLink Button	Fires when a specified button on the EyeLink button box is pressed.
	Boundary	Fires when gaze position falls inside or outside of a pre-specified invisible boundary, either after a single sample or a minimum duration. Boundary triggers can be used to implement display changes based on eye positions.
	Fixation	Fires when a fixation falls inside or outside of a specified region of the display for a certain amount of time.
	Saccade	Fires when a saccade to a specified region of the display is detected.
	Blink	Triggers when a blink event (start or end of the blink) is detected.
	Sample Velocity	Implements a fast saccade detection algorithm by checking the velocity and acceleration information on a sample-by-sample basis. The Sample Velocity Trigger fires when the sample velocity and acceleration values exceed or fall below their respective thresholds.
	Conditional	Fires when one or two conditional evaluations are met. The Conditional trigger may connect to two different target nodes, depending on whether the condition evaluates to True or False. This is useful to implement conditional branching in a graph when several conditions are possible.
	Voice Key Trigger	Triggers when ASIO input exceeds a pre-specified threshold. Only supported with an ASIO-compatible sound card or in macOS.

6.5 Other Node Types

Experiment Builder also supports other components: Variable, Results File, and Accumulator. These components mainly function as a storage of experiment data. Note that these objects are never connected to other components in an experiment in the Graph Editor Window. Instead, they are used and updated within the experiment by attribute referencing (see section 6.7).

Σ	Accumulator	Used to keep numeric values and do statistical analysis on the accumulated data. The Accumulator is a circular list, so items added to the list last are kept in case of an overflow.
	Results File	Provides a columnar output of selected variables.
i	Variable	Used to store data during run time.
	Custom Class Instance	Used to create a new instance of a custom class

6.6 Sequence

As the experiment loop controller, a Sequence is used to chain together different actions and triggers and execute them as a group. Therefore, Sequence itself can be considered as a complex action. To implement the hierarchical organization of events in an experiment, Experiment Builder allows one graph containing the triggers and actions to be nested within another graph. In a typical experiment, users need to add a few nested sequences so that the implementation of blocking, trial, and recording can be done efficiently (see Figure 6-4 for an example).

Given the repetitive nature of the sequence component, a data source can be attached to a sequence node to supply different parameters for each sequence iteration. The data source is similar to a spreadsheet. Each column of a data source contains a variable label and each row contains values for the variables. For a typical experiment created in Experiment Builder, users will create prototypical trials and to supply the actual parameters for individual trials in a data source attached to the trial sequence. During experiment runtime, individual lines can be read from the data source, providing the actual parameters for each trial, by setting relevant node attributes as references to data source columns (see section 10 "References").

	Sequence	A controller for experiment flow. Used to chain together different Actions and Triggers and execute them in a group or to simply modularize a set of experiment components.

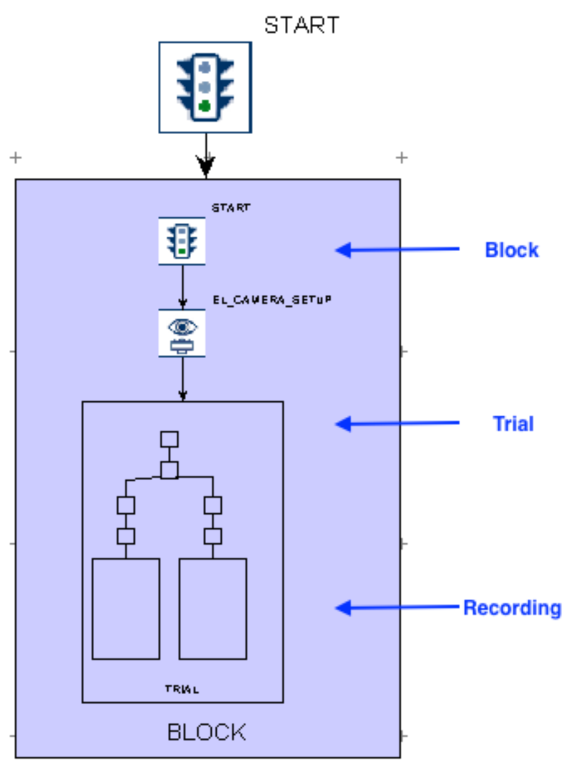


Figure 6-4. Nested Sequences in an Experiment.

6.7 References and Equations

Experiment Builder uses "references" to link or bind an attribute of one experiment component to the attribute of another component. References (see Chapter 10) are a critical part of Experiment Builder, providing much of the flexibility to the application.

For example, assume a sequence has two nodes, X and Y, and node X has attribute A_X and node Y has attribute A_Y. If attribute A_X is set to reference A_Y, then the value of A_X will always be equal to the value of A_Y. In this example it is said that A_X is the "referencing" attribute and A_Y is the "referenced" attribute. Even if A_Y changes value during the experiment, A_X will always reflect the current value of A_Y.

A reference is represented by a string that starts and ends with an @ symbol in the attribute editor for an experiment node. For example @X.A_X@ is a reference to the A_X attribute of node X. @Y.A_Y@ is a reference to the A_Y attribute of node Y. If the reference is to a node attribute that is not in the same sequence as the referencing node, the reference will also contain the graph path to the referenced node.

Users can refer a variable or an attribute of one node to an attribute of another node (trigger, action, or sequence), a variable, or a data source column. Users can also create more complex equations, which may include a combination of values and/or references. In most cases the data type of the referring attribute must match that of the referenced attribute.

As a more concrete example of using references, imagine that a user needs to show some text on the screen. In the Properties table of the text resource, the user can enter the text to be displayed directly into the "Text" property field (see left panel of Figure 6-5). This will result in the same text being presented in each iteration of the sequence. This static approach is fine for things like presenting a fixation cross, but will be problematic when the user needs to display different text across trials. An alternative, more flexible approach, is to have the "Text" attribute refer to a column of a data source. Then on each iteration of the sequence, the resource will use different text values as defined in the data source.

In addition to setting values dynamically, references can be used to access the value of attributes of an action or a trigger. In the above example, the width and height of the text shown on the screen will change dynamically across trials. To know the exact text dimension in one trial, the user can refer to the "Width" and "Height" properties of the text resource.

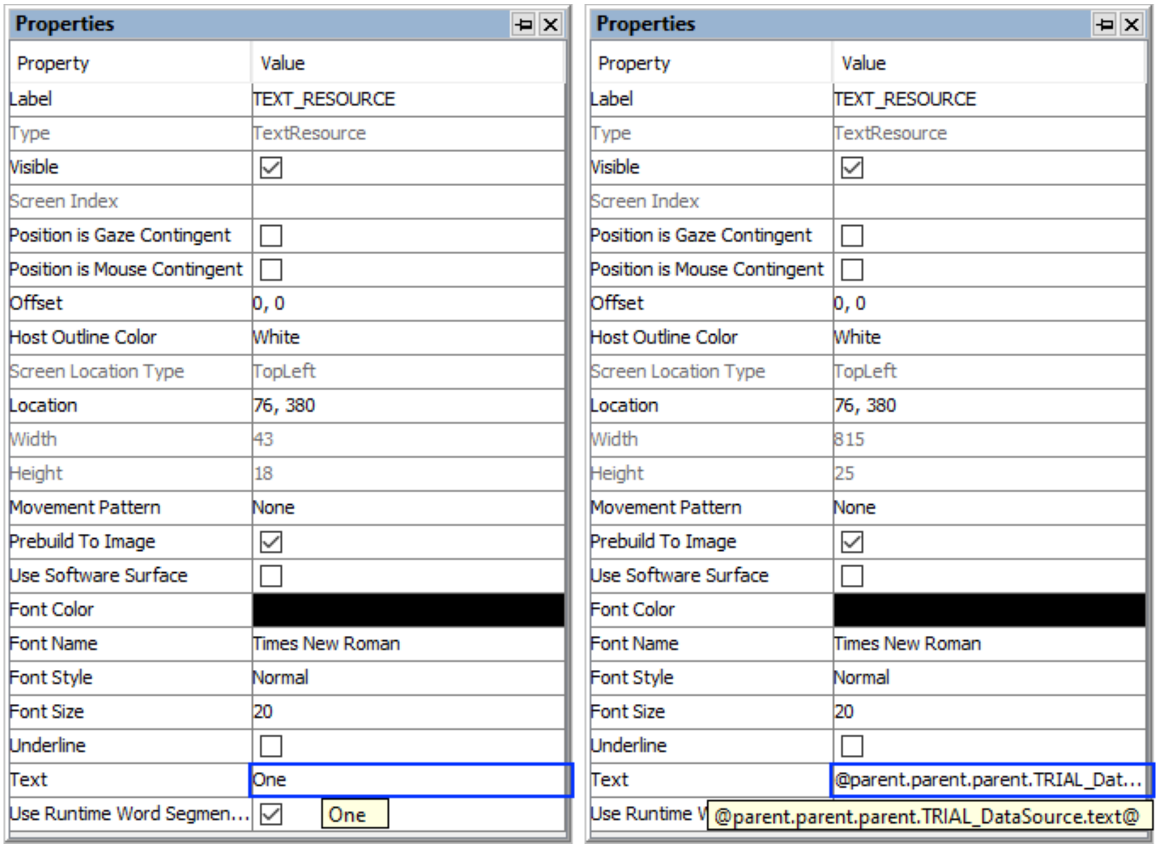


Figure 6-5. Using a Reference to Update Text to Be Displayed.

7 Experiment Graph and Components

The Component Toolbox in the Graph Editor Window contains the basic building blocks for building experiments. To create an experiment, users need to add necessary components into different sequences of the experiment and make connections between those components. Following this, the properties of the individual components should be reviewed and modified as necessary. The current chapter reviews the use and properties of the individual components in the toolbox.

7.1 Graph Editing Operations

Experiment Builder is an interactive tool, allowing users to create a new experiment graph from scratch and to modify an existing graph. With the Graph Editor Window, users are able to add/remove Experiment Builder component nodes, add/remove the connection between nodes, modify the attributes of nodes, and so on.

The following lists common operations used in editing a graph in Experiment Builder. Most of the operations can be performed by keyboard shortcuts, by using buttons on the application toolbar, or by options in the "Edit" menu.

- **Insert a new node:** Find the component to add in the Action, Trigger, or Other tab of the Component Toolbox. Left-click on the icon of the desired component, then drag it to the desired location in the work space, and release the mouse button.

- **Cut:** To remove a selection from the project and place it into the clipboard, first select the nodes to be cut, then press the Ctrl + X keys together (Command ⌘ + X in macOS). Alternatively, select the nodes, then right-click and select "Cut" from the popup menu.

- **Copy:** To copy a selection to the clipboard, select the nodes to be copied, then press the Ctrl + C keys together (Command ⌘ + C in macOS). "Copy" from the popup menu.

- **Paste:** To paste the previously copied or cut items from the clipboard to the current location, press the Ctrl + V keys together (Command ⌘ + V in macOS). Alternatively, right-click in the graph area, and select "Paste" from the popup menu.

- **Paste a selection Multiple times:** To paste the contents of the clipboard multiple times, press Ctrl + M (Command ⌘ + M in macOS). Alternatively, right-click in the graph area, and select "Paste" from the popup menu. Enter the number of copies to paste and click “OK”

- **Delete:** Select the nodes to be removed and press the "Delete" key (Command ⌘ + Delete in macOS). Alternatively, select the nodes, then right-click and select "Delete" from the popup menu.

- **Undo:** To undo the last action performed, press Ctrl + Z (Command ⌘ + Z in macOS).

7.2 Node Connection

The flow of an experiment sequence moves from the default "START" node to one or several triggers or actions and then to other triggers or actions, and so on. This requires users to connect two experiment nodes with an arrowed line to establish a directional or dependency relationship between a "Source" node and a "Destination" node.

7.2.1 Connection: Create, Cancel, and Delete

To connect a Source node to a Destination node, left-click on the Source node, then drag the arrow to the Destination node and release the mouse button. (Note that if the Source node is selected, clicking and dragging from the Source node will move the node rather than drawing a connection. To de-select a node, simply click an empty space in the graph area.) To cancel a connecting operation in progress, press the "ESC" key. To remove a connection between two nodes, click the connecting line so it is highlighted in yellow, and press the "Delete" key (Command ⌘ + Delete in macOS), or click the “Delete” button in the application toolbar.

7.2.2 Connection Order

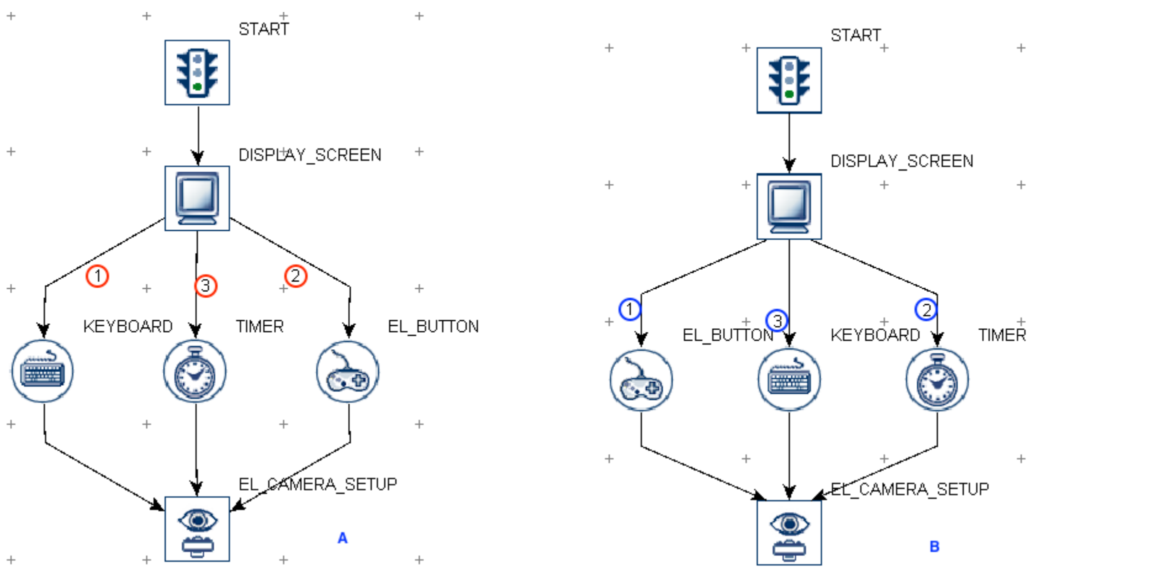


Figure 7-1. Connection Order.

When several triggers are connected to a common source node, a small number is drawn by each edge in the graph (see Figure 7-1). This number represents the order that triggers will be evaluated. In the above example (Left Panel), the keyboard trigger will be evaluated first, then followed by the EyeLink button trigger, and then by the timer trigger. To change the connection order, delete the connection arrows between the source and target nodes, and then reconnect the nodes in the desired order. For example, if a user deletes the connection between DISPLAY_SCREEN and KEYBOARD, the remaining connections increase in priority, so the EyeLink button trigger is evaluated first, and then the Timer trigger. If the user re-connects the keyboard trigger to the display screen, the keyboard trigger is now the third to be evaluated (see Right Panel).

7.3 Node Exporting and Importing

Experiment Builder allows users to share data between several experiment creation sessions by importing and exporting nodes. Users can select nodes in the graph and export to a .ebo file. The user can later import the .ebo file into another session. The following explains in detail how to share data between Experiment Builder sessions by exporting and importing.

7.3.1 Exporting

1) Select the node or sequence to be exported. Please make sure that only one node or sequence is selected. (To export multiple nodes, place all the nodes into a single sequence, then export this sequence.)
2) Click the right mouse button to bring up a popup menu, and select "Export Node" (see Figure 7-2). If the "Export Node" option is grayed out, please make sure that only one node or sequence is selected. Alternatively, click the Export button () on the application toolbar.

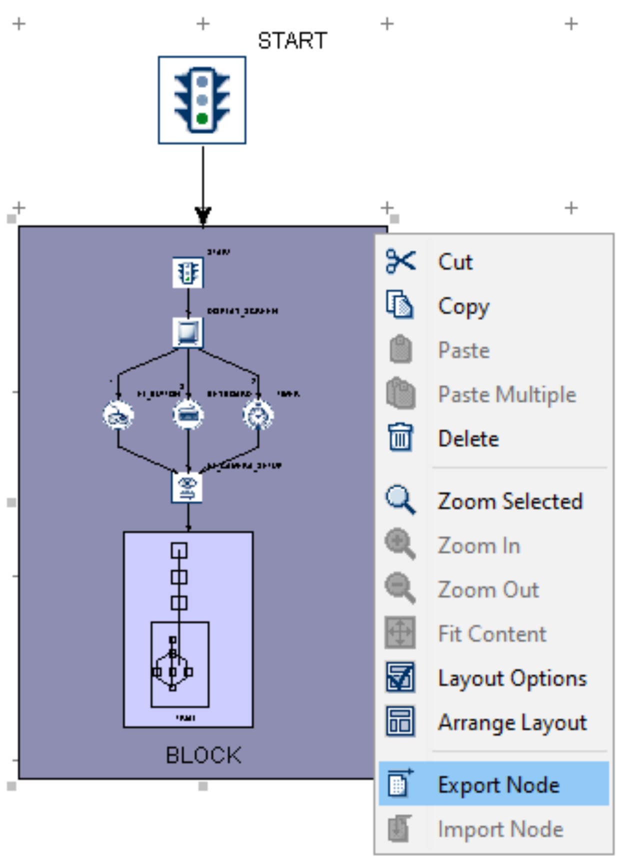


Figure 7-2. Exporting Node.

3) In the following "Export" dialog box, select the directory where the node should be exported, enter the export file name, and then click the "OK" button.

• If the node to be exported contains references to other nodes or data source columns that are not part of the selection, a "Reference Maintenance" dialog (see the figure below) will be displayed to enumerate all of the references that will be removed. Click the "Save" button to save the information to a text file if desired, then click the "OK" button to continue.

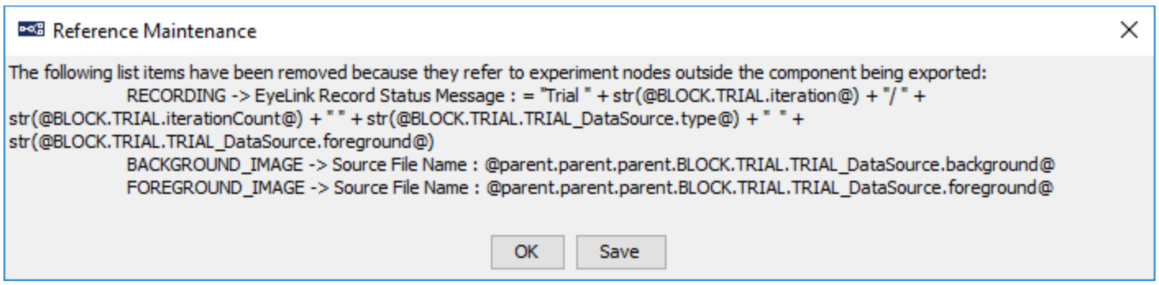


Figure 7-3. Reference Maintenance.

• A dialog box will ask whether to export all necessary library files—any image, sound, video files, etc., used in the selected node or sequence. Click "Yes" to include all necessary library files in the exported file. Click "No" to export only the node or sequence itself, excluding any library files. Click "Cancel" to abort the export process.

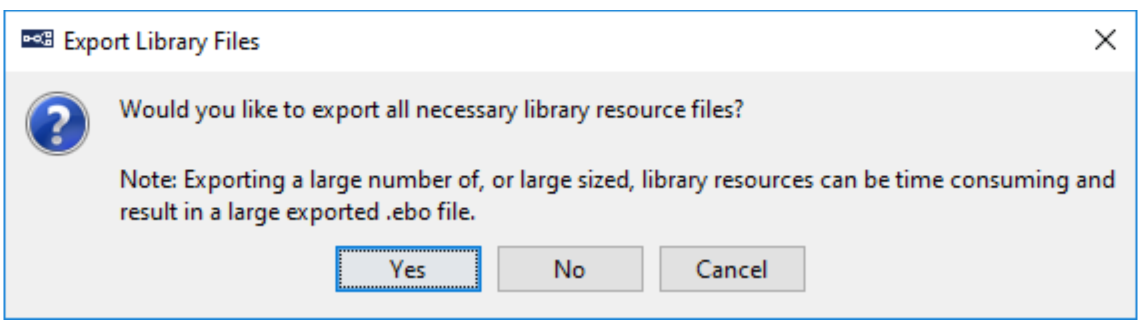


Figure 7-4. Export Library Files.

7.3.2 Importing

1) Go to the intended sequence level and click anywhere in the blank area of the workspace to make sure that no node or sequence is selected.
2) Click the right mouse button and select "Import Node" (see Figure 7-5). If the "Import Node" option is grayed out, please make sure no node is currently selected. Alternatively, click the Import button ( ) on the application toolbar.

3) In the following "Open" dialog box, go to the directory where the exported node file is located, select the ".ebo" file, and click "Open".

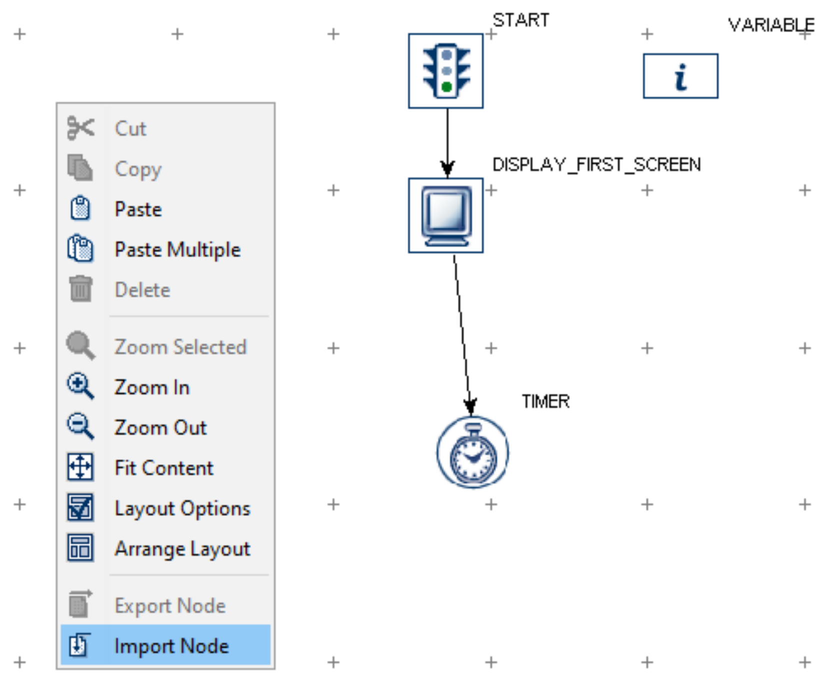


Figure 7-5. Importing Node.

7.4 Layout of Nodes in Work Space

The Work Space in the Graph Editor Window functions like a flow diagram editor which components are dragged onto and connected. If a large number of items are added, the work space may get cluttered. The Experiment Builder graphic user interface allows for automatic node arrangement and zoom-in or zoom-out operations to create high-quality drawings of a graph for ease of reading.

To rearrange the layout of items in an orderly manner, place the mouse cursor in a blank area of the Work Space, click the right mouse button to bring up a popup menu, and choose "Arrange Layout" (see Figure 7-6). From the menu, users can also zoom in or out the current graph, or to make the current graph fit the screen. The following table lists of the options available from the popup menu.

Operation	Function
Zoom Selected	When one or more components in the graph are selected, zoom in on the selected items.
Zoom In	Zoom in towards the center of the work space.
Zoom Out	Zoom out so that more items can be displayed in the work space.
Fit Content	Zoom in or out so all the components in the work space are displayed.
Layout Option	Configure the layout of components when "Arrange Layout" is applied.

Arrange Layout	Rearrange the graph components in an orderly manner.

Note: To perform "Zoom Selected", first select the nodes to zoom to, then right-click in the work space to bring up the menu.To perform the other operations listed in the table, first click a blank area in the work space to ensure no nodes are selected, then click right-click in the work space to bring up the menu and select the operation to perform.

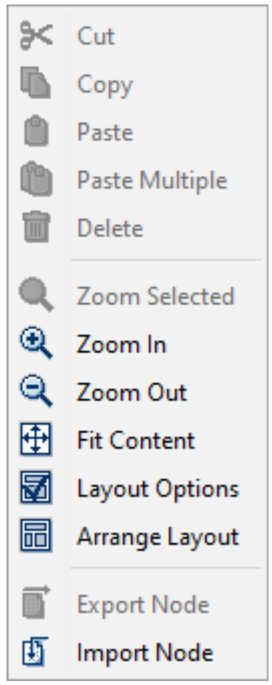


Figure 7-6. Choosing Layout of Components in Work Space.

7.5 Editing Properties of a Node

After a component is added into the workspace, some of its default property values can be modified according to the requirements of the experiment. For example, the maximum "duration" of a TIMER trigger is set to 4000 milliseconds by default. This may not be a desired value in an actual experiment and therefore users may need to set a different value for that field. To edit the properties of a node, first click the node so it is highlighted by a green border.

When one experiment node is selected, its properties and corresponding values are displayed in the property panel for review and modification. Depending on the property, it can be edited in one of the following ways:

- If a properties field (e.g., "Time" and "Start Time" of various actions) is grayed out then the value of the property is "read-only" and cannot be directly modified.
- If the value field of a property contains a check box (e.g., "Record" property of a sequence), that property can be either enabled or disabled by clicking the check box.

- If a dropdown list appears after doubling clicking the property value field (e.g., "Duration Type" property of the Timer trigger), make the selection from the list.
- For some properties (e.g., "Label" of an action), the value can be modified by double clicking on the value field, entering the desired value, and then pressing the ENTER key to register the change.
- If a button box appears at the right side of the attribute cell after selecting the field (see Figure 7-7), the property field may also be edited with Attribute Reference Editor (see Chapter 10).

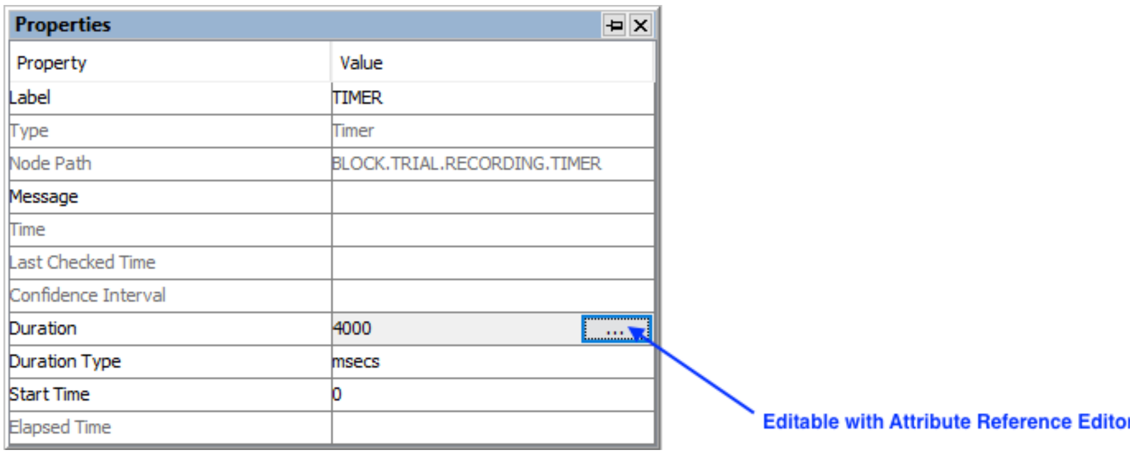


Figure 7-7. Property Field Editable with Attribute Reference Editor.

In the following sections of this chapter, a set of symbols are used to indicate the properties of each attribute of an experiment component:

#	Attribute is read-only and is not directly modifiable
*	Attribute can not reference another attribute (Attribute Reference Editor is not available for the property)
NR	The attribute cannot be referenced by other component attributes.
¶	Attribute value can be selected from a dropdown list
†	Attribute is a Boolean value. True if the box is checked; false if unchecked.

All other attributes can be modified either by entering the value directly in the edit field or by setting a reference in an attribute editor dialog box. Those fields can also be accessed for attribute references.

7.6 Experiment Node

Clicking on the topmost node () of the structure list in the Project Explorer Window displays the properties of the experiment project in the property panel.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the Experiment
Type #	NR		The Experiment Builder object type for this node (Experiment).
EyeLink DV	.dataViewerVar	List of	The list of variables and Data Source columns

Variables	iables	Strings	to be in the EDF file as trial condition data for Data Viewer. Click on the value field of this property to bring up a dialog box allowing the user to configure these variables. This attribute is only available in an EyeLink experiment (i.e., the "EyeLink Experiment" setting of the Experiment Preference is enabled).
Time Out	.timeout	Integer	The maximum time (in milliseconds) the experiment should run. If 0, the experiment will not time out.
Created Date #	.createdDate	String	Time and Date when the experiment was first created.
Last Modified Date #	.lastModifiedDate	String	Time and Date when the experiment was last modified.
Session Name #	.sessionName	String	Name of the experiment session. This is the string input in the "Session Name" dialog box when running the experiment. The value is reported by the built-in variable "SESSION_NAME_".
Test Run Command Line Arguments	.cmdargs	List of String	Extra parameters that can be passed to the experiment program. When running the deployed experiment from the command line prompt, users may enter an extra string following the {experiment}.exe command. Extra parameters can be added to Test Runs under "Preferences -> Build/Deploy".
License ID #	NR		ID of the license key. "Demo" if the Experiment Builder software is unlicensed.
Save Messages †	.saveMessages	Boolean	Whether the messages associated with any triggers or action should be logged in a messages.txt file saved in the "results\{session name}" directory. This attribute is available in Non-EyeLink Experiments only. If enabled, the "Message" property will be available in most of the triggers and actions.
Read-Only †	NR	Boolean	Check this box to prevent any changes to the experiment project from being saved.

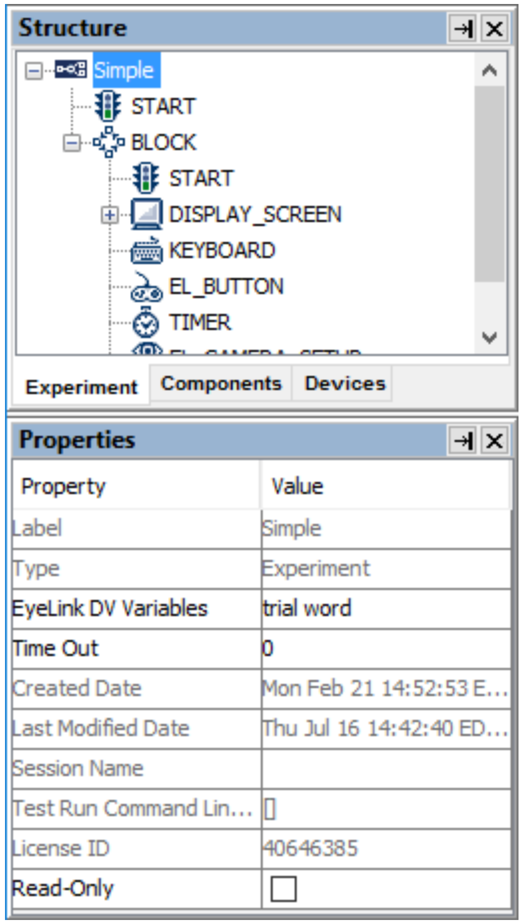


Figure 7-8. Properties of the Experiment Node.

The "EyeLink DV Variables" property is used to send trial condition messages to the EDF file so that users know exactly under which conditions each trial recording was performed. The list of possible variables includes columns in the experiment data source (see Chapter 9 "Data Source") as well as new variables created by the user (see Section 7.11.1 "Variable"). Version 2.0 of Experiment Builder now automatically adds the variables and data source columns to the EyeLink DV Variables field. To remove some variables from the list, or to change the order of the variables, click on the value field of the property. A dialog box will allow the user to choose the variables to be recorded and to reorder them in the list.

To have the experiment to time out after certain duration, enter the time out value in milliseconds into the "Time Out" field.

7.7 Sequence

A sequence () object encapsulates different actions and triggers, allowing users to perform editing operations (cut, copy, delete, paste) on all of the items contained within the sequence together. It also allows users to execute them in a loop and repeat the execution several times if required. In a typical experiment, users need to add a couple of nested sequences so that a blocking-trial-recording hierarchy can be implemented efficiently. In an EyeLink experiment, the "Record" attribute should be ticked for one of the sequences (usually the “innermost” sequence) so eye-tracker data can be collected.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the Sequence node. The default label is “SEQUENCE”.
Type #	NR		The Experiment Builder object type for this node (Sequence).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Time #	.time	Float	Display computer time (in milliseconds from the start of the experiment) when the sequence is executed.
NTP Time#	.ntpTime	Float	NTP server time when the sequence is executed.
Record †	.record	Boolean	Whether EyeLink recording should be done within the sequence. Recording is done for each iteration of the sequence, starting at the beginning of the sequence and ending after executing the nodes along one of the flow paths. The default setting is “False” (box unchecked). This attribute is only available in an EyeLink experiment.
Recording Pause Time	.recordingPauseTime	Integer	Time (in milliseconds) to wait to execute the sequence after the recording starts (typically set as 20). This attribute is only available in an EyeLink experiment with the “Record” attribute of the current sequence enabled.
EyeLink Record Status Message	.eyeLinkRecordStatusMessage	String	This supplies the title at the bottom of the Host PC recording screen. This attribute is only available in an EyeLink experiment with the "Record" setting of the current sequence enabled.
Custom Trial ID Message	.customTrialID Message	String	This property is be available if the "Enable Custom Trial ID Message" option in "Edit -> Preferences -> Experiment" is enabled. Instead of the default value of "TRIALID", users can send out a customized Trial ID message that can be used by their analysis software. For compatibility with EyeLink Data Viewer, we recommend starting this message with a "TRIALID " token, followed by whatever trial-specific condition data they wish to send.
Trial Result	.trialResult	Integer	A value used to encode the result of the current recording trial, send as a message at the end of the trial (formatted as "MSG {timestamp}

			TRIAL_RESULT {value}" in the EDF file). The result value is 0 by default, but can be set to reference values from the trial, e.g., from a participant response or a variable that codes trial accuracy. This attribute is only available in an EyeLink experiment with the "Record" setting of the current sequence enabled.
Is Real Time †	.isRealTime	Boolean	When set to True, sets the application priority to real-time mode. Real-time mode is only maintained for the duration of the sequence. The default setting is “False” (box unchecked). It may take up to 100 milliseconds, depending on the operation system, for the real-time mode to stabilize. Also note that on some (older) computers, real-time mode locks keyboard and mouse inputs from occurring. For recent computers with dual- or multicore processors, the keyboard and mouse will function properly in the real-time mode.
Iteration #	.iteration	Integer	The current iteration of the sequence execution.
Iteration Count	.iterationCount	Integer	Total number of times (1 by default) the sequence should be executed.
Split by	.splitBy	List of Integers	Specifies the number of iterations to be executed each time the sequence is encountered. If the list is empty, all possible trials will be executed each time the sequence is encountered. Multiple values can be added to the list separated by commas to execute a different number of trials each time (e.g, “[4, 16, 16]” will execute 4 trials the first time, then 16 trials the second and third time). All values in the list should be integers no less than 1.
Data Source	NR		Allows the user to specify custom parameters for different iterations of the sequence. Click on this field to open a Data Source editor. The "Columns: X/Rows: X" reports the number of parameters (Columns) and iterations (Rows) in the Data Source.
Freeze Display Until First Display Screen †	.freezeDisplayUntilFirstDisplayScreen	Boolean	If checked, the display will not be updated until the call of the first Display Screen action within the sequence (to avoid some undesired display changes). The field should be checked in most experiments.
Prompt for Dataset File †	.promptForDatasetFile	Boolean	If checked, Experiment Builder will display a prompt at the beginning of each session allowing the user to select a dataset file rather than using the values in the Data Source editor. If unchecked, Experiment Builder will use the values from the Data Source editor in the

			project.
Callback	NR		For an experiment project with custom class enabled, a method defined in the custom class can be run for every poll of the sequence. Similar to the EXECUTE action, a list of parameters will be displayed if a method is selected from a custom class instance. Please note that running this callback function may add an extra delay to sequence polling and it should be used with caution (please avoid running any callback function that takes a significant amount of time to finish).
Result #	NR		Result of the execution method.
Result Data Type #	NR		Type of the data returned by the execute method.

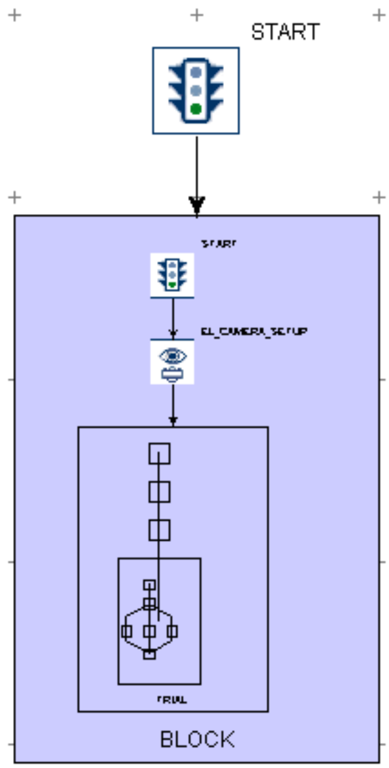
A recording sequence must be included in an EyeLink experiment. To specify a sequence as a recording sequence, select the sequence and tick the "Record" checkbox in the properties panel. This checkbox is only available in an EyeLink experiment, and only in sequences not already contained within a recording sequence.

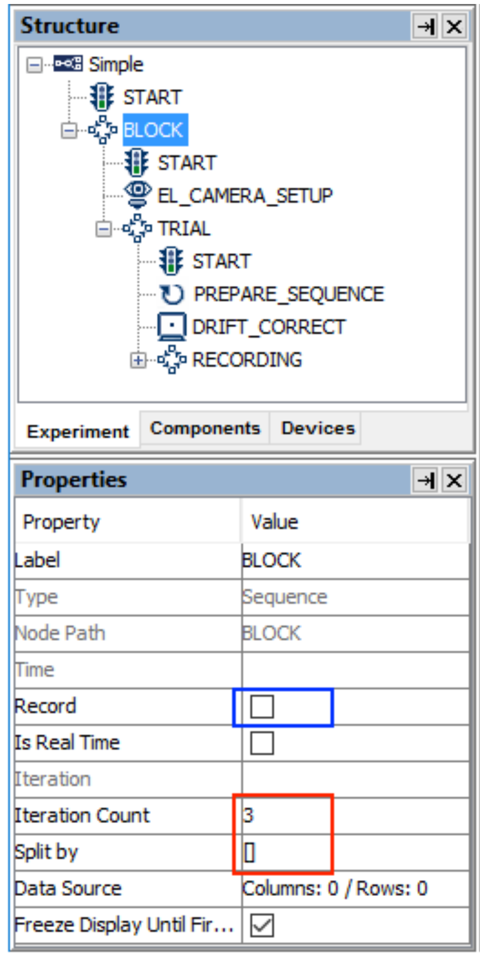
If the "Record" box is checked, users will see additional properties: "EyeLink Record Status Message" allows users to send a text message to be displayed at the bottom of the tracker screen, for instance, to inform the experimenter of the progress of experiment testing; and "Recording Pause Time" controls the delay in executing the sequence following the start of the tracker recording. To maximize real-time performance in data collection, users should have the "Is Real Time" box checked for the Recording sequence and include a prepare sequence action before executing the sequence.

The Recording sequence enables on-line access to gaze data, so all the eye-based triggers can be only used in a recording sequence—i.e., the invisible boundary, fixation, saccade, and sample velocity triggers. Conversely, the drift correction and camera setup actions cannot be used in a recording sequence.

7.7.1 Typical Use of Sequences in an Experiment

The following figure illustrates the use of sequences in a typical experiment. In this example, a RECORDING sequence that performs the actual eye-tracker recording is nested within a TRIAL sequence, which itself is nested within a BLOCK sequence. The "Record" field is checked in the RECORDING sequence but not in the BLOCK or TRIAL sequences. The RECORDING sequence also allows users to send a message (EyeLink Record Status Message) to the tracker screen so that the experimenter can be informed of the progress of the experiment.


START
BLOCK


Structure
Simple
START
BLOCK
START
EL_CAMERA_SETUP
TRIAL
START
PREPARE_SEQUENCE
DRIFT_CORRECT
RECORDING
Experiment
Components
Devices
Properties
Property
Value
Label
BLOCK
Type
Sequence
Node Path
BLOCK
Time
Record
Is Real Time
Iteration
Iteration Count
3
Split by
[]
Data Source
Columns: 0 / Rows: 0
Freeze Display Until Fir…

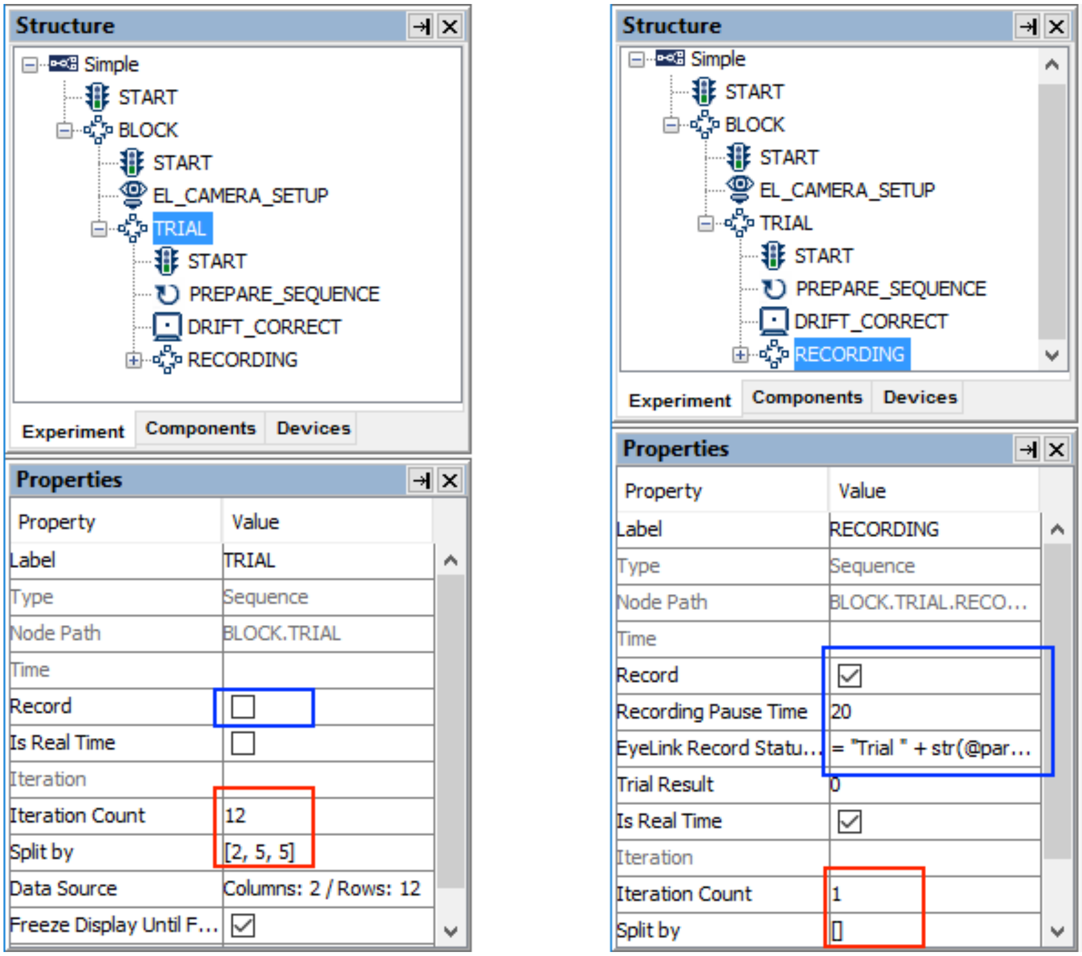


Figure 7-9. Using Sequences in an Experiment.

The iteration count of a sequence specifies the maximum number of times the sequence should be executed, while the "Split by" field allows users to flexibly configure the number of actual iterations to be executed. By default, the "Split by" field contains an empty list "[]", which means that all of the iterations should be executed each time the sequence is called. Users can add values to the split-by list to specify the actual number of iterations to be executed for each call of the sequence. This allows users to easily design experiments in which unequal numbers of trials are tested in different blocks. In the above example, the iteration count of the BLOCK sequence is 3 and the split-by list is empty. This means that the BLOCK sequence will be executed three times in total (i.e., 3 blocks). The total iteration count of the TRIAL sequence is 12 and its split-by field contains a list of [2, 5, 5]. This means that the TRIAL sequence will be executed two, five, and five times during the first, second, and last call of the BLOCK sequence. The iteration count of the RECORDING sequence is 1 and the split-by list is empty. This means that the recording sequence will be executed once for each call (in other words, once per trial). Therefore, the above graph indicates that this experiment has three blocks, which contains two, five, and five trials, respectively. Each trial will perform one eye-tracker recording.

7.7.2 EyeLink Recording Status Message

During data collection, the EyeLink Record Status Message can be used to display a text message at the bottom of the tracker screen, e.g., to inform the experimenter of the progress of the experiment, or to report trial condition information (so that the experimenter knows immediately which condition is being tested and therefore may be able to evaluate the performance of the participant). To configure the status message, select the recording sequence. Make sure that the “Record” property of the sequence is checked, otherwise the “EyeLink Record Status Message” property will not be displayed. Click the Value field of the EyeLink Record Status Message property, then click the […] button to bring up the attribute editor. Then enter the message string, making sure the string is shorter than 80 characters for an EyeLink II, 1000, 1000 Plus, or Portable Duo, and shorter than 40 characters for an EyeLink I (see Figure 7-10). Make sure to include only ASCII characters in the message screen, as non-ASCII characters will not be displayed properly.

For example, if a user has a data source with the variables “Trial” and “Word”, the record status message can be:

```
 ="Trial " + str(@parent.iteration@) + "/" +
str(@parent.iteratonCount@)+ "  " +str(@TRIAL_SEQ_DataSource.Word@)
```

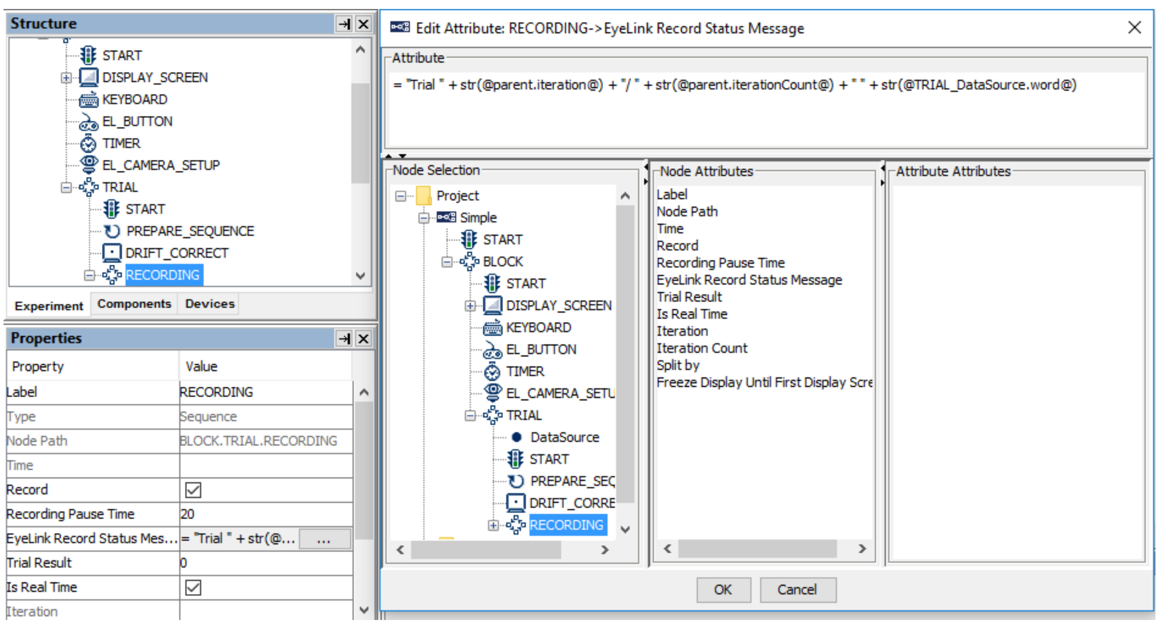


Figure 7-10. Creating Recording Status Message.

If the values for “.iteration” and “word” are “1” and “One” for the first trial and “.iterationCount” is 12, this will display “Trial 1/12 One” on the tracker screen.

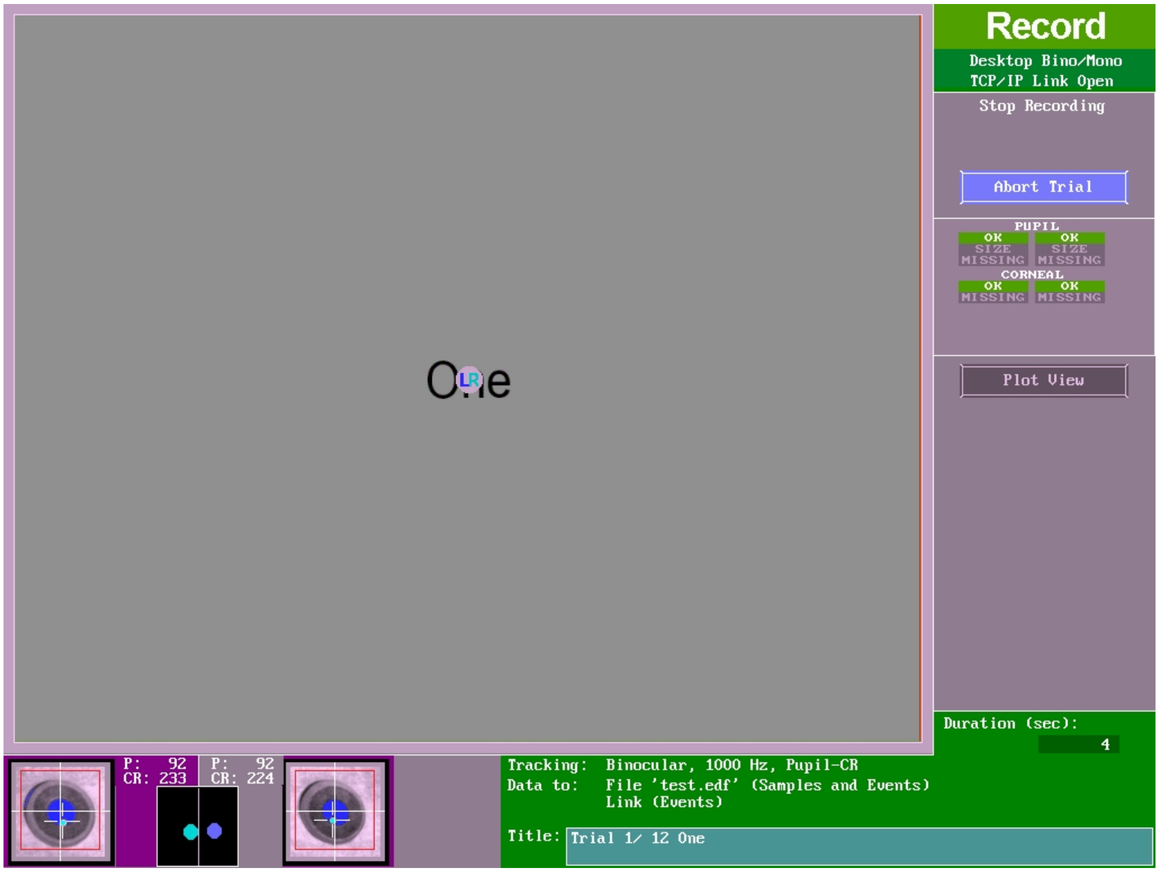


Figure 7-11. Sending the Recording Status Message to the Tracker.

7.8 Start Node

For each sequence in an experiment graph, the flow always begins with the default "START" node. Each sequence requires a connection made from the "START" node to a trigger or an action. The START node cannot receive a connection from other nodes.

Field	Attribute Reference	Type	Content
Type #	NR		The Experiment Builder object type for this node (Start).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Time #	.time	Float	Display computer time (in milliseconds from the start of the experiment) when the experiment flow starts.
NTP Time #	.ntpTime	Float	NTP server time when the experiment flow starts.

7.9 Actions

SR Research Experiment Builder supports a list of actions, such as displaying a screen, performing drift correction, performing camera setup and calibration/validation, sending a message to an EDF file or to a log file, preparing a sequence, sending a command, sending a TTL signal, updating variable values, adding to a results file, adding data to an accumulator, playing sound, recording sound, recycling a data source line, controlling EGI Net Station or BrainVision Recorder, or terminating the experiment. Actions can be accessed by clicking on the "Action Tab" of the Component Toolbox (see Figure 7-12). The following sections describe the usage and properties of each action type in detail.

Figure 7-12. Action Tab of the Component Toolbox.

7.9.1 Display Screen

The DISPLAY_SCREEN action () is used to show visual stimuli on a computer monitor. Double clicking on the newly added DISPLAY_SCREEN action will show a blank Screen Builder workspace for creating visual displays. Please follow Chapter 8 “Screen Builder” to modify the content of the screen.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the Display Screen action. The default value is “DISPLAY_SCREEN”.
Type #	NR		The Experiment Builder object type for this node (DisplayScreen).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with "Save Messages" attribute of the Experiment node checked) when display screen action is processed.
Time #	.time	Float	Display computer time (in milliseconds from the start of the experiment) for the start of the retrace when the screen was actually drawn/redrawn. **Important:** This is the field you should use to check for the time when the display is actually shown.
NTP Time	.ntpTime	Float	NTP server time for the start of the retrace when the screen was actually drawn/redrawn.
Start Time #	.startTime	Float	Display computer time (in milliseconds from the start of the experiment) when the display screen action is entered (so that the graphics can be prepared and shown). **Note:** the display screen is not shown yet by this time. Use the .time field instead to report the time when the display is actually shown.
Clear Input	.clearInputQueue	Boolea	If true, all events from input queues are flushed

Queues †	s	n	when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Prepare Time #	.prepareTime	Float	Actual time (in msec) used to prepare for the display screen action.
Width #	.width	Integer	The width of the display screen in pixels (1024 by default)
Height #	.height	Integer	The height of the display screen in pixels (768 by default)
Background Color	.backgroundColo r	Color	The background color of the screen. The default color is white (255, 255, 255).
Bits Per Pixel #	.bitsPerPixel	Integer	The number of bits (32 by default) used to represent the luminance and chroma information contained in each pixel.
Auto Generate Sync Messages †	.autoGenerateSyn cMessages	Boolea n	Whether or not to a send a default message ("SYNCTIME") when the display changes. This message will not be generated if the "Message" field is filled. The default setting is "false" (box unchecked).
Resource Count	.resourceCount	Integer	Number of resources included in the display screen action, not including screen background.
Grid Rows *	NR	Integer	When grid visibility is enabled in the Screen Builder, defines how many rows to draw in the grid (2 by default).
Grid Columns *	NR	Integer	When grid visibility is enabled in the Screen Builder, defines how many columns to draw in the grid (3 by default).
Force Full Redraw †	.forceFullRedraw	Boolea n	If checked, all resources on the display screen will be redrawn each time the screen is updated. If unchecked, only resources that require updating will be redrawn (e.g., mouse- or gaze-contingent resources, resources with, movement patterns, and any resources whose position or visibility has been modified since the last time the screen was drawn, as well as resources beneath them). This option is unchecked by default, which typically decreases the time required to update the screen. If the screen contains a large number of resources, however, performing a full redraw may sometimes be more efficient.
Prepare Next Display Screen	.prepareNextDisp layScreenAction	Boolea n	If the current display screen action is followed by one specific display screen action across all

Action			possible flow routes, checking this box will prepare the next display screen in advance for a faster display presentation. (If the current display screen may lead to multiple display screens or update attribute actions, checking this box will have no effect, as Experiment Builder does not know which screen to prepare.)
Estimated Prepare Time	.estimatedPrepare Time	Float	Time (in milliseconds) required to prepare for the display screen. This is typically set to the value of Default Estimated Prepare Time. The preparation time is influenced by screen resolution, computer video hardware, and whether the screen resources have been preloaded or not. Note that the Estimated Prepare time is useful only when a timer trigger is used before the display screen action. This allows the timer to pre-release for the preparation of the following display screen action.
Default Estimated Prepare Time #	.defaultEstimated PrepareTime	Float	Default time (in milliseconds) set for display screen preparation. Typically this is set to 1.5 times of a display refresh cycle. Note that the Estimated Prepare time is useful only when a timer trigger is used before a display screen. This allows the timer to pre-release for the preparation of the following display screen action.
Auto Update Screen	.autoUpdateScree n	Boolea n	If true (default), any changes to the current display screen will be updated automatically, without needing to enter the display screen action again. This applies to anything that modifies the currently visible screen (e.g., mouse- or gaze-contingent resources, resources with movement patterns, and any resources whose position or visibility has been modified since the last time the screen was drawn). If false, the screen is only updated when the display screen action is re-entered in the experiment flow. Note: If a static display is used (i.e., none of the onscreen resources change), turning off this option may improve timing performance (including faster trigger firing), as the program does not need to repeatedly check whether the display should be updated.
Send EyeLink DV Messages†	.sendEyeLinkDV Messages	Boolea n	If checked, writes messages ("!V DRAW_LIST" and "!V IAREA") to the EDF file for analysis with EyeLink Data Viewer. These messages will draw images and simple graphics in Data Viewer as the background for gaze data and record interest area data for the

			screen. This field is only available when the display screen action is contained in a recording sequence.
Use for Host Display †	.useForHostDispl ay	Boolea n	If checked, the current screen will be transferred to the Host PC as a bitmap or primitive drawings for online gaze feedback. This option works in conjunction with the "Draw to EyeLink Host" field of the PREPARE_SEQUENCE action. This attribute is only available in an EyeLink experiment.
Interest Area Set Name	.interestAreaSetN ame	String	If users have interest area set files, they can first add the interest area set files into the library manager, then set this field to the desired interest area set file. Please make sure the interest area file name does not contain a space or any non-ASCII characters. Returns "MISSING_DATA" if no value is set in this field. This attribute is only available in an EyeLink experiment.
Save Screen to Image	NR	Boolea n	If enabled, Experiment Builder will make a capture of the screen content when the DISPLAY SCREEN action ends. This can be useful to capture dynamic or non-prebuilt screen resources and provide proper integration for display visualization in Data Viewer. Please note, saving display content will take some time to complete, and therefore this option shouldn't be used in DISPLAY SCREEN actions where precise display timing is crucial.
Screen Capture Image Name	.screenCaptureIm ageName	String	Specifies the name of the screen capture file.
Use Saved Image For DV Integration	.useScreenCaptur eForDV	Boolea n	If enabled, Experiment Builder replaces the standard Data Viewer integration messages (based on the individual pre-built resources in the DISPLAY SCREEN action) with a reference to the name of the saved screen capture. This option is enabled by default.
Synchronize Audio †	.syncAudio	Boolea n	Allows a sound file to be played relative to the presentation of the screen. When checked, this will bring up a list of additional properties to specify the parameters of the sound playback. This option is available in macOS, and in Windows when the ASIO driver is used to play sound clips (see the "Audio Driver" setting in the Audio Device settings of the Structure panel).
Sound Offset	.soundOffset	Integer	Intended start time of the audio playing (in milliseconds) relative to the display onset. A 0 offset value means the audio and visual stimuli are presented at the same time, a positive offset

			means that the audio starts after the visual stimulus, and a negative offset means the audio starts before the visual stimulus.
Sound Time	.soundTime	Float	Display PC Time (in milliseconds from the start of the experiment) when the sound begins to play.

7.9.1.1 Reading Display Time

If the "message" property of the display screen action is filled, a message will be written to the EDF file (for an EyeLink experiment) or messages.txt file (for a non-EyeLink experiment) in the "results/{Experiment Session Name}" folder. The following is a sample output from one experiment session.

```
 5038.401 -2 DISPLAY_SCREEN_EVENTS
22220.512 PREPARE_SEQUENCE
22264.206 -15 DISPLAY_BLANK_INITIAL
23265.601 -14 DISPLAY_RED
23298.943 -14 DISPLAY_BLANK_RED
23398.964 -14 DISPLAY_GREEN
23432.382 -14 DISPLAY_BLANK_GREEN
```

The messages are written in the following format:

Time [Offset] Message_text

Where,

- "Time" reflects the time (in milliseconds) since the experiment was started for a non-EyeLink experiment or the Host PC time (EDF file time) since the EyeLink host program was started.
- "Offset" is an optional integer, which is subtracted from the above "Time" field to generate the real message time. For example, a message line of "2435806.072 -14 display_screen" means that the event the message was referring to (display_screen) actually happened at time 2435820.072 (= 2435806.072 - (-14)).
- "Message_text" is the text sent when the action is executed or trigger fires.

This means that in the above sample output file: The DISPLAY_BLANK_INITIAL was shown at time 22279.206, and DISPLAY_RED was shown at time 23279.601 (1000 following DISPLAY_BLANK_INITIAL). DISPLAY_BLANK_RED was shown at 23312.943 (33 msec following the onset of DISPLAY_RED). DISPLAY_GREEN was shown at 23412.964 (100 msec following the onset of DISPLAY_BLANK_RED). Finally, DISPLAY_BLANK_GREEN was shown at 23446.382 (34 msec following the onset of DISPLAY_GREEN).

7.9.1.2 Using Display Screen Actions

The following figure illustrates a simple experiment trial by displaying a screen and then waiting either for a button response from the participant, or for the sequence to end after a pre-specified amount of time set in the TIMER trigger. For the ease of data analysis (reaction time calculation, for example), users should record an EyeLink message to the EDF file when the display is presented. This can be done by entering a text message in the "Message" field.

In a trial with multiple display screens, each of the display-screen actions should send a unique Data Viewer integration message. In a recording sequence, users may enable the "Use for Host Display" button only for the primary display of the trial for gaze accuracy monitoring. Please add a PREPARE_SEQUENCE action before the recording sequence, with its "Draw to EyeLink Host" field enabled.

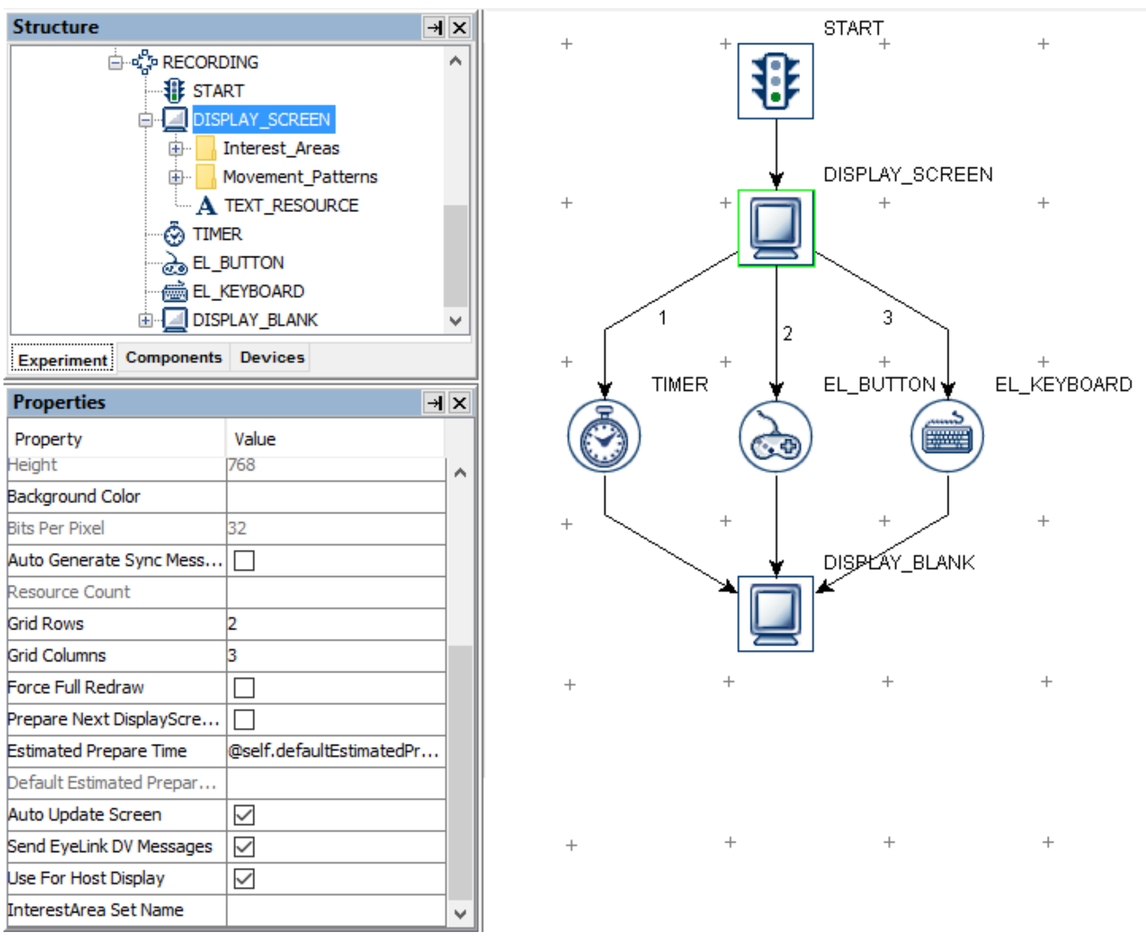


Figure 7-13. Using Display Screen.

7.9.2 Performing Drift Correction

For many experiments it can be beneficial to display a fixation point at the start of each trial or a set of trials so the participant's gaze can be checked against a known position.

EyeLink I and II eye trackers use this fixation point to correct for small drifts in the calculation of gaze position that can build up over time. Even when using the EyeLink II tracker's corneal reflection mode, a fixation target should be presented, and a drift correction allows the experimenter the opportunity to recalibrate if needed.

For the EyeLink 1000, 1000 Plus, and Portable Duo, a drift check, rather than a drift correction, will be performed by default. A drift check measures and reports the fixation error without actually correcting for it, and allows the experimenter to recalibrate if needed. To enable drift correction on these later trackers, users may add the line “driftcorrect_cr_disable = OFF” to the Final.ini file in the host directory or by sending an EyeLink Command at the beginning of the experiment.

Experiment Builder implements the drift correction/drift check feature using the Drift Correction action (). The display coordinate of the fixation target should be supplied. Usually this is at the center of the display, but can be anywhere that gaze should be located at the start of trial recording, for instance, in a line of text, the target could be positioned just before the first word.

When the experiment is tested in the Dummy Mode without an actual connection to the eye tracker, the Drift Correction action will simply be skipped.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the Drift correction action. The default value is “DRIFT_CORRECT”.
Type #	NR		The Experiment Builder object type for this node (DriftCorrection).
Node Path #	.absPath	String	The absolute path of the current node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file when the drift correction action is done.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the drift correction action is done.
NTP Time	.ntpTime	Float	NTP server time when the drift correction action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the drift correction state is entered (the drift correction is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not

			cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
X Location	.xLocation	Integer	X coordinate of the drift correction target in screen pixels. Typically this is center of the screen, but can be set to any other screen location.
Y Location	.yLocation	Integer	Y coordinate of the drift correction target in screen pixels. Typically this is center of the screen, but can be set to any other screen location.
Apply Correction	.applyCorrection	String	Whether a correction will be applied to the calibration mapping. If set to “Yes”, a true Drift Correction will be performed; if set to “No”, the tracker will perform a Drift Check, reporting the error without correcting for it; and if set to “Current” (default), the drift check or correction behavior currently selected on the Host PC will be used. This option is only available if when using an EyeLink 1000 (host software version 3.0 or later), EyeLink 1000 Plus, or Portable Duo.
Allow Setup †	.allowSetup	Boolean	If checked, the Camera Setup screen on the host software can be called up by pressing the ESC key during drift correction so that calibration problems can be corrected. The default setting is "True".
Draw Drift Correction Target †	.drawDefaultTarget	Boolean	By default (the box is checked), the drift correction procedure clears the screen, draws the fixation target, and clears the screen when done. Sometimes, however, the user may wish to draw the target themselves, e.g., if the drift correction is part of the initial fixation in a task, and the target should stay on the screen after drift correction. If this field is unchecked, the user should draw the drift correction target in a DISPLAY_SCREEN action before the drift correct.
Clear Target At Exit †	.clearTargetAtExit	Boolean	If checked, the screen will be cleared to the background color after the drift correction finishes; otherwise, the drift correction target remains on the screen. This option is valid only if the "Draw Drift Correction Target" option is enabled; it has no effect if the drift correction drawing is supplied by the users.
Foreground Color	.foregroundColor	Color	Color in which the drift correction target is drawn.
Background Color	.backgroundColor	Color	The color to which the entire display is cleared before calibration. The background color should match the average brightness of your

			experimental displays as closely as possible, as this will prevent rapid changes in the subject's pupil size at the start of the trial. This will provide the best eye-tracking accuracy as well. Using white or gray backgrounds rather than black helps reduce pupil size and increase eye-tracking range, and may reduce retinal afterimages.
Use Animation Target †	.useAnimationTa rget	Boolea n	If checked, a video clip can be used as the drift correction target. Users should preload the intended video clip into the library manager.
Animation Target ¶	.animationTarget	String	The name of the video clip used as the drift correction target. The video to be used as the animation calibration target should be a type 1 .avi file, containing both video frames and audio stream. This field is only available if the "Use Animation Target" option is checked.
Animation Play Count	.animationPlayCo unt	Integer	Total number of times the video clip will be played before the calibration target is accepted. If -1, the clip will be played continuously (looping). This field is only available if the "Use Animation Target" option is checked.
Apply Transparency	.applyTransparen cy	Boolea n	If checked, transparency manipulation will be applied to the video resource similar to that which is done on the image resources (i.e., pixels with the same color value as the transparency color will not be displayed). We recommend keeping the default setting (unchecked).
Use Custom Target †	.useCustomTarge t	Boolea n	If checked, drift correction will use a custom target supplied by the user. The target should be a small image file, with a "feature"/interesting part appearing in the center of the image.
Custom Target *	.customTarget	String	The name of the image file that is used for drawing the drift correction target. The image files should be preloaded into the library manager. This property is only available if "Use Custom Target" is checked.
Target Outer Size	.outerSize	Integer	Diameter of the outer disk of the default drift correction target in pixels. This property is only available if "Use Custom Target" is not checked.
Target Inner Size	.innerSize	Integer	Diameter of the inner disk of the default drift correction target in pixels. This property is only available if "Use Custom Target" is not checked.
Use Custom Background †	.useCustomBack ground	Boolea n	If checked, drift correction will use the custom background image supplied.
Custom	.customBackgrou	String	The name of the image file that is used to draw

Background *	nd		the drift correction background. The image file should ideally be a full-screen image and must be preloaded into the library manager. This property is only available if "Use Custom Background" is checked.
Target Beep ¶	.targetBeep	String	Sets sound to play when the drift correction target is presented. If set to DEFAULT, the default sound is played; if set to OFF, no sound will be played for that event; otherwise a sound file from the audio library can be played.
Error Beep ¶	.errBeep	String	Sets sound (DEFAULT, OFF, or sound file) to play on failure or interruption.
Good Beep ¶	.goodBeep	String	Sound (DEFAULT, OFF, or sound file) to play on successful operation.
Enable External Control	.enableExternalC ontrol	Boolea n	Toggling through different camera views, adjusting pupil and CR thresholds, and accepting calibration, validation and drift correction targets are usually done through key presses on the Display or Host PC keyboard. However, the keyboard may not be easily accessible in some experiments. Enabling this option allows the use of an external control device to assist the pupil/CR thresholding and calibration process.
External Control Device Config	.externalControl DeviceConfig	String	This specifies a file used to define button functions to control the pupil/CR thresholding and to accept calibration, validation, and drift correction target. If this field is left blank, the default configuration is used. This property is only available if the "Enable External Control" option is checked.
External Control Device	.externalControl Device	String	The type of external device that is used to control the drift correction process. This can be "CEDRUS" (Lumina fMRI Response Pad or RB Series response pad from Cedrus), "KEYBOARD" (computer keyboard or keypad), or "CUSTOM" (a user control device interfaced through a callback function defined in the custom class code). This property is only available if the "Enable External Control" option is checked.
Button State Callback Function	NR		For an experiment project with custom class enabled, a method defined in the custom class can be run to check the button status of an external control device (the HTML version of this document provides a usage example) and thus to control the camera image thresholding and calibration through the "External Control Device Config" setting. This property is only available if the "External Control Device"

			option is set to "CUSTOM".
Result #	.result	Integer	0 if successful; 27 if the ESC key is pressed to enter Setup menu or abort; "None" if this attribute is accessed before this action is done.

The Drift Correction action is only available in an EyeLink experiment and must be placed outside of a recording sequence (see Section 6.2.3 "Linking Rules"). In addition, this action cannot be connected to another drift correct action or any trigger. If a prepare sequence action is used, it should be placed before the drift correction action.

The "Allow Setup" field is checked by default, so that when the "ESC" key is pressed, the host software switches to the camera setup screen. This allows the experimenter to make adjustments to the camera setup and thresholding, and redo calibration and validation, then return to the drift correction screen to continue with the experiment.

The "Draw Drift Correction Target" box should be checked if the built-in or custom drift correction target should be displayed when entering the drift correction mode. In some (e.g., pursuit or saccade) experiments, users may want to have the drift correction target be the same as the pursuit target or other display items. If this is the case, users may uncheck this box and insert a display screen action to pre-draw the drift correction target. However, a drawback with this approach is that if users have to interrupt the drift correction process by switching to the camera setup screen and then come back to the drift correction again, the target will no longer be drawn. Alternatively, users may have both the "Draw Drift Correction Target" and "Use Custom Target" fields checked and supply an image for the "Custom Target" field.

Settings such as foreground and background color, custom targets, etc., will only be used for this node—if a drift correction is triggered through the camera setup/calibration screen (e.g., by pressing D or clicking "Drift Correct/Drift Check" button from the Camera Setup screen on the Host PC), the target specified in the Camera Setup action will be used. Similarly, if a Camera Setup is triggered through this Drift Correction (by pressing "Esc" from the Drift Correction screen), the settings specified in this node will be used.

The following figure illustrates the use of the drift correction action in a typical trial.

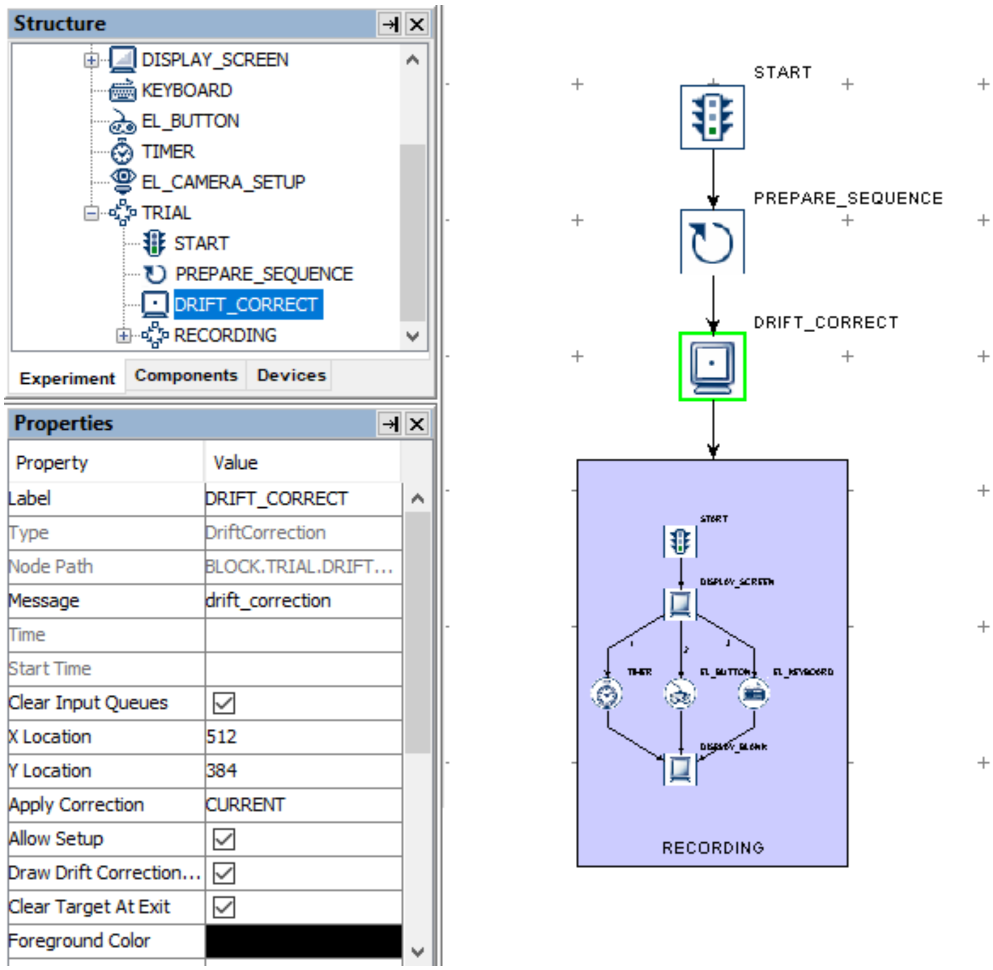


Figure 7-14. Using Drift Correction Action.

7.9.3 Performing Camera Setup and Calibration

The Camera Setup action () will bring up a camera setup screen on the EyeLink Host PC for the experimenter to perform camera setup, calibration, and validation. Scheduling this at the start of each block gives the experimenter a chance to fix any setup problems. Simply pressing the ESC key immediately can skip calibration. This also allows the participant an opportunity for a break - the entire setup can be repeated when the participant is reseated. Users can set the calibration type and other calibration configurations through this action. When the experiment is tested in the Dummy Mode without an actual connection to the eye tracker, the Drift Correction action will simply be skipped.

Typical operations for the camera setup and calibration can be performed by using either the Host PC keyboard or the Display PC keyboard. Using the display computer monitor and peripherals, Camera Setup and Calibration can also be performed through an external control device for environments in which the Host PC is located far away from the display (e.g., MEG/MRI environments).

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the Camera setup action. The default value is "EL_CAMERA_SETUP".
Type #	NR		The Experiment Builder object type for this node (EyeLinkCameraSetup).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file when camera setup action is done.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the camera setup action is done.
NTP Time	.ntpTime	Float	NTP server time when the camera setup action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when camera setup action starts (the calibration is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Calibration Type ¶	.calibrationType	String	This sets the calibration type. One of these calibration types can be selected from the dropdown list: H3: horizontal 3-point calibration HV3: 3-point calibration, bilinear HV5: 5-point calibration, biquadratic HV9: 9-point grid calibration, biquadratic with corner correction HV13: 13-point calibration (EyeLink II version 2.0 or later; Any versions of EyeLink 1000, EyeLink 1000 Plus, EyeLink Portable Duo). The default calibration type is HV9. When using the head-free remote mode, the HV13 is recommended.
Horizontal Target Y Position	.horizontalTargetLocation	Integer	This sets the Y position of the automatically-generated targets for the H3 calibration type. This option is only available when the calibration type is set to H3.

Pacing Interval	.pacingInterval	Integer	Sets the time delay in milliseconds for calibration and validation if calibration triggering is done automatically.
Randomize Order †	.randomizeOrder	Boolean	If checked, randomizes the presentation sequence of the calibration and validation targets.
Repeat First Point †	.repeatFirstPoint	Boolean	If checked, redisplays the first calibration or validation fixation dot.
Force Manual Accept †	.forceManualAccept	Boolean	If checked, users have to manually accept each calibration and validation fixation point.
Lock Eye After Calibration †	.lockEyeAfterCalibration	Boolean	If checked, locks the recording eye on the display computer keyboard if performing a monocular recording.
Select Eye After Validation †	.selectEyeAfterValidation	Boolean	Controls whether the best eye is automatically selected as the default after validation. If unchecked, binocular tracking is kept. Version 2.2 or later of the software disables this option by default.
Enable Customized Calibration Positions †	.enableManualCalibrationPositions	Boolean	If checked, user-defined calibration positions can be used, instead of the default positions.
Customized Calibration Positions	.calibrationPositions	List of Points	A list of X/Y pairs to specify the calibration target positions in the intended display screen resolution. The number of points included in the list must match the calibration type. This option is only available if the "Enable Customized Calibration Positions" setting is enabled. The following lists example (default) calibration/validation point lists under a 1024 * 768 recording resolution. **Please be aware that the points in the list MUST be ordered on screen.** * Point order for 5, 9, or 13 point calibrations: 6 2 7 10 11 4 1 5 12 13 8 3 9 HV5: [(512,384), (512,65), (512,702), (61,384), (962,384)] HV9: [(512,384), (512,65), (512,702), (61,384), (962,384), (61,65), (962,65), (61,702), (962,702)] HV13: [(512,384), (512,65), (512,702), (61,384), (962,384), (61,65), (962,65), (61,702),

			(962,702), (286,224), (737,224), (286,543), (737,543)] * Point order for H3 calibration type: 2 1 3 H3: [(512,384), (61,384), (962,384)] * Point order for HV3 calibration type: 1 3 2 HV3: [(512,65), (962,702), (61,702)]
Enable Customized Validation Positions †	.enableManualValidationPositions	Boolean	If checked, user-defined validation positions can be used, instead of the default positions.
Customized Validation Positions	.validationPositions	List of Points	A list of X/Y pairs to specify the validation target positions in the intended display screen resolution. These points MUST be ordered on screen and match the calibration type selected. See “Customized Calibration Positions” for examples. This option is only available if the "Enable Customized Validation Positions" setting is enabled.
Foreground Color	.foregroundColor	Color	Color used to draw calibration targets, and for the text on the camera image display. It should be chosen to supply adequate contrast to the background color.
Background Color	.backgroundColor	Color	The color to which the entire display is cleared before calibration. This is also the background for the camera images. **The background color should match the average brightness of your experimental displays as closely as possible**, as this will prevent large changes in the participant's pupil size at the start of the trial. This will provide the best eye-tracking accuracy as well.
Use Animation Target †	.useAnimationTarget	Boolean	If checked, a video clip can be used as the calibration target. Users should preload the intended video clip into the library manager.
Animation Target ¶	.animationTarget	String	The name of the video clip used as the calibration target. The video to be used as the animation calibration target should be a type 1 .avi file, containing both video frames and audio stream. This field is only available if the “Use Animation Target” option is checked.
Animation Play Count	.animationPlayCount	Integer	Total number of times the video clip will be played before the calibration target is accepted.

			If -1, the clip will be played continuously (looping). This field is only available if the “Use Animation Target” option is checked.
Apply Transparency	.applyTransparency	Boolean	If checked, transparency manipulation will be applied to the video resource similar to that which is done on the image resources (i.e., pixels with the same color value as the transparency color will not be displayed). We recommend keeping the default setting (unchecked).
Use Custom Target †	.useCustomTarget	Boolean	If checked, drift correction will use a custom target supplied by the user. The target should be a small image file, with a "feature"/interesting part appearing in the center of the image.
Custom Target	.customTarget	String	The name of the image file that is used for drawing the calibration target. The image file should be preloaded into the library manager. This property is only available if "Use Custom Target" is checked.
Use Custom Background †	.useCustomBackground	Boolean	If checked, calibration will use the custom background image supplied.
Custom Background	.customBackground	String	The name of the image file that is used to draw the drift correction background. The image file should ideally be a full-screen image and must be preloaded into the library manager. This property is only available if "Use Custom Background" is checked.
Target Outer Size	.outerSize	Integer	The standard calibration and drift correction target is a filled circle (for peripheral detectability) with a central "hole" target (for accurate fixation). The disk is drawn in the calibration foreground color, and the hole is drawn in the calibration background color. The "Target Outer Size" property specifies the diameter of the outer disk of the default calibration target in pixels. This property is only available if "Use Custom Target" is not checked.
Target Inner Size	.innerSize	Integer	Diameter of the inner disk of the default calibration target in pixels). If hole size is 0, no central feature will be drawn. This property is only available if "Use Custom Target" is not checked.
Target Beep ¶	.targetBeep	String	Experiment Builder plays alerting sounds during calibration. These sounds have been found to improve the speed and stability of calibrations by cueing the participant, and make the experimenter's task easier. The "Target Beep" property specifies the sound to play when the calibration target is presented. If set to

			DEFAULT, the default sound is played; if set to OFF, no sound will be played for that event; otherwise a sound file from the audio library can be played.
Error Beep ¶	.errBeep	String	Sound (DEFAULT, OFF, or sound file) to play on failure or interruption.
Good Beep ¶	.goodBeep	String	Sets sound (DEFAULT, OFF, or sound file) to play on successful operation.
Enable External Control	.enableExternalControl	Boolean	Toggling through different camera views, adjusting pupil and CR thresholds, and accepting calibration, validation and drift correction targets are usually done through key presses on the Display or Host PC keyboard. However, the keyboard may not be easily accessible in some environments. Enabling this option allows the use of an external control device to assist the pupil/CR thresholding and calibration process.
External Control Device Config	.externalControlDeviceConfig	String	This specifies a file used to define the button functions to control the pupil/ CR thresholding and accept calibration, validation, and drift correction targets. If this field is left blank, the default configuration is used. This property is only available if the "Enable External Control" option is checked.
External Control Device	.externalControlDevice	String	The type of external device that is used to control the camera setup and accept calibration and validation targets. This can be "CEDRUS" (Lumina fMRI Response Pad or RB Series response pad from Cedrus), "KEYBOARD" (computer keyboard or keypad), or "CUSTOM" (a user control device interfaced through a callback function defined in the custom class code). This property is only available if the "Enable External Control" option is checked.
Button State Callback Function	NR		For an experiment project with custom class enabled, a method defined in the custom class can be run to check the button status of an external control device and thus to control the camera image thresholding and calibration/drift correction through the "External Control Device Config" setting. This property is only available if the "External Control Device" option is set to "CUSTOM".
Result #	.result	Integer	Always returns “None”.

The Camera Setup action is only available in an EyeLink experiment and must be placed outside of a recording sequence. As a linking rule, the camera setup action cannot be connected to another camera setup action or any triggers. Settings such as foreground and background color, custom targets, etc., will only be used for this node—if Camera Setup is triggered through a Drift Correction node (e.g., by pressing “Esc” from the Drift Correction screen on the Host PC), the target specified in the Drift Correction node action will be used.

Figure 7-15 illustrates the use of camera setup in a typical experiment.

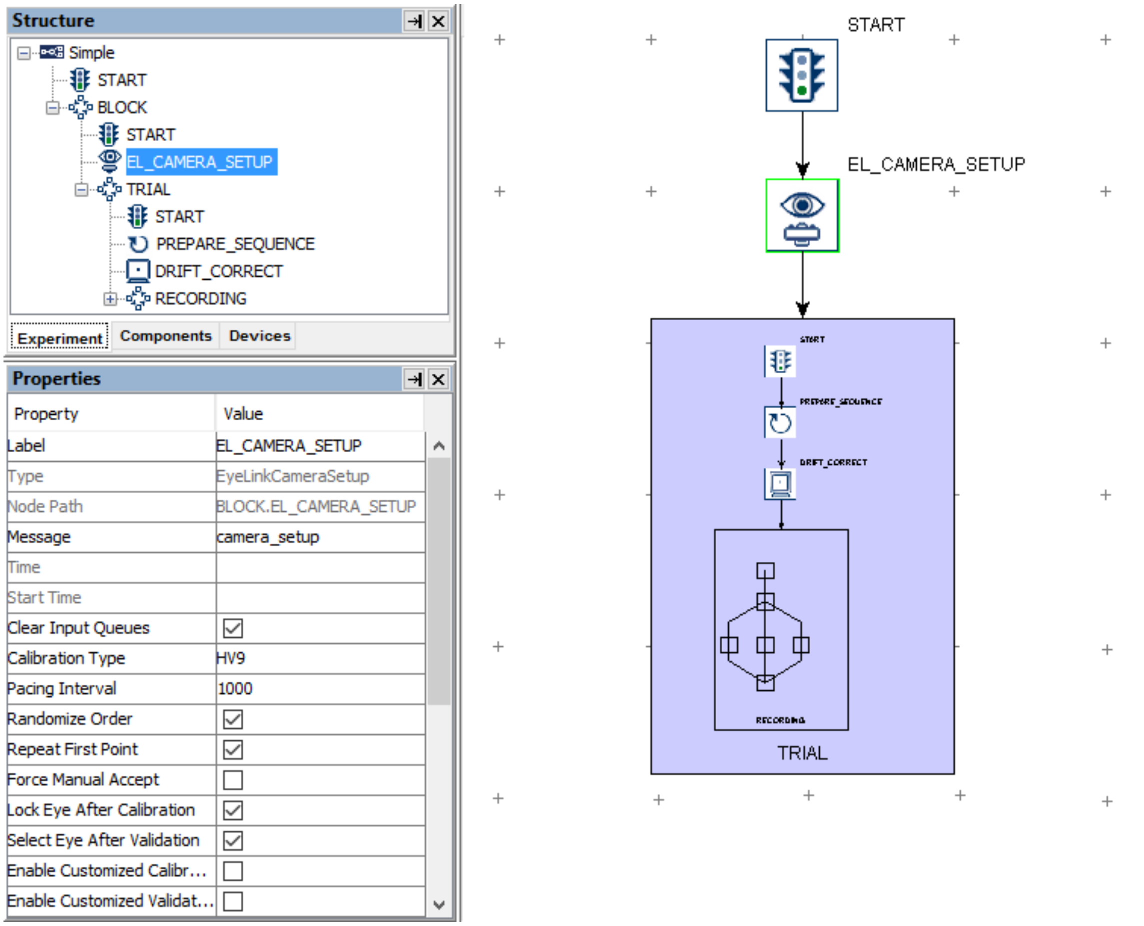


Figure 7-15. Using Camera Setup Action.

7.9.4 Sending EyeLink Message

While messages can be sent by filling out the “Message” property of a relevant node, the SEND_EL_MESSAGE action () can be used to send an additional text message to the EyeLink eye tracker, which timestamps the message and writes it to the EDF data file. Messages are useful for logging trial conditions, recording responses from participants, or marking time-critical events for debugging and analysis. The EDF message text can be created with the attribute editor to include references to node attributes, equations and other expressions. This action is not available in non-EyeLink experiments.

When using the SEND_EL_MESSAGE action, users should avoid end-of-line characters (“\n”) in the message text and avoid making reference to strings with quotes (“”). Message text should be no more than 128 characters in length – the tracker will truncate text messages longer than that limit. Also be careful not to send messages too quickly: the eye tracker can handle about 2 messages a millisecond. Above this rate, some messages may be lost and not written to the EDF file.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the SEND_EL_MSG action. The default value is "SEND_EL_MSG".
Type #	NR		The Experiment Builder object type for this node (SendEyeLinkMessage).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the message is sent.
NTP Time	.ntpTime	Float	NTP server time when the message is sent.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Message	.message	String	Text to be sent to the eye tracker.

The following figure illustrates the use of the SEND_EL_MESSAGE action. In the EyeLink Message field, users can enter a string directly (see the left panel at the bottom). In case runtime data accessing is required, users may use references and equations and create the message text in the attribute editor (see the right panel at the bottom; see Chapter 10 “References” for details).

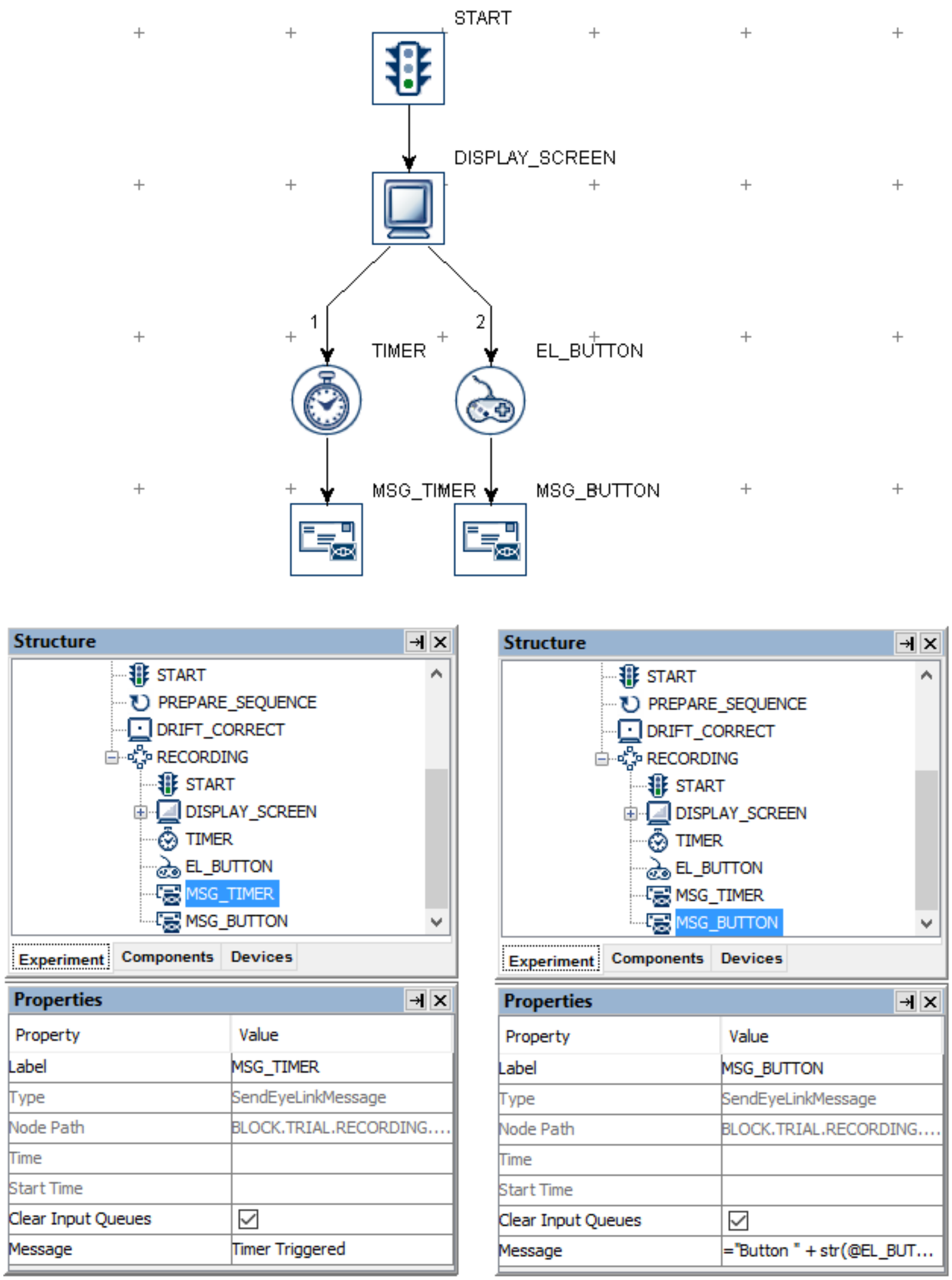


Figure 7-16. Using Sending Message Action.

7.9.5 Sending EyeLink Command

The EyeLink tracker accepts text commands sent through the link. The SEND_COMMAND action () is used for on-line tracker configuration and control. Please refer to the .ini files in the EyeLink directory of the Host PC (typically "elcl\exe" for EyeLink 1000 Plus and Portable Duo, "c:\elcl\exe" for EyeLink 1000, "c:\eyelink2\exe" for EyeLink II and "c:\EyeLink\exe" for EyeLink I) for a list of possible commands that can be sent with this action. The send_command action is not available in non-EyeLink experiments.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the SEND_COMMAND action. The default value is "EL_COMMAND".
Type #	NR		The Experiment Builder object type for this node (EyeLinkCommand).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the SEND_COMMAND action is done.
NTP Time	.ntpTime	Float	NTP server time when the SEND_COMMAND action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Command	.command	String	The command used to configure or control the EyeLink tracker. For a complete list of commands and current tracker configuration, examine the *.INI files in the EyeLink directory of the eye-tracker computer.
Text	.text	String	The parameters to be passed along with the command.
Priority †	.priority	Boolean	If enabled, causes the command to be executed with the highest priority. This priority is even higher than the output of analog or link sample data, so please use it carefully. The use of this prefix should be limited to the "write_ioport" command. Typical command execution is 1-20 ms after the action is pressed. With priority enabled, this is reduced to less than 1 ms 99% of the time—in the worst case, it may be about 10 ms but is rarely higher than 2 ms. The default setting is "False". This setting has no effect on EyeLink I.

Log Time †	.logTime	Boolean	If enabled, logs the command and its delay in execution to the EDF file (and link if message events are enabled). The default setting is "False". The message time is when the command completed execution. The message syntax is: !CMD < execution delay> <text of command> This setting has no effect on EyeLink I.
Wait for Result †	.waitForResult	Boolean	Whether the program should wait for a response from the tracker.
Result Timeout	.resultTimeout	Integer	Sets the maximum amount of time to wait for a response from the tracker. If no result is returned, then the error code NO_REPLY is returned.
Exit On Fail †	.exitOnFail	Boolean	Whether the experiment should be terminated if there is an error in the command. **Important**: please leave this field unchecked unless it is absolutely necessary that you should terminate the experiment if the EyeLink send command action fails.
Result #	.result	Integer	Result code for the command: 0: Command successfully sent; 1: Unknown command; -1: Unexpected end of line; -2: Syntax error; 1000: No reply from the tracker.
Result Message #	.resultMessage	String	Returns text associated with last command response: may have error message (see above).

Figure 7-17 illustrates how to draw a white filled box on the top-left quadrant of the tracker screen using the EyeLink Command action. In the “Command” field, type in “draw_filled_box” (without quotes) and in the “Text” field, enter “0 0 512 384 15” (without quotes). Please refer to the .ini files on the Host PC for the syntax of EyeLink commands.

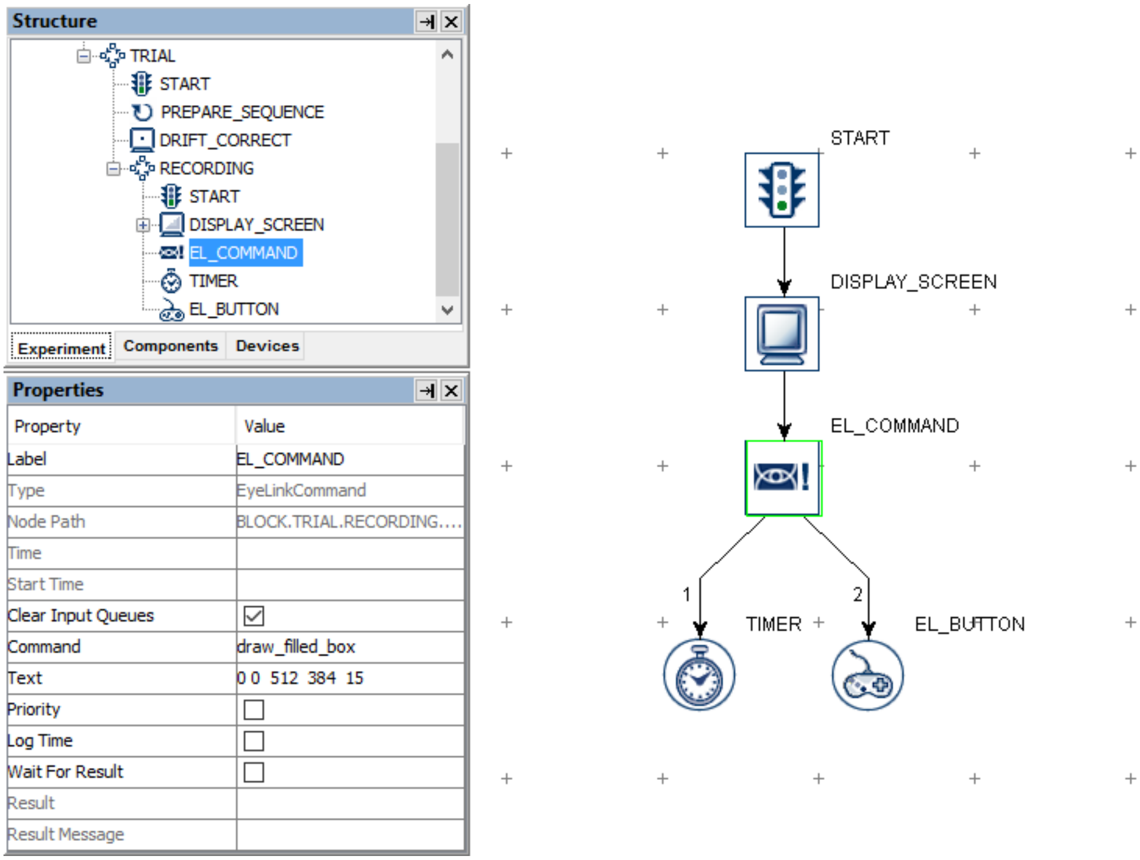


Figure 7-17. Using Sending EyeLink Command Action.

7.9.6 Sending TTL Signals

The SET_TTL action ( ) sends a TTL signal through the parallel port, USB-1208 HS or USB2TTL8 on a Windows PC, or through USB2TTL8 on macOS. Version 1.6.121 or later of this software automatically installs the I/O port driver necessary for interfacing with the parallel port in Windows (both 32-bit and 64-bit versions).

If a parallel port is used, Experiment Builder will typically identify the base address of the parallel port automatically if the “Parallel Port Base Address” property of the “Parallel Port” Device is left as 0x0. In the rare cases where Experiment Builder cannot detect the parallel port base address, it may be set manually. First determine the base address through the Device Manager in Windows. In the Device Manager list, find the entry for the parallel port device under "Ports (COM & LPT)". (If using a PCI, PCI Express, or PCMCIA parallel port adapter card, you'll need to install a driver for the port before it is correctly recognized by Windows.) Click the port and select the "Resources" in the properties table. This should list the I/O address of the card. For the built-in LPT1 on a desktop computer, this is typically "0378-037F" (hex value). Once you have found out the parallel port address, open the Experiment Builder project, go to the "Parallel Port" device setting, and enter the hex value for the port reported by the device manager (e.g., 0x378 for "0378" you see in the device manager).

Version 2.2 of Experiment Builder adds support for the USB2TTL8 device from Labhackers (http://www.labhackers.com/usb2ttl8.html). This USB Serial interface is plug-and-play on Windows 10 and macOS. If using Windows 7, please install the required USB Serial driver from www.labhackers.com/downloads.html. To send TTL signals through the USB2TTL8, make sure the "USB2TTL8 Mode Selection" property of the USB2TTL8 device is set to "Write Mode".

Also supported is the USB-1208HS box from Measurement Computing, which can be used on a Windows PC. No extra driver installation is required as long as you have installed the libusb-win32 component when you first run through the installation procedure in Windows (see Figure 3-1). If for any reason you have to install the device driver, please first connect the box to the Windows PC. When asked "Can Windows connect to Windows Update to search for software?", choose "No, not this time". When asked "What do you want the Wizard to do?", choose "Install from a list or specific location (Advanced)". On the "Please choose your search and installation options" screen, select the "Search for the best driver in these locations", check the "Include this location in the search" option only and browse to "C:\Program Files\SR Research\3rdparty\usb1208hs" in 32-bit Windows or "C:\Program Files(x86)\SR Research\3rdparty\usb1208hs" in 64-bit Windows).

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the SET_TTL action.
Type #	NR		The Experiment Builder object type for this node (SetTTL).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the TTL signal is sent.
NTP Time	.ntpTime	Float	NTP server time when the TTL signal is sent.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not

			cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Device	.device	String	Which device (parallel port, USB2TTL8, or USB-1208 HS) is used to send or receive TTL signals.
Register ¶	.register	String	Usually set as "DATA" register. Note that this option is only available when the "Device" is set to a parallel port.
Mode *	.mode	String	Either "Word" mode (the decimal or hexadecimal value of the TTL output signal) or "Pin" mode (status of each individual pin).
Data	.data	Integer	The byte value of the current TTL output signal. It could be a decimal or hexadecimal value. This field is only available if the "Mode" property is set to "Word". If a decimal value is entered, it will be automatically translated into a hexadecimal value.
Pin0 Pin1 Pin2 Pin3 Pin4 Pin5 Pin6 Pin7 Pin8 Pin9 Pin10 Pin11 Pin12 Pin13 Pin14 Pin15	.pin0 .pin1 .pin2 .pin3 .pin4 .pin5 .pin6 .pin7 .pin8 .pin9 .pin10 .pin11 .pin12 .pin13 .pin14 .pin15	String	The desired status for the corresponding pins. The pin value can be either "ON" (high) or "OFF" (low). These fields are only available if the "Mode" property is set to "Pin". For parallel port and USB2TTL8, eight pins are available. If using a USB-1208HS box, the available output pins can be configured through the device preferences.

The TTL communication works by the detection of a change in the pin status in the receiving end. Typically a clearing signal should be sent (e.g., 0x0) after sending the intended TTL signal. The clearing signal may be sent using a second SET_TTL action either at the end of the trial, or some time after the initial TTL signal (at least a 20 msec gap is recommended). If the same TTL value is sent repeatedly, no change will be detected on the receiving end.

For most applications involving a parallel port, users will need to use the "DATA" register in the "Register" property of the SET_TTL action to send out a signal. Users need to make sure the parallel port of the Display PC is not in a bi-directional mode, in which the data register is used to read incoming signals, and thus users are not able to send a signal from this register. Bidirectional mode is set by pin 5 of the control register. To turn off the bidirectional mode, users may add a SET_TTL action at the beginning of the experiment, and set the "Register" to "CONTROL", "Mode" to "Word", and "Data" value to 0x0.

The pins on a USB-1208 HS box can be configured either for sending signals or for receiving signals. To set which pins are used for sending and receiving, go to the “USB-1208HS” device settings and click the "Value" field of the “Pins” property. This will bring up a USB-1208HS configuration window. The arrows indicate the directions of data flow that each pin is configured for: if the arrow points towards the box, the pin is used to receive signals; if the arrow points away from the box, the pin is used to send signals. To change whether a pin is used for sending or receiving signals, simply click on the arrow next to the pin to change its direction. The following figure illustrates a configuration in which pins 0 to 7 are used to send signals and pins 8 to 15 are used to receive signals.

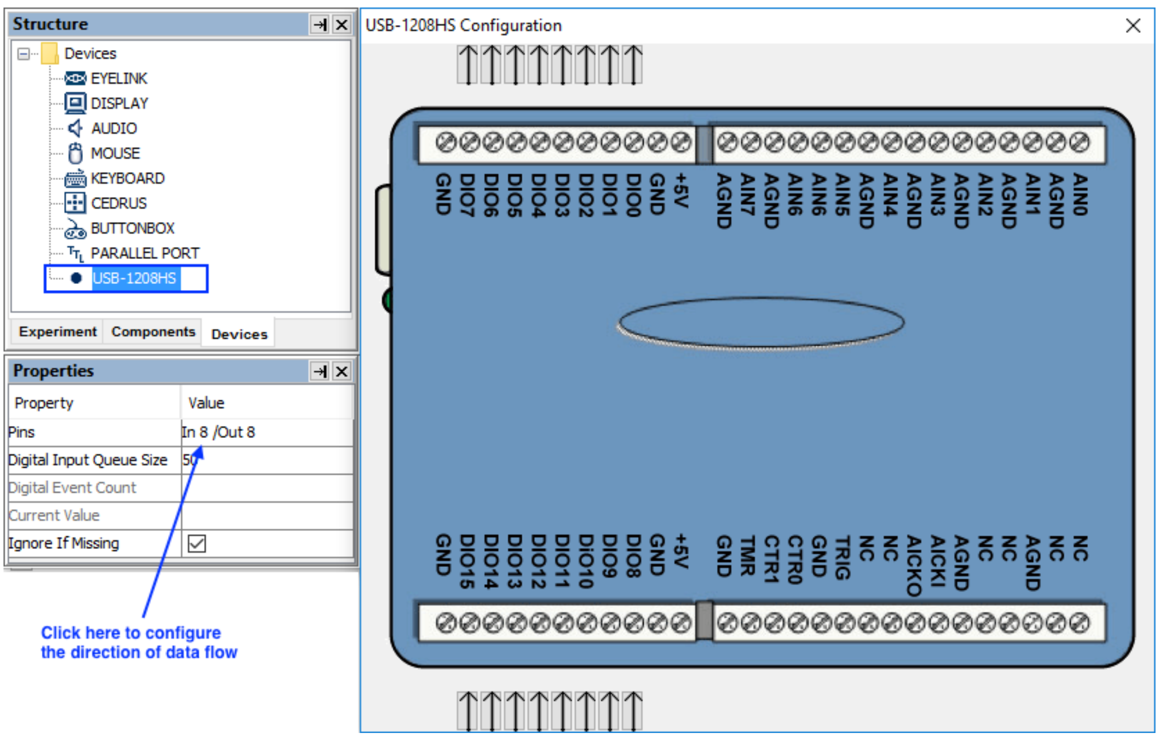


Figure 7-18. Configuring the Direction of Data Flow on USB-1208HS

7.9.7 Adding to Experiment Log

For the ease of experiment debugging, messages can be written to a log file so that errors in the experiment programming can be detected early. The ADD_TO_LOG action () allows users to send one log message per call. While the SEND_EL_MSG action is available in an EyeLink experiment only, the ADD_TO_LOG action can be used in both EyeLink and non-EyeLink experiments.

Field	Attribute	Type	Content

	Reference		
Label *	.label	String	Label of the ADD_TO_LOG action. The default value is "ADD_TO_LOG".
Type #	NR		The Experiment Builder object type for this node (AddToExperimentLog).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the action is processed.
NTP Time	.ntpTime	Float	NTP server time when the action is processed.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Log File Message	.logMessage	String	Message to be written to the log file.
Log File *	.logFile	String	File to which the log message is written. The default file name is "Logfile". If this field is left empty, the message will be printed to command line (or the output tab of Experiment Builder if test running the project).

In the following example (Figure 7-19), the user added a sample velocity trigger in the experiment and wants to check out whether the correct values (e.g., left eye gaze position, eye velocity and acceleration, and trigger time) are reported when the trigger fires. The user may add an ADD_TO_LOG action following the sample velocity trigger, and set the "Log File Message" field of the action as:

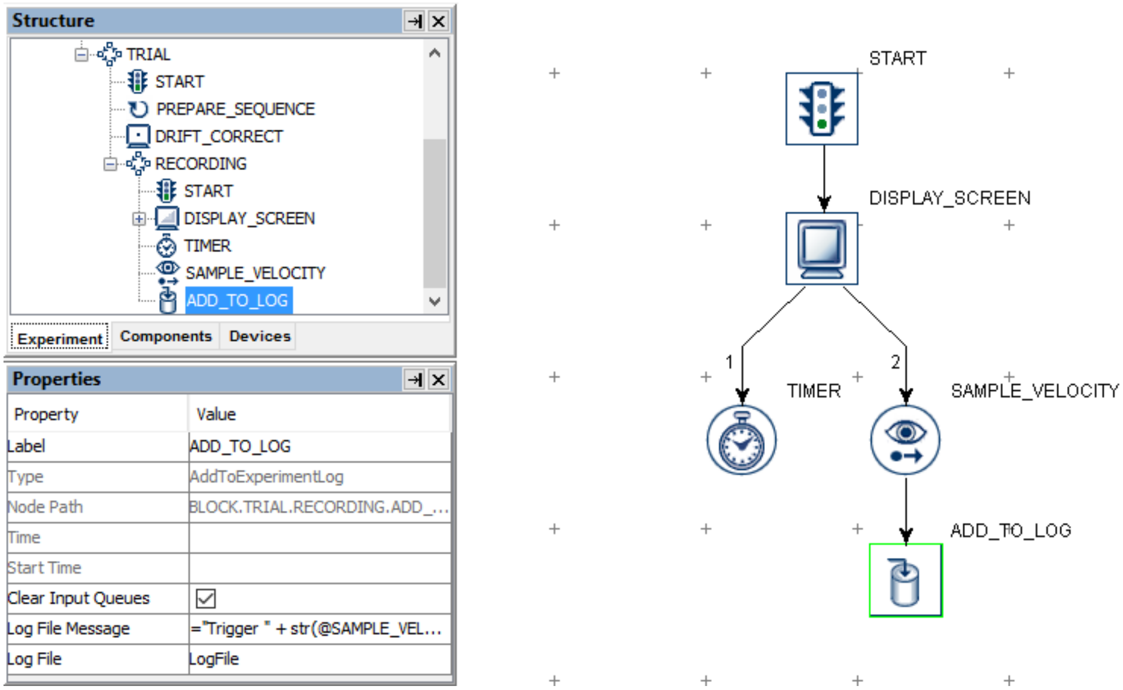


Figure 7-19. Using Add to Experiment Log Action.

```
= "Trigger " + str(@SAMPLE_VELOCITY.triggeredData.EDFTime@)
+ " LOC "+ str(@SAMPLE_VELOCITY.triggeredData.leftGazeX@)
+ " " + str(@SAMPLE_VELOCITY.triggeredData.leftGazeY@)
+ " VEL " + str(@SAMPLE_VELOCITY.triggeredData.leftVelocity@)
+ " AC1000 " +
str(@SAMPLE_VELOCITY.triggeredData.leftAcceleration@)
```

The following is one sample output from the LogFile.txt file when the sample-velocity trigger fires:

```
Trigger 852012 LOC 500.299987793 403.399993896 VEL 196.741027908
AC1000 98370.5273723
```

7.9.8 Updating Attribute

The UPDATE_ATTRIBUTE action (
) modifies the value of a variable or an attribute of an experiment component. For example, in a change-detection experiment (see section 7.11.1 “Variable”), users may want to display two slightly different images for a certain number of cycles and then stop the presentation after that. To do that, users may create a new variable to keep track of the current iteration status (behaving as a counter) and use the UPDATE_ATTRIBUTE action to update the counter’s value following each cycle.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the UPDATE_ATTRIBUTE action. The default value is “UPDATE_ATTRIBUTE”.
Type #	NR		The Experiment Builder object type for this node (UpdateAttribute).
Node Path #	.absPath	String	The absolute path of the node in the experiment

			graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the UPDATE_ATTRIBUTE action is done.
NTP Time	.ntpTime	Float	NTP server time when the UPDATE_ATTRIBUTE action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Attribute-Value List	NR		Used to set up an attribute-value list; the number of currently established attribute-value pairs is displayed in the value field of the property. To add or edit attribute-value pairs, click the value field or double click the UPDATE_ATTRIBUTE node. The "Attribute" column of the dialog box allows the user to specify one or more variables or attribute to be updated, and the "Value" column specifies the new values assigned to those attributes.

Users can update the value of an attribute by assigning a value directly (e.g., setting the value of VARIABLE1 to 0), referring to another attribute (e.g., retrieving the time when the EyeLink button box was pressed and assign this time to VARIABLE2), or using an equation (e.g., increasing the value of VARIABLE3 by 1).

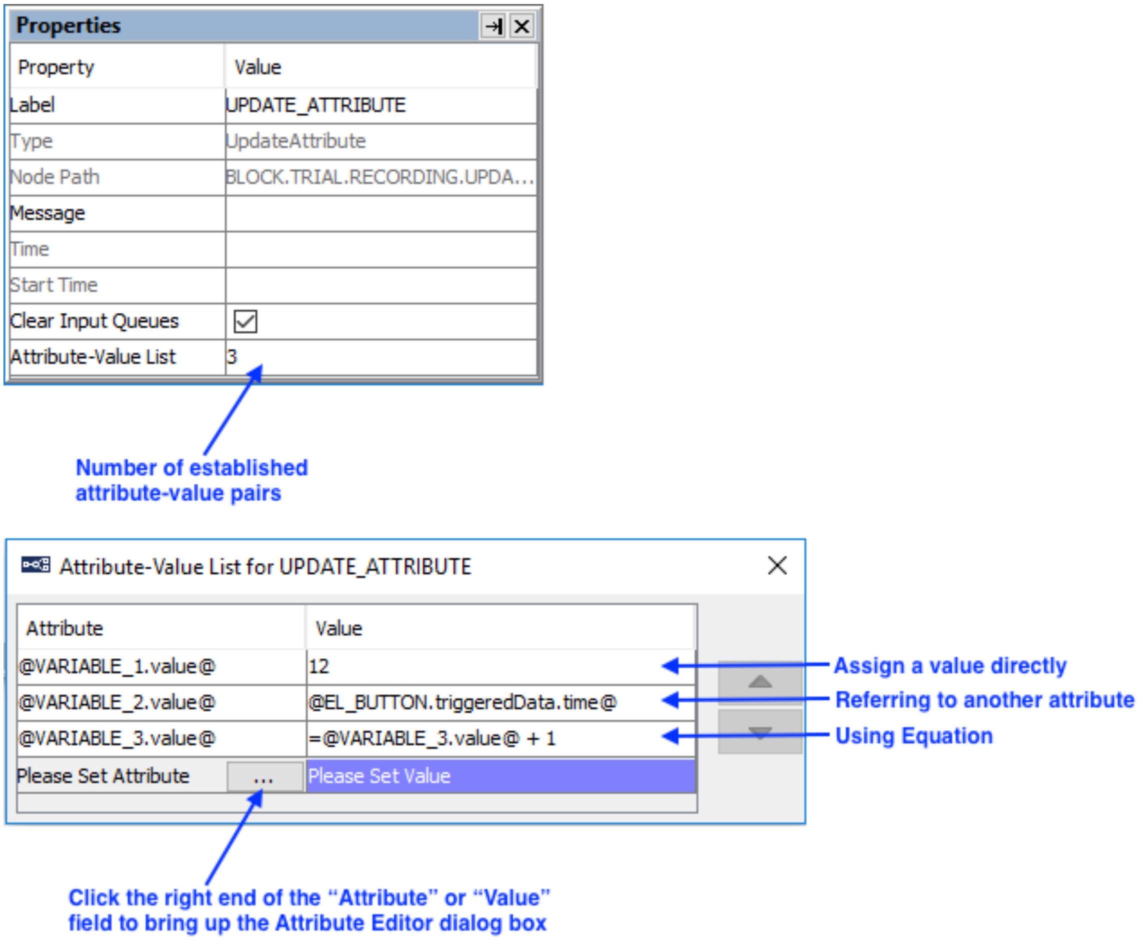


Figure 7-20. Using Update Attribute Action.

7.9.9 Adding to Accumulator

The ADD_ACCUMULATOR action () is used to add data to an accumulator object (see Section 7.11.3 “Accumulator” for example) so that statistical analysis can be performed on the stored data.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the ADD_ACCUMULATOR action. The default value is “ADD_ACCUMULATOR”.
Type #	NR		The Experiment Builder object type for this node (AddAccumulator).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages"

			attribute of the Experiment node checked) when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the action is done.
NTP Time	.ntpTime	Float	NTP server time when the action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Accumulator ¶*	NR		The accumulator the current action is referring to.
Add Value	.addValue	Float	This specifies the value (0.0 by default) to be added to the accumulator.

7.9.10 Adding to Results File

The ADD_TO_RESULTS_FILE action () is used to send data to a results file so that users will get a columnar data output. Users should first add a RESULTS_FILE object (see Section 7.11.2 "Results File" for example) into the experiment graph and then configure the columns of the data source file and/or the variables to the results file. Note - version 2.0 of Experiment Builder now automatically adds the variables and data source columns to the "Columns" field of the results file node. If necessary, users can double click on the field and use the dialog box to remove some variables/columns from the list or to change the order of the variables/columns.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the ADD_TO_RESULTS_FILE action. The default value is "ADD_TO_RESULTS_FILE".
Type #	NR		The Experiment Builder object type for this node (AddToResultsFile).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the action is done.

NTP Time	.ntpTime	Float	NTP server time when the action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Results File ¶*	NR		The Results File to be updated.

7.9.11 Prepare Sequence

Before starting the portion of the experiment that contains the important experiment manipulations and time-critical actions (often this is the sequence in which eye tracker data is recorded as well), the experiment should be given the opportunity to prepare the upcoming actions. The Prepare Sequence Action () includes the following operations:

a) Preload the image or audio files to memory for real-time image drawing or sound playing;
b) Draw feedback graphics on the Host PC so that the participants' gaze accuracy can be monitored;
c) Re-initialize trigger and action settings;
d) Synchronize the clocks between the display computer and Cedrus button box;
e) Flush data to the log files.

In a typical experiment, users should call the Prepare Sequence action before entering the recording sequence of a trial, preferably before performing a drift correction. In most of the experiments, the "Reinitialize Triggers" box should be checked so that the data for each trigger are reset for the nodes to function properly.

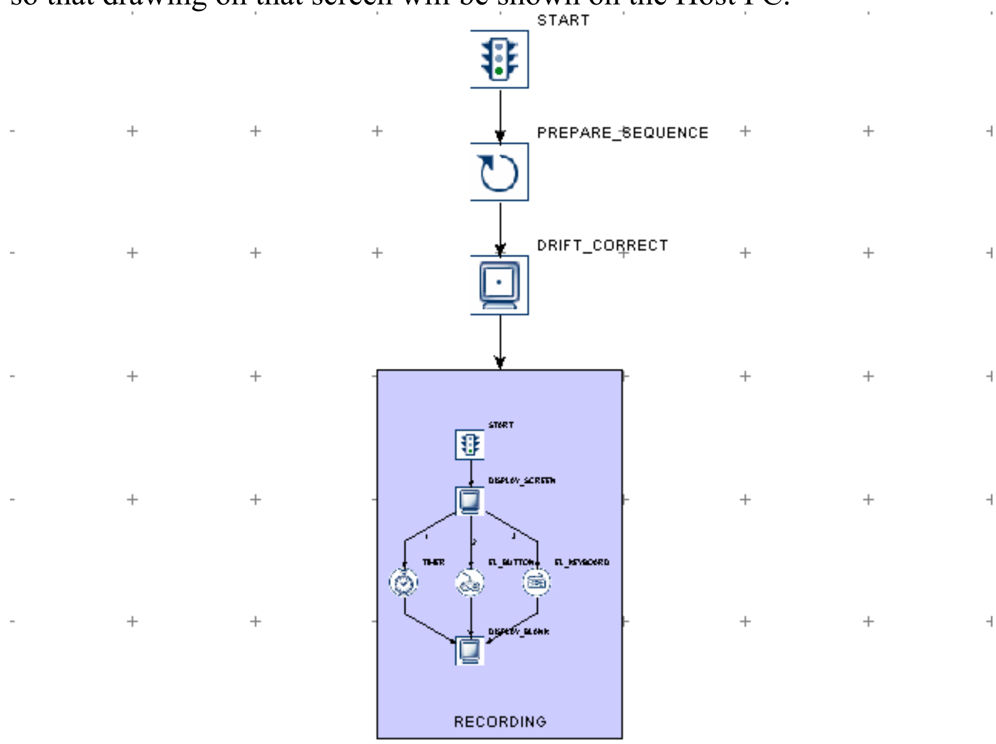
IMPORTANT: For the proper event timing, it is critical that the Prepare Sequence Action should be called before the trial run-time for **EACH** iteration of the sequence.

IMPORTANT: The Prepare Sequence Action loads the image and audio files based on the state of display screen and Play Sound actions at the time the Prepare Sequence is called. This means that if an image name or audio file name is changed after the Prepare Sequence action is called, the new image or audio resource will not be preloaded and timing may be affected. If an image or audio file has not been preloaded when it is used in the Display Screen or Play Sound action that references it, a warning message will be written to the warnings.log file for the experiment session.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the PREPARE_SEQUENCE action. The default value is "PREPARE_SEQUENCE".
Type #	NR		The Experiment Builder object type for this node (PrepareSequence).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the PREPARE_SEQUENCE action is processed.
NTP Time	.ntpTime	Float	NTP server time when the PREPARE_SEQUENCE action is processed.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Load Screen Resources *†	.loadImages	Boolean	If enabled (default), all of the possible images used in the current sequence (and sequences nested within it) will be preloaded for real-time performance.
Load Audio *†	.loadAudio	Boolean	If enabled (default), all of the possible sound clips used in the current sequence (and sequences nested within it) will be preloaded for real-time performance.
Draw to EyeLink Host *¶	.drawToEyeLinkHost	Integer	If set to "NO" (0), no feedback graphics are drawn on the Host PC screen. If set to "IMAGE" (1), transfers one of the display screens to the tracker PC as the backdrop for gaze cursors. If set to "PRIMITIVE" (2), draws primitive line drawings on the Host PC to

			indicate the location of resources used in a display screen. This attribute is only available in an EyeLink experiment.
Reinitialize Triggers *†	.reinitTriggers	Boolean	If checked, performing this action will also clear trigger data for re-initialization.
Reinitialize Actions *†	.reinitActions	Boolean	If checked, performing this action will also clear action data for re-initialization.
Reinitialize Video Resources *†	.reinitVideoResources	Boolean	If checked, any video resources used in the previous trial will be rewound to the beginning of the clip.
Flush Log *†	.flushLogs	Boolean	If checked, this will write the messages to the log file and clear the buffer.

The following (Figure 7-21) illustrates the use of the PREPARE_SEQUENCE action. In this example, "Draw to EyeLink Host" field of the PREPARE_SEQUENCE action is set to IMAGE. The "Use for Host Display" field of the DISPLAY_SCREEN is also checked so that drawing on that screen will be shown on the Host PC.



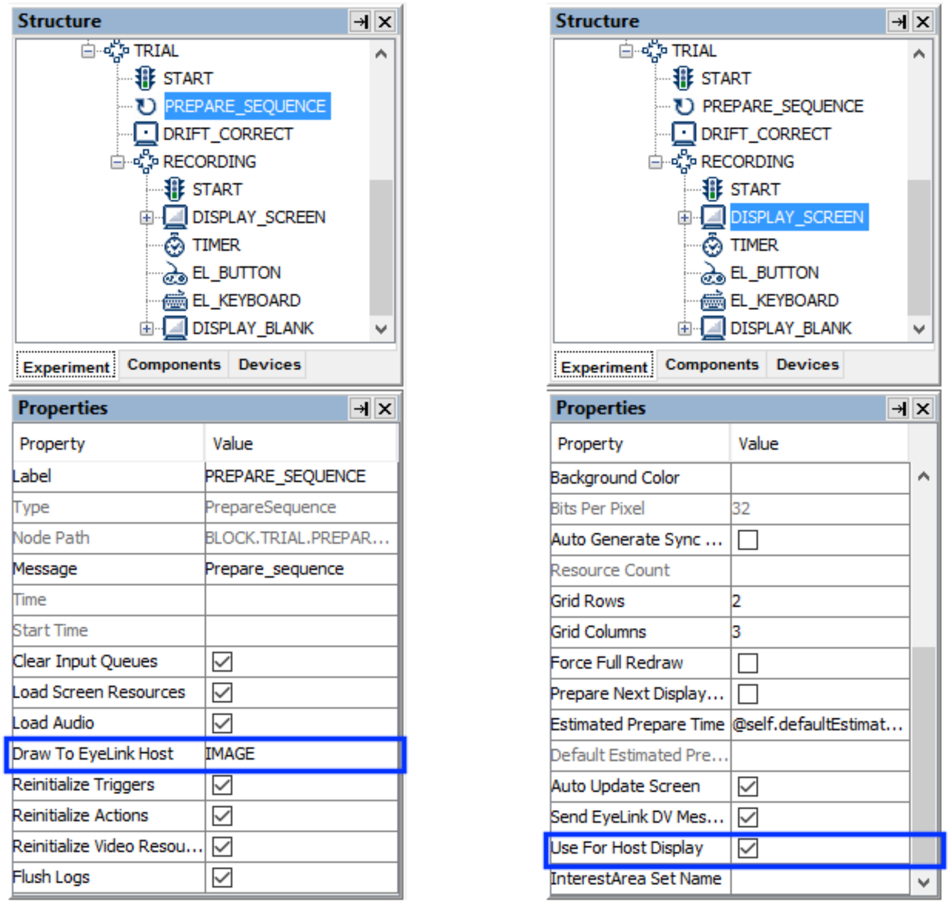


Figure 7-21. Using Prepare Sequence Action.

7.9.12 Reset Node

Similar to the PREPARE_SEQUENCE action, the RESET_NODE action () can be used to re-initialize trigger and action data. The RESET_NODE can also be used to clear the data stored in an accumulator.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the RESET_NODE action.
Type #	NR		The Experiment Builder object type for this node (ResetNode).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when this action is done.
NTP Time	.ntpTime	Float	NTP server time when this action is done.

Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Reset Node *¶	NR		The node to be reset.

7.9.13 Playing Sound

Experiment Builder supports playing .WAV audio files using the PLAY_SOUND action (). Please make sure the target sound files are loaded into the library manager of the experiment by clicking “Edit → Library Manager” from the application menu bar (see Figure 7-22). The Library Manager dialog allows users to load in images, videos, sound resources, and interest area set files. Select the “Sound” tab and click the “Add” button to load in audio files, or select the audio files in Windows Explorer (Finder in macOS) and drag them into the Library Manager window. The name of the audio files to be imported should not contain spaces or non-ASCII characters. Experiment Builder expects the .wav files are encoded in 16-bit PCM. It throws an import error for .wav files that are not in the supported format.

Please note that the playing of an audio clip in Experiment Builder is asynchronous (i.e., the action returns before the sound finishes playing). As a result, if a sound clip is played at the end of a sequence (e.g., used as a feedback to the participant), users must attach a timer following the play sound action to ensure that the whole sound clip will be played.

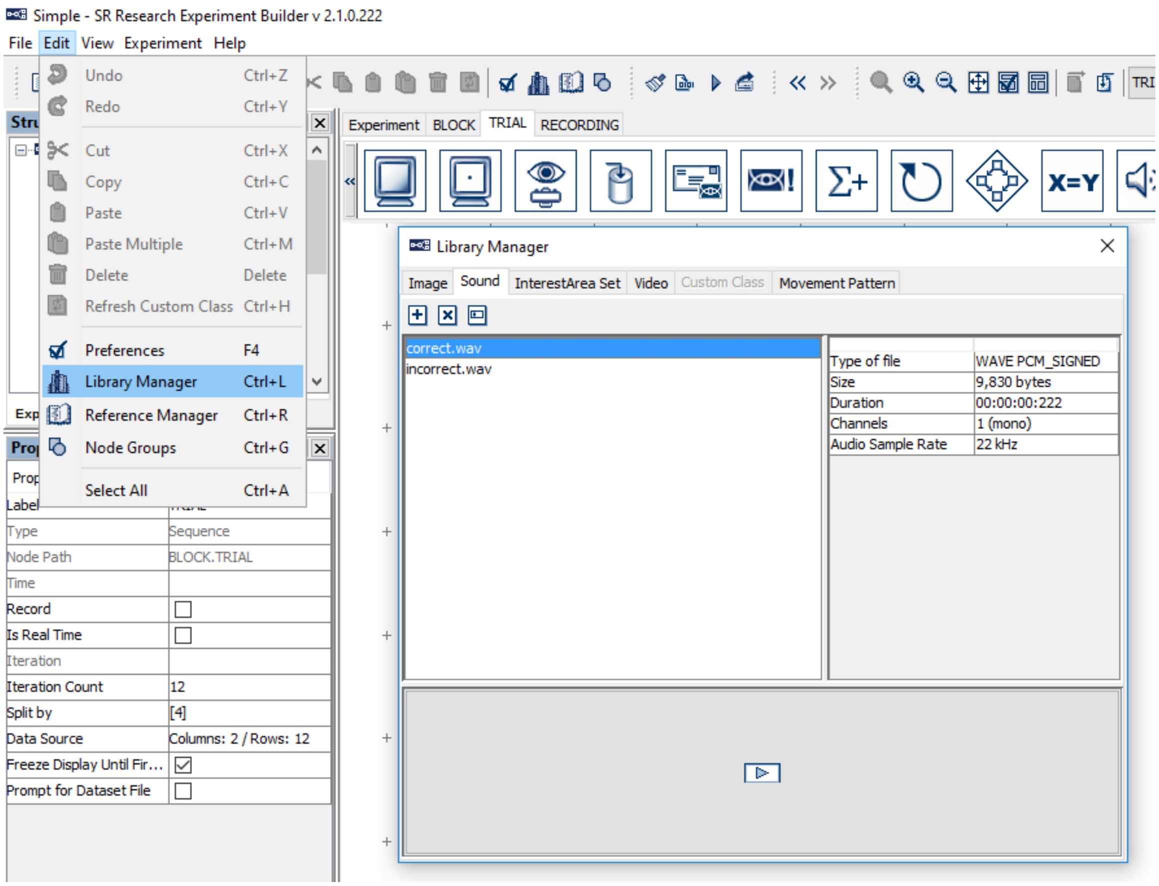


Figure 7-22. Adding Audio Files to the Library Manager.

In Windows, users may choose either the DirectX or ASIO audio driver to play the sound files (chosen from the "Devices → Audio" settings; see Figure 7-23). The ASIO driver supports predictable and low latency audio playback and recording, and is therefore ideal for experiments that require high audio timing precision (e.g., with audio-visual synchronization or an audio stimulus onset asynchrony manipulation). If using the ASIO driver, make sure a sound card that supports the ASIO 2.0 specification is installed on the computer(s) used for developing and running the experiment. In the device setting for the ASIO driver (Figure 7-23, left panel), "ASIO Audio driver" indicates the name of the ASIO driver. The "Output Interval" property returns the interval (in milliseconds) between the ASIO buffer swaps, which determines how often new sounds can be output. The "Minimum Output Latency" property indicates the minimum output latency of the ASIO driver (delay from the buffer switch to first sample output).

In macOS, the audio driver is set to "OSX". Similar to the ASIO driver, it schedules audio events ahead of time to achieve a precise playing time. All audio clips scheduled with a TIMER trigger with a duration longer than the "Minimum Scheduling Latency" (which is about 40 ms) or played through the "Synchronize Audio" option of a

DISPLAY_SCREEN action will be played at the intended/scheduled time.

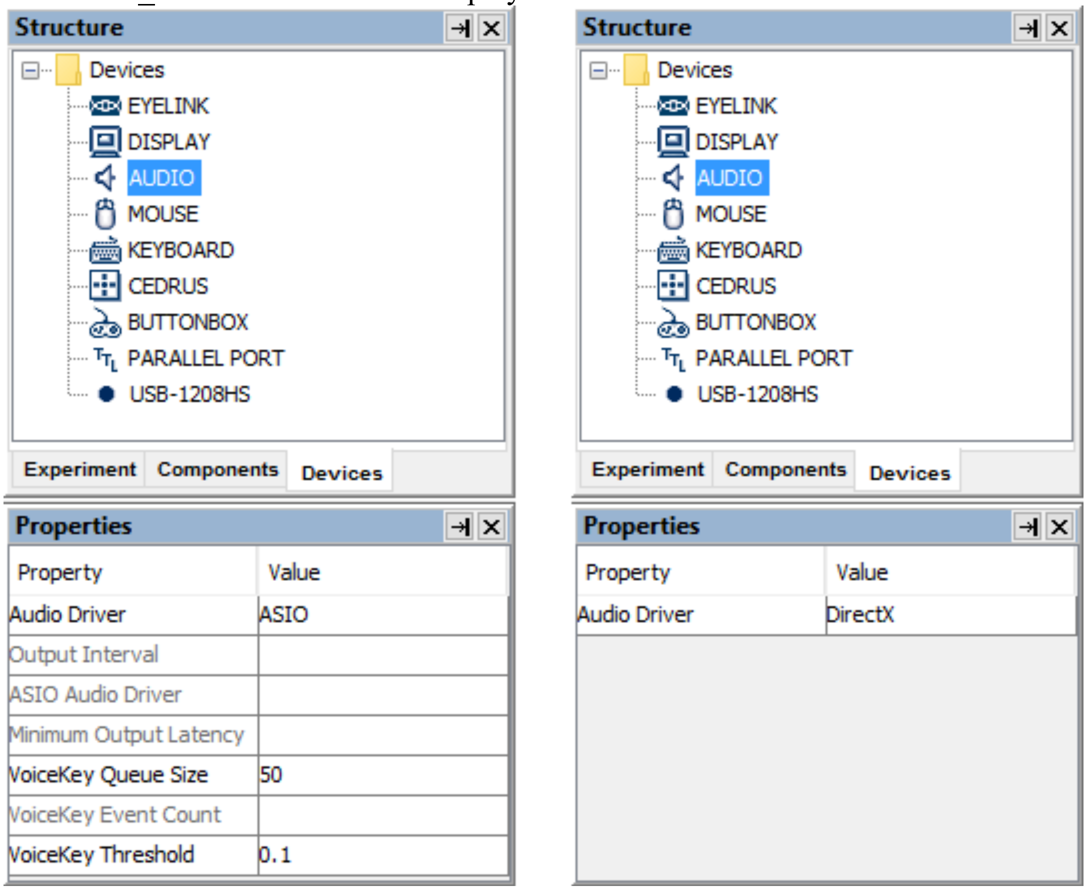


Figure 7-23. Choose Audio Driver.

The following table lists the properties of a PLAY_SOUND action.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the PLAY_SOUND Action. The default value is "PLAY_SOUND".
Type #	NR		The Experiment Builder object type for this node (PlaySound).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the sound called in the PLAY_SOUND action begins playing.
NTP Time	.ntpTime	Float	NTP server time when the PLAY_SOUND action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the

			node starts (the sound playing has not started yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Audio Device #	NR		Indicates the current audio driver setting (either DirectX or ASIO in Windows, or OS X in macOS). This field is neither editable nor referable.
Sound File	.firstSoundFile	String	The name of the sound file. This is automatically set to one of the sound files in the library ("None" if no sound file is loaded in the library).
Volume	.firstVolume	Float	Adjusts the volume of audio playing. Volume ranges from 0.0 (muted) to 1.0 (full volume). The default value is 1.0.
Playing #	.playing	Boolean	Whether the sound is currently playing. The possible values are "True" and "False". Returns "False" if the sound has not started playing, if sound playing is paused (with DirectX driver), or if sound playing is done.

Note: The following fields are specific to the ASIO driver only.

Balance	.firstPan	Float	Adjusts the balance of the sound buffer. Balance ranges from -1.0 (left channel only) through 0.0 (left and right channels have equal volume) to 1.0 (right channel only). Balance works by attenuating one of the channels: for example, at a pan of 0.5 the right channel is at full volume while the left channel is at a volume of 0.5. This option is not available on macOS.
Estimated Prepare Time	.estimatedPrepareTime	Float	If the sound is scheduled enough in advance it will play on time. The estimated time to prepare for clip playing for guaranteed performance will be the ASIO minimum output latency * 2.
Play Start Sample	.playStartSample	Integer	The position within the buffer for the start of play (samples from the beginning of the file loaded into buffer; 0, beginning of the buffer). In Windows, this option is only available when using the ASIO driver.
Play End Sample	.playEndSample	Integer	The position within the buffer for the end of play (samples from the beginning of the file

			loaded into buffer; 0, end of the buffer). In Windows, this option is only available when using the ASIO driver.
Play Start Time #	.playStartTime	Float	Reports the Display PC time (in milliseconds from the start of the experiment) at which the first sample of a clip was played. This is set to 0 when the clip playing is scheduled, and is updated when the clip begins playing. End of audio play can be determined by checking when the .playing attribute returns "False" and the .playStartTime attribute returns a value greater than 0.
Buffer Max Samples #	.bufferMaxSamples	Integer	Reports the maximum number of samples the audio buffer allocated can hold.
Sample Count #	.sampleCount	Integer	Reports the actual sample count stored in the buffer.
Is Mono #	.ismono	Boolean	Reports whether the buffer contains mono or stereo data.
Sample Rate #	sampleRate	Integer	Reports the sample rate (in samples per second) of the buffer. All of the audio buffers have a sample rate of either 48,000 or 24,000 samples per second, chosen to be compatible with most ASIO drivers.
Current Play Position #	playPosition	Float	Reports the current play position (time in milliseconds from the start of the clip playing).
Current Sample #	.currentSample	Integer	Reports the current sample being played.

When you run a project using the ASIO driver in Windows, a "Creative ASIO Control Panel" dialog box will show up. This latency sets the minimum output latency of the ASIO driver (delay from buffer switch to first sample output) and the interval (in milliseconds) between ASIO buffer swaps (i.e., how often new sounds can be output). For better ASIO playing/recording performance, set the ASIO buffer latency to 10 ms (the default is 50 ms).

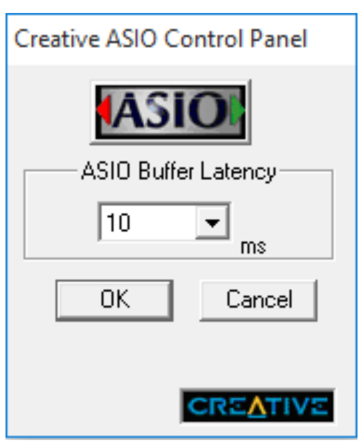


Figure 7-24. Setting ASIO Buffer Latency.

The synchronization of audio and visual presentations is critical in some experiments. When the DirectX driver is used for playing an audio clip, the play sound action is done as quickly as possible; however, no timing certainty should be expected when using this audio driver. If using Windows to create and run an experiment requiring accurate audio timing, the ASIO driver should be used. The ASIO driver creates two audio buffers for each input or output channel. When producing sounds, one buffer is being played by the sound card while the other buffer is being filled with sound data by Experiment Builder. When the ASIO driver finishes playing its buffer, the application and driver buffers are switched. This means that sounds are actually produced at a short (but highly predictable) delay after the data is stored in the buffer. Since the Creative Labs sound cards we recommended have a typical latency setting of 10 milliseconds, this would have a buffer switch interval of 10 milliseconds and an output delay of 10 milliseconds. The time that the clip was actually played will be accurately reported in the EDF file. When using an ASIO driver:

- If the start of a sound has been commanded far enough in advance of the time the sound is to be played (e.g., the PLAY_SOUND action is preceded by a TIMER trigger with a duration of greater than 20 ms), Experiment Builder will be able to write the sound data in advance to the ASIO buffer and therefore the first sample of the clip will be emitted from the sound card within 3 milliseconds (plus or minus) of the scheduled time.

- If the sound is commanded to happen as quickly as possible (e.g., for example in response to a participant's response, external signal, or eye movement event), or if the sound play command was not given far enough in advance (e.g., the PLAY_SOUND action is preceded by a TIMER with a duration shorter than 20 ms or is not preceded by a timer), Experiment Builder is unable to compensate for system delays and the audio will begin after a short delay. However, the exact moment that the sound will play is predictable and can be reported precisely for analysis later.

- Experiment Builder allows users to schedule the audio playback at a predictable time relative to the visual stimulus presentation when the display screen and play sound actions are separated by only a TIMER trigger. Experiment Builder also allows users to play audio files directly from the DISPLAY_SCREEN action by enabling the "Synchronize Audio" check box. Users then specify the clip to be played and the time offset relative to the display onset (a negative offset value means the audio clip will be played before the visual stimulus, and a positive offset means the visual information will be presented earlier). A PLAY_SOUND action is not necessary if the audio playing is scheduled through the "Synchroniz e Audio" option of the DISPLAY_SCREEN action. You may check out one example in the .CHM version of this document (section "Installation → Windows PC System Requirements → ASIO Card Installation → Related → Using ASIO Driver"). In Windows this option is only available if ASIO is selected as the Audio Device.

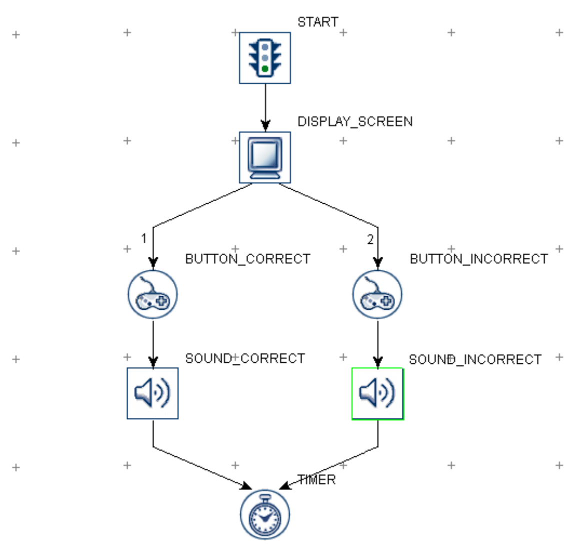
Audio played with the ASIO driver will have messages automatically logged in the EDF (EyeLink experiment) or message file (non-EyeLink experiment with the "Save Messages" option enabled in the project node). The start time of audio playing is logged with a "!V APLAYSTART" message and the end time is marked by a "!V APLAYSTOP " message. Both messages have a negative time offset typically preceding this message.

- Playing Starts: MSG <EDF time> <offset> < !V APLAYSTART> <start frame> <clip id> <audio file>
- Playing Ends: MSG <EDF time> <offset> <!V APLAYSTOP > <stop frame> <clip id> <audio file>

In the following example, the FIXATION_SCREEN is displayed at time 10400921 [10400919 - (-2)], and the PLAY_BEEP sound is emitted at time 10401021 [10401007 - (-14)]. So the delay between FIXATION_SCREEN and PLAY_BEEP is 100 ms.

```
MSG 10400919 -2 FIXATION_SCREEN
MSG 10401007 -14 !V APLAYSTART 0 1 library\audio\innertrialbeep.wav
MSG 10401021 PLAY_BEEP
MSG 10401903 -14 !V APLAYSTOP 19755 1 library\audio\innertrialbeep.wav
```

The following figure illustrates the use of the PLAY_SOUND action to provide feedback on participant's performance: if the participant presses the correct button, one sound is played; if the participant presses the wrong button, another sound is played. For each PLAY_SOUND action, the user specifies the desired sound file to be played from the library.



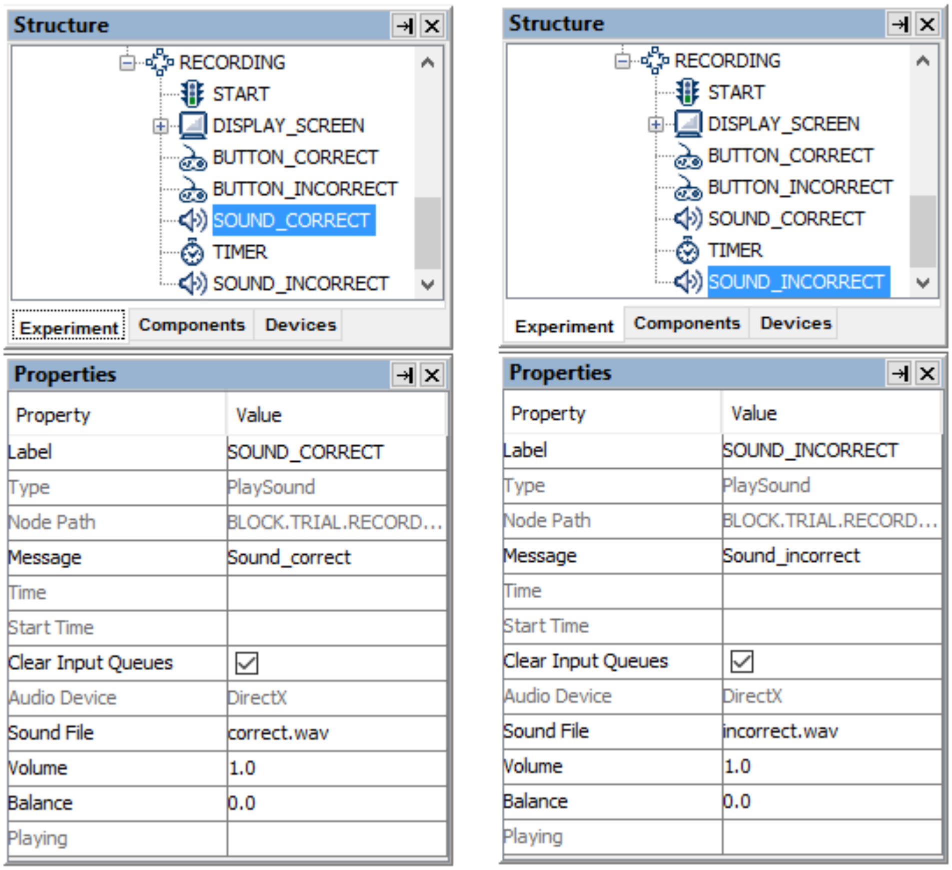


Figure 7-25. Using Play Sound Action.

7.9.14 Play Sound Control

The PLAY_SOUND_CONTROL action () stops, pauses, or plays a specified play sound action.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the Play Sound Control action. The default label is "PLAY_SOUND_CONTROL".
Type #	NR		The Experiment Builder object type for this node (PlaySoundControl).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the action is done.
NTP Time	.ntpTime	Float	NTP server time when the action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start

			of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Target Play Sound Action *¶	NR		The intended sound action to be controlled (stop, pause, or play). This can be either a Play Sound action, or a Display Screen action with the "Synchronize Audio" option enabled.
Operation *¶	.operation	String	Action to control the current audio playing: STOP, PAUSE, or PLAY (continue playing a paused audio).

The following graph illustrates playing a sound file (PLAY_SOUND_DIRECTX) for 1 second (TIMER_PLAYING), pausing the playback (PAUSE_AUDIO) for 1 second (TIMER_PAUSING), and then resuming playback (UNPAUSE AUDIO) with the DirectX driver.

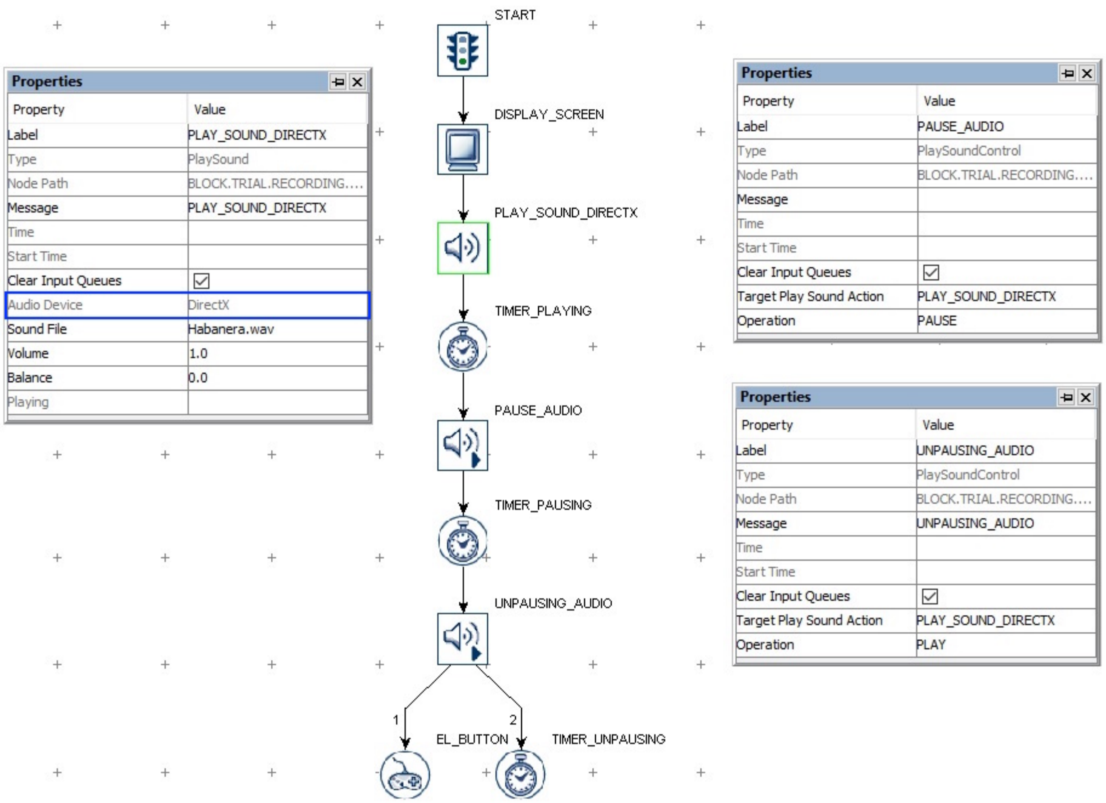


Figure 7-26. Using Play Sound Control Action.

7.9.15 Record Sound

The Record_Sound action () supports recording audio to a .WAV file, and can be used with the Voicekey Trigger to record and measure latency of verbal responses. The recommended experimental procedure would be to record a .WAV file for each trial, specifying a unique filename for each trial, and to use the Voicekey Trigger to detect the response. Recorded data is always written to an audio buffer first, and can later be copied to a .WAV file. A message placed in the EDF file will mark the exact time and position in the .WAV file of the first recorded sample for analysis. The resulting .wav files are saved in "results\{session name}\recorded_audio" folder.

This action is only supported in macOS or in Windows using the ASIO Audio Device.

The following table lists the properties of a RECORD_SOUND action.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the Record Sound action. The default label is "RECORD_SOUND".
Type #	NR		The Experiment Builder object type for this node (RecordSound).

Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the action is processed (i.e, Experiment Builder releases execution from the current node and is ready to move on to the next node; the audio recording is already in progress).
NTP Time	.ntpTime	Float	NTP server time when the action is processed.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
File Name	.fileName	String	Filename (.wav) for the audio clip. Ideally this should use a unique file name for each of the recording trials (e.g., a reference to the trial iteration or a data source column with a unique trial identifier). If the same file name is used across trials, only the recording of the last trial will be saved.
Duration	.duration	Integer	Maximum duration for the sound recording. **Note:** An "Audio not recording; End of buffer reached" message will be written to the warning.log file if the maximum recording duration has been reached.
Status #	.status	Integer	Current status of the record_sound action. 1 (recording yet to be started), 0 (recording in progress), -1000 (recording finished).
Position #	.position	Integer	Position into recording (in milliseconds since the recording started). Returns 0 before or after recording.
Record Start Time #	.recordStartTime	Float	Display PC time (in milliseconds from the start of the experiment) when the audio recording starts (i.e., the first audio sample as reported by

			the audio device). This is the property you may use to report the actual start time of the audio recording. Returns 0 before or after recording.

A possible trial recording sequence involving audio recording would be:

1) Add a RECORD_SOUND action to open the recording file for the trial.
2) Present visual events with DISPLAY_SCREEN action.
3) Add a Voice Key trigger to the DISPLAY_SCREEN in addition to other trigger types (if required).
4) Wait until timeout or a VOICE_KEY trigger event.
5) Blank the display immediately (or after a very short delay) to let the participant know their utterance has been detected.
6) Add a timer trigger so that recording can be continued for a short period (e.g., 1000 ms) to ensure the entire word has been recorded. If a long response is expected, you may want to continue checking the Voice Key and end only after 1000 ms or so of silence.
7) Close the recording .WAV file with the RECORD_SOUND_CONTROL action.

The following graph illustrates the above event sequence.

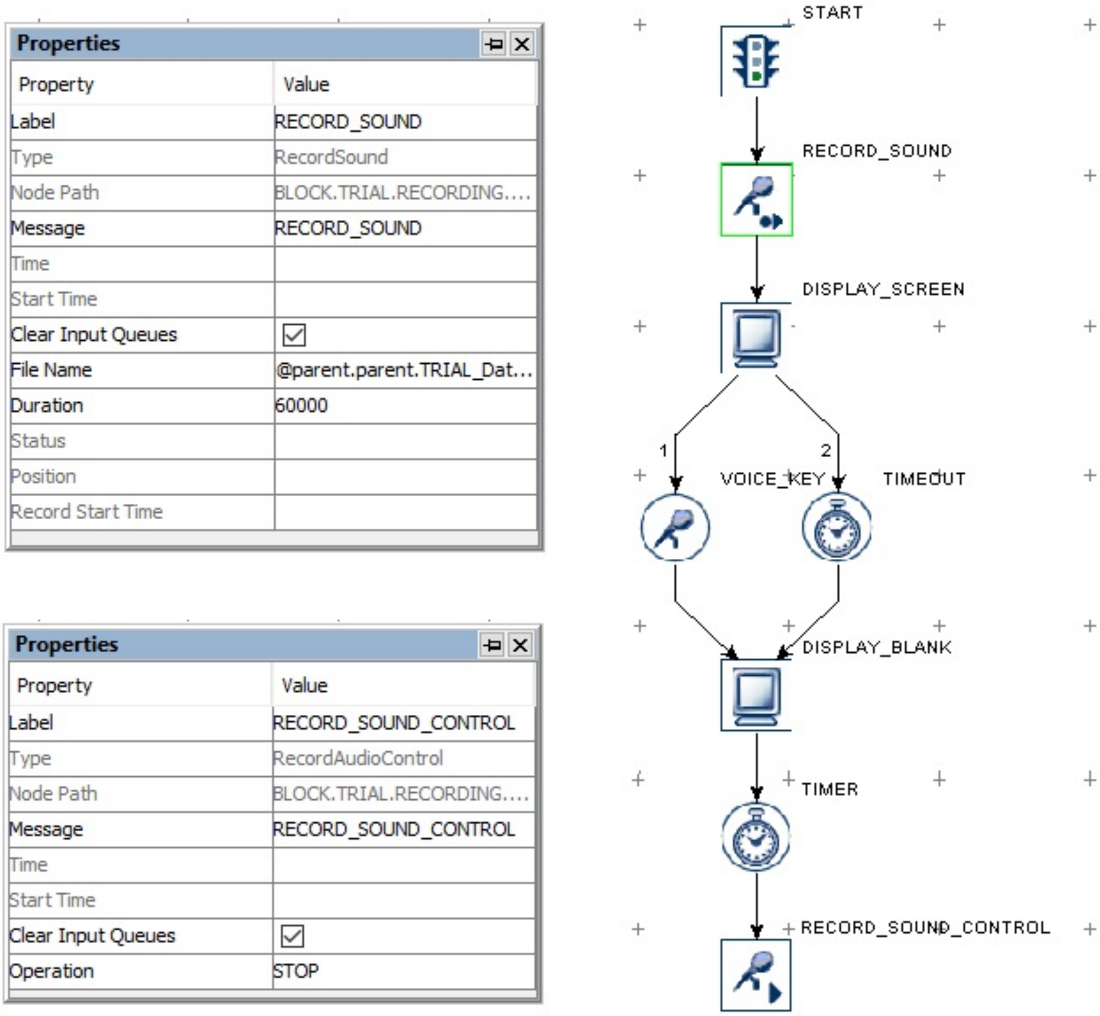


Figure 7-27. Using Record Sound Action.

7.9.16 Record Sound Control

The Record Sound Control action () is used to stop, pause, resume, or abort the current sound being recorded. This action is only supported if macOS is used or if an ASIO-compatible sound card is installed in the Windows computer and the Audio Device is set to "ASIO".

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the Record Sound Control action. The default label is "RECORD_SOUND_CONTROL".
Type #	NR		The Experiment Builder object type for this node (RecordAudioControl).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an

			EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the action is done.
NTP Time	.ntpTime	Float	NTP server time when the action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Operation *¶	.operation	String	Action (STOP, PAUSE, RECORD, or ABORT) used to control the current audio recording. STOP: Stops the current audio recording, writes out the data stored in the record buffer to the .wav file; and frees the buffer. ABORT: Stops the current audio recording without saving the .wav file. PAUSE: Pauses the current audio recording. Recording may be continued by using the "RECORD" action. RECORD: Resumes a paused recording.

The RECORD_SOUND_CONTROL action can only be applied after a RECORD_SOUND action. For the usage of this action, please take a look at the Record Sound example.

7.9.17 Terminating an Experiment

The experiment ends when all iterations of sequences have been executed. Users can choose to terminate an experiment earlier by using the TERMINATE_EXPERIMENT action (). All of the nodes following the TERMINATE_EXPERIMENT node and remaining sequence iterations will be ignored.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the TERMINATE_EXPERIMENT action. The default value is “TERMINATE_EXPERIMENT”.

Type #	NR		The Experiment Builder object type for this node (TerminateExperiment).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the TERMINATE_EXPERIMENT action is done.
NTP Time	.ntpTime	Float	NTP server time when the TERMINATE_EXPERIMENT action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.

In the following example (Figure 7-28), an ERROR_COUNT variable is used to store the number of errors made in the experiment. When a target button is pressed, the ERROR_COUNT is updated. If the error count exceeds a pre-set number, the experiment can be terminated earlier by the TERMINATE_EXPERIMENT action.

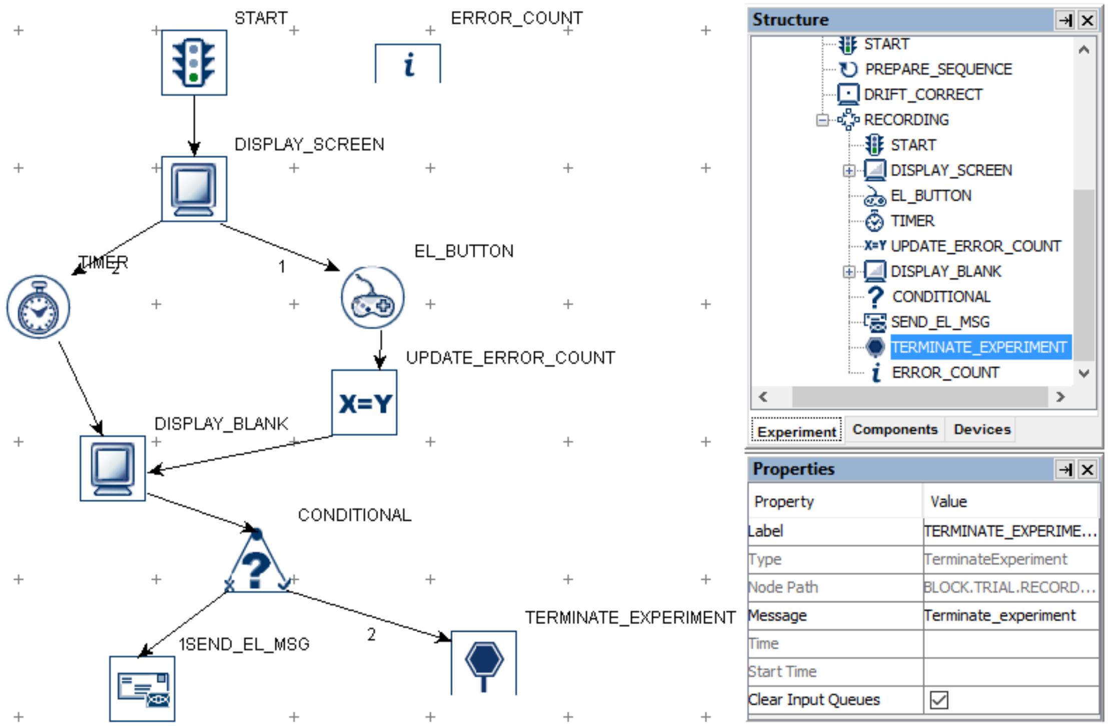


Figure 7-28. Using Terminate Experiment Action.

7.9.18 Recycle Data Line

The Recycle Data Line action () directs the experiment program to perform the current data-source line at a later time. **Note**: A Recycle Data Line action must be used inside a sequence. If a Recycle Data Line action is used when neither the current sequence nor the parent sequences have a data source, a build-time error will be raised.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the Recycle DataLine action. The default value is "RECYCLE_DATALINE".
Type #	NR		The Experiment Builder object type for this node (RecycleDataLine).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the action is done.
NTP Time	.ntpTime	Float	NTP server time when the action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this

			time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Data Source #	NR		The data source from which the current trial data line will be repeated.
Recycling Mode *¶	.recyclingMode	String	Method of data source line recycling. If set to "IMMEDIATE", the same data-source line will be repeated in the next trial; if set to "RANDOM", the data-source line will be repeated at a random point later; if set to "END", the data-source line will be repeated at the end of the experiment. If the experiment uses internal randomization with a blocking level manipulation, the recycled trial will be repeated within the current blocking level.

The Recycle Data Line action can be used to recycle a trial and rerun it at a later time. The built-in Boolean variable "TRIAL_RECYCLED_" reports the recycling status of the current trial. The following graph illustrates the case of recycling the trial if the participant presses button 5. (**Note**: A dummy action such as NULL_ACTION or ADD_TO_LOG node should be added to the false/left branch of the CONDITIONAL trigger.)

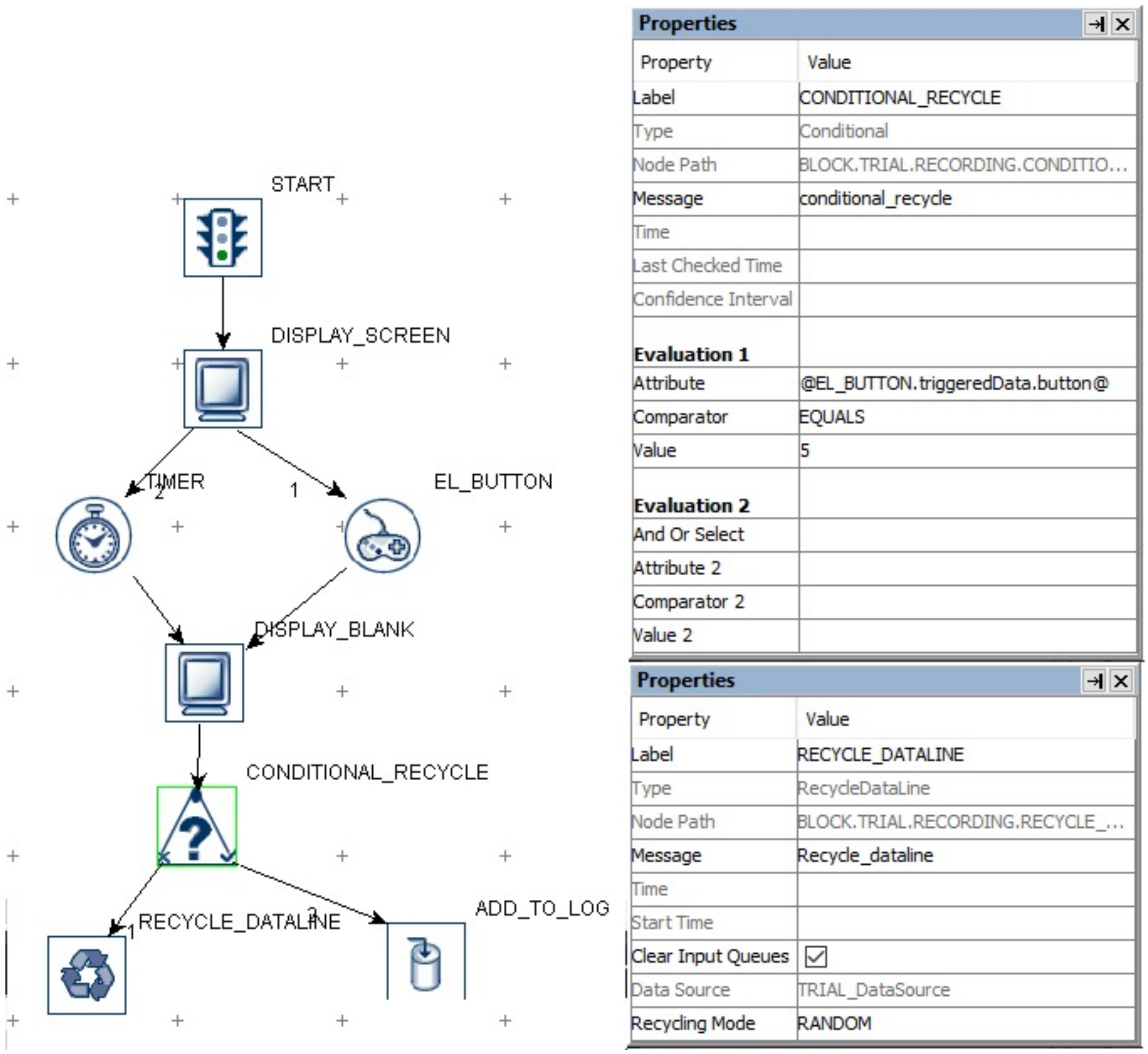


Figure 7-29. Using Recycle Dataline Action.

7.9.19 Execute Action

The Execute action () is used to execute a method defined in the custom class python code (see section 12.5 "Using Custom Class" for details). This node will be available only if the "Enable Custom Class" option is enabled in the Experiment Preferences (see section 17.1 "Experiment").

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the Execute action. The default label is "EXECUTE".
Type #	NR		The Experiment Builder object type for this node (Execute).
Node Path #	.absPath	String	Path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an

			EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the action is done.
NTP Time	.ntpTime	Float	NTP server time when the action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Execute Method	NR		Method of a custom class to be executed. Click the right side of the value field to start the attribute editor to locate a method defined in a custom class instance. If a method defined in a custom class is already linked to this field, double clicking the EXECUTE node should bring up the custom class editor, with the current editing position set to the start of the method that the execute action is using.
Parameter(s)	NR		A list of parameters the execute method may take.
Result #	.result		Result of the execution method.
Result Data Type #	NR		Type of the data returned by the execute method.

7.9.20 Null Action

The Null Action node ( ), as suggested by its name, does not perform any actual action. It is primarily used for two reasons:

a) Controlling the experiment flow. For example, the current linking rules do not allow for a direct connection between a sequence and triggers. A null action can be used as a dummy action in between, instead of using a SEND_EL_MESSAGE action or an ADD_TO_LOG action. The null action can also be attached to the unused branch of a conditional trigger so that the experiment flow can continue. It can also be used between two successive triggers to make the reading of the experiment graph less ambiguous.

b) Clearing cached trigger data.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the NULL_ACTION action. The default value is "NULL_ACTION".
Type #	NR		The Experiment Builder object type for this node (NullAction).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the action is done.
NTP Time	.ntpTime	Float	NTP server time when the action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.

The following illustrates one common use of the NULL_ACTION node. Suppose that in an experiment, the participant's response should be recorded without ending the trial (e.g., pressing a key or button whenever the participant detects a specific event in the video clip). This can be done by adding a NULL_ACTION node after the DISPLAY_SCREEN and having the input trigger branch looping back to the NULL_ACTION - use an UPDATE_ATTRIBUTE action following the input trigger to collect response data. All other triggers initially attached to the DISPLAY_SCREEN action should be connected from the NULL_ACTION as well. Please note that if a TIMER trigger is used to end the trial, the "start time" should be set to the .time of the DISPLAY_SCREEN so that the start time of the TIMER trigger will not be reset whenever a key is pressed.

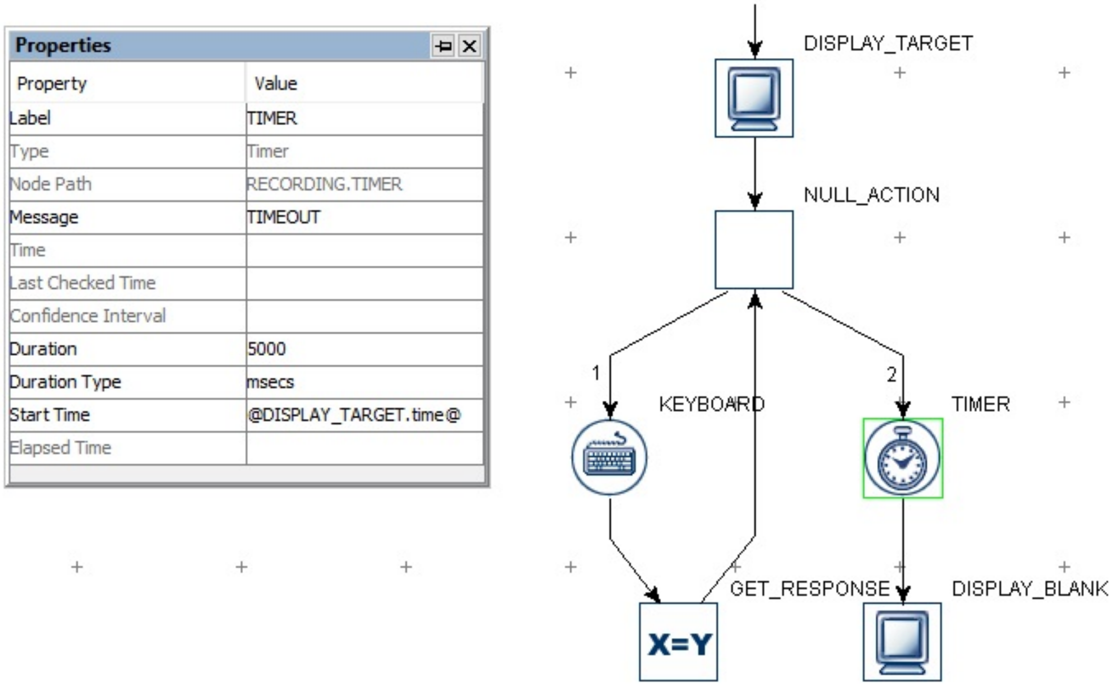
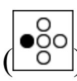


Figure 7-30. Using a NULL_ACTION node.

7.9.21 ResponsePixx LED Control

If a ResponsePixx button box is used as the EyeLink button box, this action () allows the user to turn on/off the LEDs on the button box. This option is only available in EyeLink experiments when the "Type" of the BUTTONBOX device is set to "ResponsePixx Button Box".

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the RESPONSEPIXX_LED_CONTROL action.
Type #	NR		The Experiment Builder object type for this node (RESPONSEPixxLEDControl).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file when the action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the RESPONSEPIXX_LED_CONTROL action is done.
NTP Time	.ntpTime	Float	NTP server time when the RESPONSEPIXX_LED_CONTROL action is done.

Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	I If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Button One †	.button1	Boolean	Whether the LED for button one should be turned on or not.
Button Two †	.button2	Boolean	Whether the LED for button two should be turned on or not.
Button Three †	.button3	Boolean	Whether the LED for button three should be turned on or not.
Button Four †	.button4	Boolean	Whether the LED for button four should be turned on or not.
Button Five †	.button5	Boolean	Whether the LED for button five should be turned on or not.

The following figure illustrates the use of the ResponsePixx_LED_Control action. All of the LEDs are turned off at the beginning of the trial. The participant presses either button 2 or 4. Once the button is pressed, the LED for that button is turned on. The experiment project can be downloaded from the HTML version of this document.

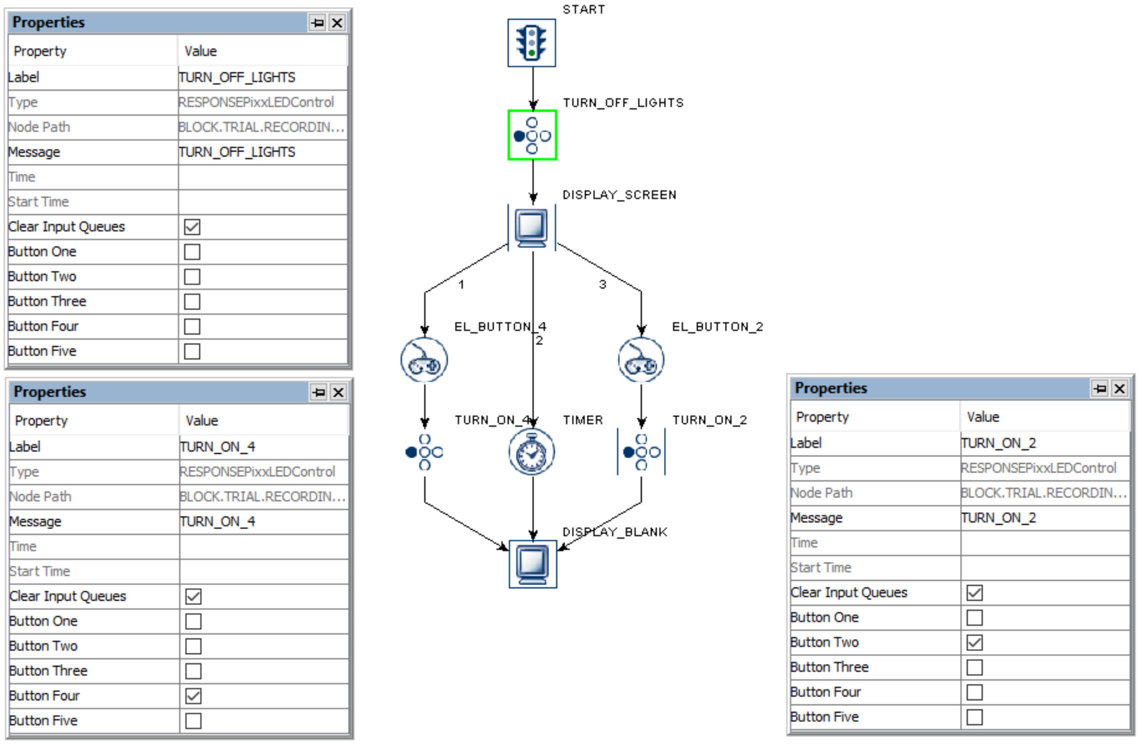


Figure 7-31. Using a ResponsePixx LED Control Action.

7.9.22 Biometric TTL Control

The Biometric TTL Control action ( ) is used to send event markers to biometric recording devices that accept incoming TTL signals. An improved version of the SET_TTL action, the Biometric TTL Control action includes enhanced device support, and streamlines the process of configuring and sending event markers to biometric recording devices. With the Biometric TTL Control, users can send TTL signals from a Windows Display PC using a parallel port, LabHackers USB2TTL8 device, or Measurement Computing USB-1208HS device, or from USB2TTL8 on a Mac, or from the EyeLink Host PC using a parallel port, USB-1208HS, or digital port from a supported analog card. If using the Biosemi EEG system, the Biosemi USB interface is also supported (users need to set the proper COM port of the Generic Serial Port device). When users change the “TTL Device” selection of the Biometric_TTL action, a prompt will be displayed so that users can decide whether the change in the TTL device will be applied to all other existing and future Biometric_TTL nodes that interface the same recipient biometric instruments.

The Biometric TTL Control also allows users to easily send a clearing signal (typically 0x0) shortly after the initial signal by enabling the “Send Clearing TTL” property. Users can then configure separate messages for the signal TTL and clearing TTL events. If sending only one signal (and no clearing signal), the action returns immediately after the signal is sent; if the clearing is performed, the node will return only after the clearing signal is sent, so it is best to keep the Signal Duration brief (the default duration is 20 msec). If using the Biosemi USB interface, please disable “Send Clearing TTL” as the device has a built-in 8 millisecond pulse duration.

The “Start Recording” and “Stop Recording” options of the Biometric TTL Control action can send signals controlling the start and stop of the recording for many recording devices from Experiment Builder. When the Recipient Biometric Device is set to “Biosemi” or “Neuroscan”, the Start Recording and Stop Recording operations will already be configured appropriately for these devices. Please see “Neuroscan_EyeLink_Simple.pdf” or “Biosemi_EyeLink_Simple.pdf” in the “\Documents\ExperimentBuilder Examples\EEG Integration” folder to see instructions on how to configure the start and stop recording trigger values on the Neuroscan (if running on the Curry software) or Biosemi host computer. If using another type of recording device, set the Recipient Biometric Device to “Generic Biometric Device”. To configure the signals sent to control the recording, first select the operation to configure (i.e., Start Recording or Stop Recording). Then click the value cell for the “TTL Signal Properties” property to open an editor window. Any modifications will be saved upon closing the editor and will be applied to all other Biometric TTL control nodes using the same operation.

As noted above, the Biometric TTL action provides built-in integration with Neuroscan (if running on the Curry software) and Biosemi EEGs, and can be used to interface other biometric devices that receive TTL signals. Note however that integration with Brain Products and EGI EEGs is done through dedicated control interfaces. The Brain Products EEG integration uses a Brain Products device (see section 17.1.14) and Brain Products Control action (section 7.9.24); integration with EGI’s Net Station interface uses a dedicated Net Station Device (section 17.1.12) and Net Station Control action (section 7.9.23).

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the BIOMETRIC_TTL action.
Type #	NR		The Experiment Builder object type for this node (BiometricTTL).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the first TTL signal is sent. If the “Send Clearing Signal” option is enabled, users can send an additional message using the “Clearing Message” field.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the TTL signal is sent. If the “Send Clearing Signal” option is enabled, this will be the time when the clearing signal is

			sent.
NTP Time	.ntpTime	Float	NTP server time when the TTL signal is sent. If the "Send Clearing Signal" option is enabled, this will be the time when the clearing signal is sent.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Recipeint Biometric Device ¶ *	.biometricDevice	String	Select the Biometric device to which to send TTL signals. The default is "Generic Biometric Device". If "Biosemi" is chosen, the settings for the node will be automatically configured to Biosemi defaults. If using an EGI or Brain Products EEG device, you can instead enable the TCP/IP integration for these devices under "Edit -> Preferences -> Experiment" by checking the box to enable either the Net Station or Brain Products Control Interface. Examples and documentation can be found in "Examples\EEG Integration" folder.
Operations ¶ *	.operations	String	Select one of the operations that can be performed using this action: "Send TTL Signal to Biometric Device", "Start Recording", or "Stop Recording".
TTL Device ¶ *	.TTLDevice	String	Select a device from which to send TTL signals. Includes the Display PC parallel port (Windows only), Host PC parallel port (EyeLink projects only), the LabHackers USB2TTL8 device, and the Measurement Computing USB-1208HS device.
Register ¶	.register	String	Usually set as "DATA" register. Note this option is only available when the "TTL Device" is set to a parallel port.
Mode *	.mode	String	Either "Word" mode (the decimal or hexadecimal value of the TTL output signal) or "Pin" mode (setting the value of each individual pins).
Data	.data	Integer	The byte value of the current TTL output signal.

			It could be a decimal or hexadecimal value. This field is only available if the "Mode" property is set to "Word". If a decimal value is entered, it will be automatically translated into a hexadecimal value.
Pin0 Pin1 Pin2 Pin3 Pin4 Pin5 Pin6 Pin7 Pin8 Pin9 Pin10 Pin11 Pin12 Pin13 Pin14 Pin15¶	.pin0 .pin1 .pin2 .pin3 .pin4 .pin5 .pin6 .pin7 .pin8 .pin9 .pin10 .pin11 .pin12 .pin13 .pin14 .pin15	String	The desired value for the corresponding pins. The pin value can be either "ON" (high) or "OFF" (low). These fields are only available if the "Mode" property is set to "Pin". For parallel port, USB2TTL8 and EyeLink Host TTL, eight pins are available. If using a USB-1208HS box, the available output pins can be configured through the device preferences.
TTL Signal Properties *	NR		The properties of the TTL signal to be sent as the Start and Stop Recording operations. Clicking on the value field will bring up an "Edit TTL Signal Properties" dialog box to edit the values. Note that editing the TTL Signal Properties of a node set to Start Recording or Stop Recording will change the TTL Signal Properties of all nodes set to the same Operation.
Send Clearing TTL * †	.sendClearingSignal	Boolean	Whether a clearing TTL should be sent following the main signal.
Signal Duration	.signalDuration	Integer	Duration of the first TTL signal before the clearing TTL is sent. This option is only available if the "Send Clearing TTL" option is enabled.
Clearing Value	.clearingValue	Integer	The byte value of the clearing TTL. This can be a decimal or hexadecimal value—if a decimal value is entered, it will be automatically translated into a hexadecimal value. This option is only available if the "Send Clearing TTL" option is enabled.
Clear Pin0 Clear Pin1 Clear Pin2 Clear Pin3 Clear Pin4 Clear Pin5 Clear Pin6 Clear Pin7	.cpin0 .cpin1 .cpin2 .cpin3 .cpin4 .cpin5 .cpin6 .cpin7	String	The desired value for the corresponding clearing pins. The pin value can be either "ON" (high) or "OFF" (low). These fields are only available if the "Mode" property is set to "Pin". For parallel port, USB2TTL8 and EyeLink Host TTL, eight pins are available. If using a USB-1208HS box, the available output pins can be configured through the device preferences.

Clear Pin8 Clear Pin9 Clear Pin10 Clear Pin11 Clear Pin12 Clear Pin13 Clear Pin14 Clear Pin15¶	.cpin8 .cpin9 .cpin10 .cpin11 .cpin12 .cpin13 .cpin14 .cpin15		
Clearing Message	.clearingMessage	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the clearing TTL is sent. This option is only available if the "Send Clearing TTL" option is enabled.

7.9.23 Net Station Control

Experiment Builder supports controlling the recording of NA300 and NA400 series EEG systems by Philips Neurodiagnostics/EGI. It integrates with the Net Station software using TCP/IP communications to the Net Station PC, using the NTP timing protocol to ensure synchronization between events recorded in Experiment Builder and the EEG data collected in Net Station. To enable the Net Station TCP/IP communication, go to "Preferences -> Experiment" and then enabling the "Use Net Station Experiment Control Interface" option. When the experiment is run, Experiment Builder will read the clocks of the Display PC, EyeLink Host PC, and EEG amplifier at the beginning of the session, then at regular intervals (60 seconds by default). At each synchronization point, Experiment Builder will log a "__NTP_CLOCK_SYNC__" message to the EDF file.

When Net Station Experiment Control is enabled, the NET_STATION_CONTROL action () will be available. This action is used to control Net Station operations and to send event data to Net Station.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the NET_STATION_CONTROL action.
Type #	NR		The type of Experiment Builder object ("NetStationControl") the current node belongs to.
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be written to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when

			performing the Net Station Control action.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the Net Station Control action is performed.
NTP Time #	.ntpTime	Float	NTP Server time when the Net Station Control action is performed.
Start Time	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueue s	Boolea n	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Operation *¶	.operation	String	The operation "START RECORDING", "STOP RECORDING", "BEGIN TRIAL", "END TRIAL", "SEND EVENT" to be executed by the Net Station Control action. (The Initialization and Disconnect operations are handled automatically when the experiment starts and ends.)
Stabilization Period (in milliseconds) *	.stabilizationPeri od	Integer	A delay added to the experiment execution following the START RECORDING command of the Net Station so that the amplifier recording stabilizes (1000 to 10000 milliseconds ,depending on the filter; consult the EGI documentation to find the appropriate value). This operation is only applicable when the "START RECORDING" operation is selected.
Event Marker for Beginning of Trial	.beginTrialMarke r	String	When the "BEGIN TRIAL" operation is selected, this specifies the four-character code to to send to Net Station to mark the start of the trial in the data stream ("bgn1" by default).
Additional Data to Send *	.additionalDataT oSend	String	Users may send additional data to the event marker that corresponds to the beginning of the trial. Click the value cell of this property to select the variables to be logged to the begin trial marker. This operation is only applicable when "BEGIN TRIAL" operation is selected.
Trial Specific (TRSP) Event *	.trialSpecificEven t	String	When the "END TRIAL" operation is selected, the Trial Specific Event notifies Net Station of the end of a trial and logs event data to the data stream. Click the value cell of this property to

			select the variables to be logged to the TRSP event marker. To avoid bog down the network communication, please limit the number of variable-value pairs to be sent.
Event Markers *			When the “SEND EVENT” operation is selected, click the value cell of this property to open an “Edit Net Station Event Marker” window to configure the details of the event(s) to be sent to Net Station. To avoid flooding the network communication, include no more than 10 variables in the Key List.
Result #	.result	Integer	The return value from the Net Station. case -1: errstr='Net Station has not been initialized'; case 0: errstr='No error'; case 1: errstr='Net Station host not connected'; case 2: errstr='NS connect: Net Station host name must be specified'; case 3: errstr='NS connect: Unable to connect to host'; case 4: errstr='NS connect: ECI error'; case 5: errstr='NS connect: Unknown ECI version'; case 6: errstr='NS event: Unsuccesful'; case 7: errstr='Unknown Net Station command'; case 8: errstr='Incorrect event calling parameters'; Other: errstr='NS unknown error';

An example experiment can be found in the “Examples\EEG Integration” folder. The “NetStation_EyeLink_Simple” example illustrates creating experiments with simultaneous EEG and eye tracking recordings. The “NetStation_NonEyeLink_Stroop” example illustrates using Experiment Builder to control the Net Station without recording eye tracker data. A quick instruction guide for each example can also be found in the same folder.

Experiment Builder automates the operations of connecting and disconnecting from Net Station, and opening and closing Net Station sessions. (When starting a new experiment, users will still need to manually provide the name of the EEG recording file on the Net Station control computer.) Within an Experiment Builder project, the Net Station Control action can be used to start and stop the EEG recordings, mark the beginning and end of each trial, and send out customized event markers (e.g., marking event conditions, responses, etc.). Typically, users will send a Start Recording command at the beginning of a block of trials and a Stop Recording at the end the block, or just a single Start Recording at the beginning of the experiment and a single Stop Recording at the end of the experiment—please check your EEG analysis software to determine the optimal recording configuration required. (It is not advisable to start and stop the Net Station recording on each trial.) Users can call the “BEGIN TRIAL” operation at the beginning of the trial and the “END TRIAL” operation at the end of the trial to mark the trial segmentation and send trial-specific data if desired. When the "START RECORDING" operation is called, a delay will be added to the experiment execution so that the amplifier recording stabilizes (1000 to 10000 milliseconds depending on the filter used; consult the EGI documentation for more information). We recommend presenting a DISPLAY_SCREEN action right before the "START RECORDING" operation to inform the user of the delay period.

Users can send an event to Net Station marking each of the critical events (e.g., display and audio onsets, participant responses) in the trial. The "Send Event" operation to mark these events can be performed immediately after the target event, or at the end of the trial. If timing within a portion of the trial is an important factor, users may delay the sending of the event until later, including multiple event markers in a single Net Station Control action at the end of the trial. **Important:** Do not send simultaneous events (that is, events with the same time stamps) to Net Station. Although Net Station can record simultaneous ECI events, users will not be able to access them properly because the events appear on the same track.

When the "SEND EVENT" operation is used, clicking the "Event Markers" field will display an "Edit Net Station Event Markers" dialog box (see Figure 7-32). Click the "New" button to add a new event in the table and the "Delete" button to remove a selected event. Users can configure the details of the event marker. To avoid flooding the network communication, please limit the number of variable-value pairs in the "Key List" to no more than 10. A build time warning will be given if the number of variables in the Key List exceeds 10.

Event Code (Required field)	A unique, user-defined, four-character descriptor type that identifies this event type. For example, you might user the code "AUDI" to indicate the audio stimulus.
Start Time (Required field)	Start time of the event to be logged (in milliseconds). This field may be set as a reference to the time field of an action, or to the triggeredData.time field of a trigger. Please do not use any "NTP Time" property—Experiment Builder will automatically derive the correct time. If a value (integer or float) entered instead of reference for the start time, it will be treated as offset (whether it's zero or any number) and the offset get added to the current time. If the start time is actually before the initial sync time (when NetStation and NTP sync is made) or a missing data (-32768), then the event marker will be ignored, and a message will be logged to the warning.log file in the results folder.
Duration (Required field)	Event duration (in milliseconds). All events must have a duration of at least one millisecond. By default, use 1 millisecond as the event duration.
Event Label (Optional)	A string with any additional information about the event (256 characters. Max).
Event Description (Optional)	A string that further describes the event.
Key List (Optional)	A list of fields that containing additional properties and data to further relate information about the event. Click this field to select variables to be logged to the event marker.

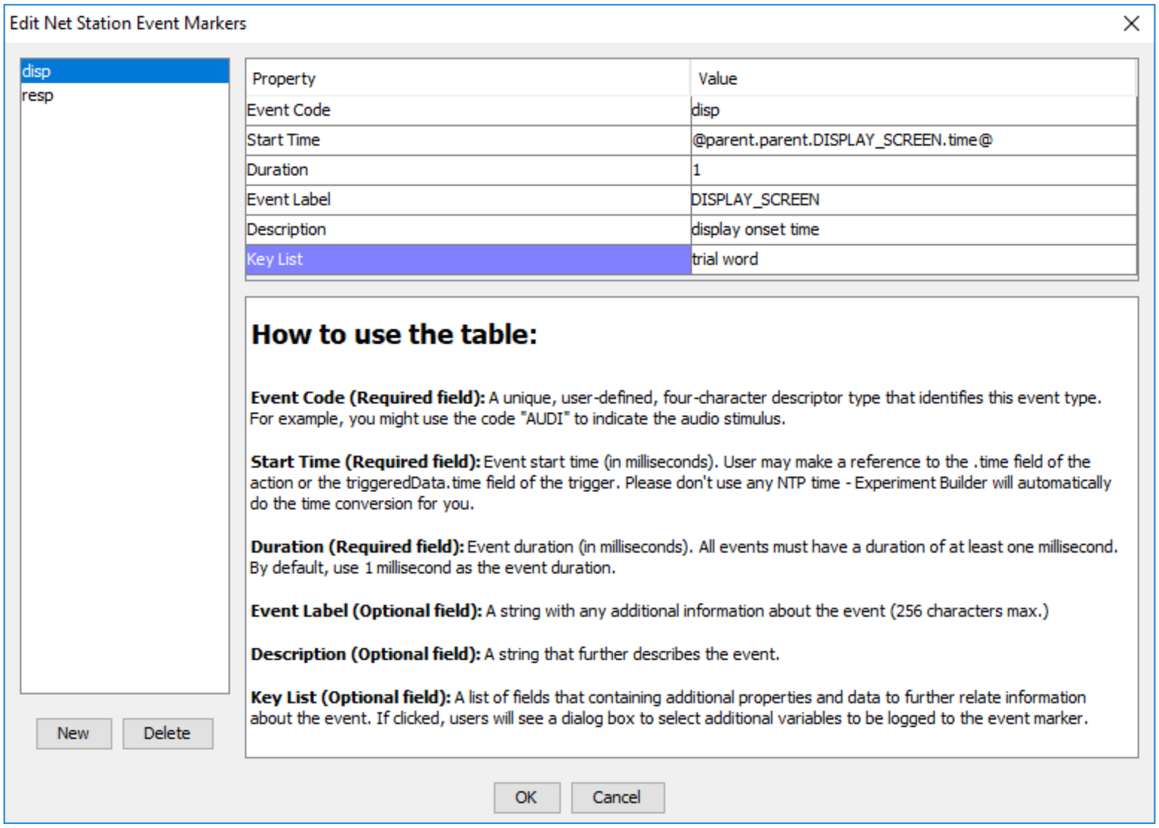


Figure 7-32.Editing Net Station Event Markers.

7.9.24 Brain Products Control

Version 2.2 of Experiment Builder implemented integration with Brain Products EEGs using Remote Control Server 2.0 (RCS 2.0), an interface between TCP/IP and OLE automation interface commands in the BrainVision Recorder. This integration allows an EEG recording using the BrainVision Recorder to be controlled via the network. Make sure the Remote Control Server 2.0 (http://www.brainproducts.com/downloads.php) is installed on the BrainVision Recorder computer. Users of the RCS 2.0 must be familiar with the use of BrainVision Recorder (please see BrainVision Recorder User Manual). To enable the RCS 2.0 communication in Experiment Builder, go to "Edit -> Preferences -> Experiment", and enable the "Use Brain Products Remote Control Interface (RCS 2.0)" option. Enabling the Remote Control Interface will create a BRAIN_PRODUCTS device in Experiment Builder.

Experiment Builder automates the process of opening and closing both the EEG and eye-tracking experiment sessions so the recording sessions from the two devices will be matched. When the Brain Products Remote Control interface is enabled, a BRAIN_PRODUCTS device will be added. Users can configure the IP Address and Port of the BrainVision Recorder computer, the BrainVision Recorder Workspace, Experiment Number, TTL device and other experiment settings through the BRAIN_PRODUCTS device settings.

The Brain Products Remote Control Interface also adds the BRAIN_PRODUCTS_CONTROL action ( ), which can be used in the experiment to start, stop, pause, and resume EEG recordings; send event markers through TTL to mark stimulus and response events; set recorder modes (Monitoring, Impedance, View Test Signal); send annotations; and check the BrainVision application state, Recorder state, and acquisition state. Please note that some of the BRAIN_PRODUCTS_CONTROL operations required certain other steps to be carried out beforehand. For example, RCS 2.0 can only initiate the recording of EEG data if BrainVision Recorder is running in ViewData (monitoring) mode. Users should be familiar with the use of BrainVision Recorder and keep these conventions in mind when programming the experiment.

The Mac version of the Experiment Builder provides the same level of integration support as the Windows version, except that the parallel port and Trigger Box are not available as TTL device on macOS.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the BRIAN_PRODUCTS_CONTROL action.
Type #	NR		The Experiment Builder object type for this node (BrainProductsControl).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the Brain Products Control action is executed.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the Brain Products Control action is done.
NTP Time #	.ntpTime	Float	NTP server time when the Brain Products Control action is done.
Start Time #	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the node starts (the action is not done yet by this time).
Clear Input Queues †	.clearInputQueues	Boolean	If true, all events from input queues are flushed when the action starts. This includes all Experiment Builder triggers, such as keyboard, mouse, TTL, and EyeLink inputs (button, saccade, fixation). This feature is designed to ensure the software only evaluates the upcoming triggers that occur after the start of

			the action. If false, the input queues are not cleared when the action is performed. This means that events already in the queues may be evaluated by the triggers following the action.
Operation ¶ *	.operation	String	The operation ("Set Mode", "Control Recording", "Check State", "Send Annotation", "Send Event Marker", and "Send Raw Command") to be executed. (The initialization and disconnect operations are automatically handled when the experiment starts and ends.)
Results #	.result	String	Results of the control operation.
When the operation is set to "Set Mode"			
View Mode ¶*	.viewMode	String	Sets the view mode of the BrainVision Recorder (i.e., "View Data (Monitoring)", "Impedance Check", "View Test Signal", and "Stop viewing/monitoring"). Note that to record data, the Recorder must be set to the View Data (Monitoring) state.
When the operation is set to "Control Recording"			
Control Recording ¶*	.controlRecording	String	Command to send to the BrainVision Recorder to control the recording status ("Start Recording", "Pause Recording", "Resume Recording", "Stop Recording", and "Perform DC Reset"). Note the operations listed here may require certain other steps to be carried out beforehand: for instance, Start Recording cannot be called if the Recorder is not in "Monitoring" state; and Stop Recording, Pause Recording, and Resume Recording can be called only when the BrainVision Recorder is in the "Recording" state.
When the operation is set to "Check State"			
Application State #	.applicationState	String	The RCS 2.0 allows users to check the state of the BrainVision Recorder during data acquisition. This property returns the state of the BrainVision Application (Opened, Closed, Error).
Recorder State #	.recorderState	String	Returns the state of the BrainVision Recorder (Idle, Monitoring, Calibration, Impedance, Recording, Pause).
Acquisition State #	.acqusitionState	String	Returns the state of the acquisition (Closed, Running, Warning, Error).
Last Error #	.lastError	String	Returns the last acquisition error (if any).
When the operation is set to "Send Annotation"			
Annotation Description	.annotationDescription	String	Users can send an annotation (marker) to the RCS 2.0 (and to BrainVision Recorder) to provide more information on some events when timing is not that relevant/critical. Annotations can only be sent when the Recorder is running

			“Monitoring” or “Saving” state. This property is the description of the annotation. It can have any character value, except for “;” which is used as a separator between the annotation’s description and its type.
Annotation Type	.annotationType	String	This is the type of the annotation. It can have any character value, except for “;” which is used as a separator between the annotation’s description and its type.
Wait for Response †	.annotationWaitForResponse	String	If checked, the action will wait for the RCS 2.0 to send back the whole message, with an additional “:OK” to confirm the acknowledgement, or a message with the last error in case of an error.
When the operation is set to “Send Event Marker”			
Device #	.TTLDevice	String	Reports the device used to send TTL signals (parallel port, EyeLink Host TTL, USB2TTL8, USB-1208HS, or TriggerBox). The TTL Device can be configured in the “Brain Products” device settings. Note that the parallel port and TriggerBox are only supported in Windows, and the EyeLink Host TTL is only supported in an EyeLink experiment.
Register ¶	.register	String	Usually set as "DATA" register. Note that this option is only available when the "Device" is set to a parallel port.
Mode ¶*	.mode	String	Either "Word" mode (the decimal or hexadecimal value of the TTL output signal) or "Pin" mode (the value of each individual pins).
Data	.data	Integer	The byte value of the current TTL output signal. This can be a decimal or hexadecimal value; if a decimal value is entered, it will be automatically translated into a hexadecimal value. This field is only available if the "Mode" property is set to "Word".
Pin0 Pin1 Pin2 Pin3 Pin4 Pin5 Pin6 Pin7 Pin8 Pin9 Pin10 Pin11 Pin12 Pin13 Pin14	.pin0 .pin1 .pin2 .pin3 .pin4 .pin5 .pin6 .pin7 .pin8 .pin9 .pin10 .pin11 .pin12 .pin13 .pin14	String	The desired value for the corresponding pins. The pin value can be either "ON" (high) or "OFF" (low). These fields are only available if the "Mode" property is set to "Pin". For parallel port, TriggerBox, USB2TTL8 and EyeLink Host TTL, eight pins are available. If using a USB-1208HS box, the available output pins can be configured through the device preferences.

Pin15¶	.pin15		
Send Clearing TTL * †	.sendClearingSignal	Boolean	Whether a clearing TTL should be sent following the main signal.
Signal Duration	.signalDuration	Integer	Duration of the first TTL signal before the clearing TTL is sent. This option is only available if the “Send Clearing TTL” option is enabled.
Clearing Value	.clearingValue	Integer	The byte value of the clearing TTL. This can be a decimal or hexadecimal value; if a decimal value is entered, it will be automatically translated into a hexadecimal value. This option is only available if the “Send Clearing TTL” option is enabled.
Clear Pin0 Clear Pin1 Clear Pin2 Clear Pin3 Clear Pin4 Clear Pin5 Clear Pin6 Clear Pin7 Clear Pin8 Clear Pin9 Clear Pin10 Clear Pin11 Clear Pin12 Clear Pin13 Clear Pin14 Clear Pin15¶	.cpin0 .cpin1 .cpin2 .cpin3 .cpin4 .cpin5 .cpin6 .cpin7 .cpin8 .cpin9 .cpin10 .cpin11 .cpin12 .cpin13 .cpin14 .cpin15	String	The desired value for the corresponding clearing pins. The pin value can be either "ON" (high) or "OFF" (low). These fields are only available if the "Mode" property is set to "Pin". For parallel port, TriggerBox, USB2TTL8 and EyeLink Host TTL, eight pins are available. If using a USB-1208HS box, the available output pins can be configured through the device preferences.
Clearing Message	.clearingMessage	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the clearing TTL is sent. This option is only available if the “Send Clearing TTL” option is enabled.
When the operation is set to “Send Raw Command”			
Command to be sent	.rawCommand	String	The command to be sent to RCS2.0 to control Brain Products EEG (e.g., change the view mode of the BrainVision Recorder) or read the system configuration. Please see the "Remote Control Server 2.0 for BrainVision Recorder User Manual" for the list of supported commands. Since most of the commands have already been wrapped in other operation options (Set Mode, Control Recording, Check State, Send Annotation), users will rarely need to send individual raw commands themselves.
Raw Command Timeout (in	.rawCommandTimeout	Integer	The amount of time that Experiment Builder will wait to receive the command results back

milliseconds)			from the Remote Control Server 2.0 (10 milliseconds by default).

An example project "BrainProducts_EyeLink_Simple" and a quick instruction guide are provided in the "Examples\EEG Integration" folder. The example illustrates creating experiments with simultaneous EEG and eye tracking recordings. Another example, BrainProducts_NonEyeLink_Stroop, illustrates using Experiment Builder to control the Brain Products EEG systems without recording eye tracker data. During an experimental session, Experiment Builder automatically connects to the RCS 2.0, sends a command to open the BrainVision Recorder application, then initializes the workspace and sets the experiment name and subject ID. At the end of the experiment, Experiment Builder sends a command to close the BrainVision Recorder, deletes all of the variables passed with initialization commands, and then disconnects. Within the Experiment Builder project, users will need to first set the BrainVision Recorder to the "View Data (Monitoring)" mode using the "Set Mode" operation of the BRAIN_PRODUCTS_CONTROL node. When setting the mode, the BRAIN_PRODUCTS_CONTROL node will not return until the Recorder has fully switched to the proper mode, which may take a few seconds. For this reason we recommend presenting some instructions using a DISPLAY_SCREEN action right before the first BRAIN_PRODUCTS CONTROL node to inform users of the delay.

Typically, users will send a Start Recording command at the beginning of a block of trials and a Stop Recording at the end the block, or just a single Start Recording at the beginning of the experiment and a single Stop Recording at the end of the experiment. (It is not advisable to start and stop the EEG recording in BrainVision Recorder recording on each trial.) Please check your EEG analysis software to determine the optimal recording configuration required.

The Remote Control Server 2.0 allows users to start, stop, pause, and resume EEG recordings through BrainVision Recorder via the network. Users can send event markers to BrainVision Recorder with the "Send Event Marker" operation of the Brain Products Control node marking each of the critical events in the trial (e.g., display and audio stimulus onsets, audio, participant responses). When sending TTL signals, please make sure the Brain Products Control action is placed immediately AFTER the critical event(s) to be logged (e.g., DISPLAY_SCREEN action, keyboard or button triggers, etc.). Please also make sure the "Message" field of the Brain Products Control node is filled for easy alignment of the EEG and eye tracking data.

7.10 Triggers

Triggers are used to control the experiment flow, such as the transition from one action to the other, or ending the sequence. Experiment Builder supports several kinds of triggers, including a duration-based trigger, responses from an input device (keyboard, mouse, TTL, Cedrus, voice key, and EyeLink button box), those involving online eye data (invisible boundary, fixation, saccade, and sample velocity), and conditional evaluations. The following sections list the use of each trigger type. Triggers can be selected from the trigger tab of the component toolbox (Figure 7-33).

Figure 7-33. Triggers Implemented in Experiment Builder.

7.10.1 Timer Trigger

The Timer Trigger () fires when a specified amount of time has elapsed since the trigger started. Timer triggers can be used to introduce a delay between actions and/or triggers, and to control the maximum amount of time a sequence can last. The following table lists the properties of a timer trigger.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the Timer trigger. The default value is "TIMER".
Type #	NR		The Experiment Builder object type for this node (Timer).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the timer trigger fires.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the trigger is done (so the experiment flow is ready to move to the next node).
NTP Time #	.ntpTime	Float	NTP server time when the processing of the trigger is done (so the experiment flow is ready to move to the next node).
Last Checked Time #	.lastCheckedTim e	Float	Experiment Builder checks for the status of the timer trigger about every 1 msec. This property can be used to retrieve the Display PC time (in milliseconds from the start of the experiment) when the trigger was last checked.
Confidence Interval #	.confidenceInterv al	Float	Time difference between the trigger time and last check time of the trigger. This indicates a window of uncertainty as the true trigger time could be between the last check time (.lastCheckedTime) and the reported trigger time (.time).
Duration	.duration	Integer	The duration after which the trigger will fire (4000 msec by default).
Duration Type ¶	.durationType	String	Unit of timer duration (either "msecs" or "retraces").
Start Time	.startTime	Float	Display PC time (in milliseconds from the start

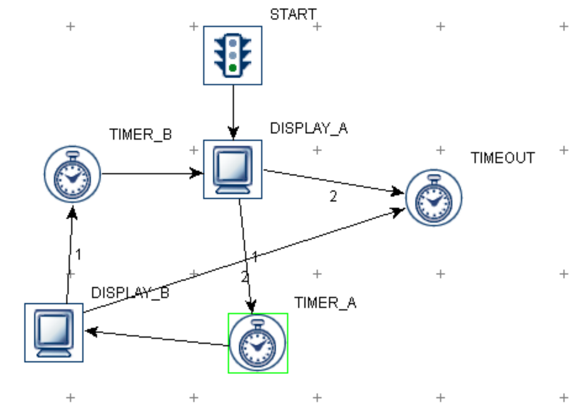
			of the experiment) when the trigger starts. The default value is 0 - the timer starts from the last action to which the timer is linked and resets if that action is re-entered in a loop. If a different start time should be used for the trigger, users can set the Start Time as an attribute reference, e.g., to the .time property of an earlier node.
Elapsed Time #	.elapsedTime	Float	Amount of elapsed time (in milliseconds) since the timer started.

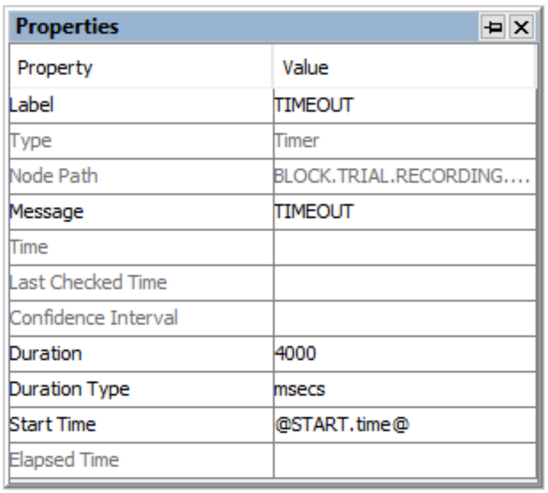
By default, the start time of the timer trigger is set to "0", which means that the timer starts from the end time of the previous action. Therefore, if a timer trigger immediately follows a display screen, the trigger doesn't start until the display screen's retrace starts. Similarly, if it is attached to an EyeLink Message action, the timer will start only after the message is sent. Please note if the timer is connected from a trigger, the start time of the timer trigger will still be the end of the last action—not the time when the previous trigger fires. In general, users should avoid having two triggers connected directly in sequence for ease of interpreting the experiment graph. Rather, use a NULL action in between two triggers for better control of experiment timing.

Users need to explicitly set the 'Start Time' value of the TIMER trigger when the desired start time is the triggered time of the previous trigger, or when the action from which the timer trigger is connected may be repeated (see FAQ: "Using an EyeLink button trigger without ending the trial sequence" in the html version of this document).

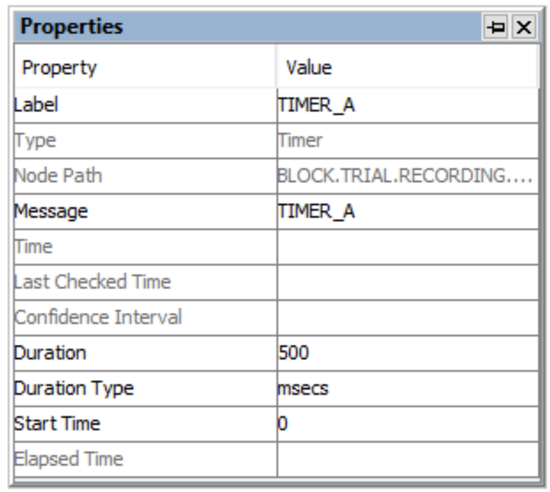
The TIMER trigger uses a pre-release mechanism when it is connected to a DISPLAY SCREEN action or a PLAY SOUND action (when using either the ASIO or OS X audio driver) to ensure the upcoming audio/visual event will be presented at the intended time. To make this preleasing mechanism work, please do not insert any intervening trigger/actions between the TIMER trigger and the intended DISPLAY SCREEN or PLAY SOUND action. Therefore, a sequence like "DISPLAY A → TIMER → DISPLAY B → UPDATE_ATTRIBUTE" is recommended for accurate timing while "DISPLAY A → TIMER → UPDATE_ATTRIBUTE → DISPLAY B" is not.

The following illustrates the use of TIMER triggers to control the duration of display presentation and how long a sequence should be run. Imagine that the user wants to show display A for 500 milliseconds, then show display B for 500 milliseconds, and then display A again for 500 milliseconds, and so on, while the whole sequence should end in 4000 milliseconds. Users may design the graph as the following:





Property	Value
Label	TIMEOUT
Type	Timer
Node Path	BLOCK.TRIAL.RECORDING....
Message	TIMEOUT
Time	
Last Checked Time	
Confidence Interval	
Duration	4000
Duration Type	msecs
Start Time	@START.time@
Elapsed Time	



Property	Value
Label	TIMER_A
Type	Timer
Node Path	BLOCK.TRIAL.RECORDING....
Message	TIMER_A
Time	
Last Checked Time	
Confidence Interval	
Duration	500
Duration Type	msecs
Start Time	0
Elapsed Time	

Figure 7-34. Using Timer Trigger.

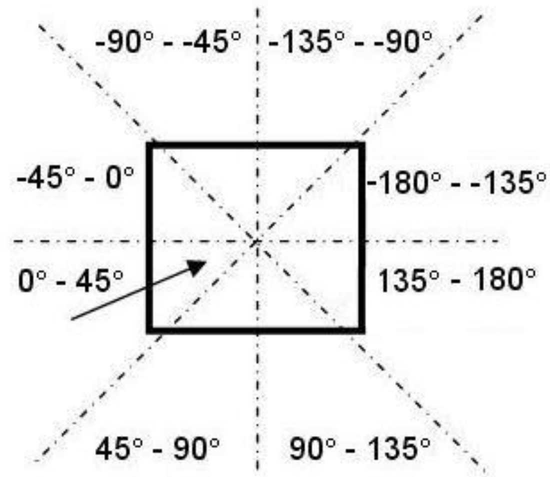
Note that the "Start Time" of TIMER_A and TIMER_B is set to 0, which means that the timers reset themselves when Display_A and Display_B actions are repeated. The Timer TIMEOUT controls the duration to stay within the sequence and therefore its start time shouldn't be reset when either of the two display screen actions is repeated. The start time of this trigger is set to the start of the sequence (@START.time@) instead.

7.10.2 Invisible Boundary Trigger

The Invisible Boundary trigger () fires when the gaze position is detected inside or outside of a specified region, either after a single sample or after a specified duration. This trigger can be used to implement a display change based on the gaze position. For example, a line of text may be changed when the reader proceeds past a critical word in a sentence. This trigger is only available in an EyeLink experiment. Please note that the “Link Filter Level” setting in the EyeLink device influences how quickly the trigger will fire.

Field	Attribute	Type	Content

	Reference		
Label *	.label	String	Label of the Invisible Boundary trigger. The default value is "INVISIBLE_BOUNDARY".
Type #	NR		The Experiment Builder object type for this node (Boundary).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file when the invisible boundary trigger fires.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the invisible boundary trigger is done (so the experiment flow is ready to move to the next node). **Note:** To check the time when the triggering sample occurs, you should use @*.triggeredData.time@ instead.
NTP Time #	.ntpTime	Float	NTP server time when the processing of the invisible boundary trigger is done (so the experiment flow is ready to move to the next node).
Last Check Time #	.lastCheckTime	Float	This property can be used to retrieve the Display PC time (in milliseconds from the start of the experiment) when the trigger was checked for the last time.
Confidence Interval #	.confidenceInterval	Float	Time difference between the trigger time and last check time of the trigger. This indicates a window of uncertainty as the true trigger time could be between the last check time (.lastCheckedTime) and the reported trigger time (.time).
Region Direction	.regionDirection	List of Strings	A range of eye angles from a multiple-selection list ['0 - 45', '45 - 90', '90 - 135', '135 - 180', '-180 - -135', '-135 - -90', '-90 - -45', '-45 - 0'] used to restrict the direction in which the invisible boundary trigger fires. For each angle range, the first value is inclusive and the second value is not.

			
Region Type ¶	.regionType	String	The type of Triggering Region used: RECTANGLE, ELLIPSE, or INTEREST AREA. The "INTEREST AREA" option is only available when interest areas are defined in one of the display screens in the same recording sequence.
Region Location (Top Left)	.regionLocation	Point	Pixel coordinate of the top-left corner of the boundary region in (x, y) tuple. The default value is (0, 0). The x and y coordinates of the region location can be further referred as .regionLocation.x and .regionLocation.y, respectively. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Region Width	.regionWidth	Integer	Width (0 by default) of the boundary region in screen pixels. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Region Height	.regionHeight	Integer	Height (0 by default) of the boundary region in screen pixels. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Interest Area Screen *¶	NR		The display screen on which the target interest area regions are located. This property is only available when the "Region Type" property is set to INTEREST AREA.
Interest Area Regions¶	NR		Target interest areas used to define the triggering region. This property is only available when the "Region Type" property is set to INTEREST AREA.
Within †	.within	Boolea n	If set to "True" (default), the trigger will fire when gaze samples are within the boundary region; otherwise, the trigger fires when samples are outside the region.
Enable Outer	.enableOuterRegi	Boolea	This property is only enabled if the "Within"

Boundary (Screen Bound)	on	n	option is unchecked. If "Enable Outer Boundary (Screen Bound)" is enabled, the trigger will fire only when the gaze position is within the area of the display, and not when the gaze position is offscreen. If disabled, the triggering region will extend beyond the display area.
Tracking Eye ¶	.trackingEye	Integer	Determines which eye's data is used for online triggering. The default value is "EITHER" (2). It can also be set to LEFT (0) or RIGHT (1).
Minimum Duration	.minimumDuratio n	Integer	Duration (in milliseconds) in or out of the region before the trigger fires. If the default value 0 is used, the trigger fires immediately after detecting a sample inside (or outside) of the boundary.
Fire on Missing Data	.fireOnMissingD ata	Boolea n	This option is only available if both the "Within" and "Enable Outer Boundary (Screen Bound)" options are unchecked. If "Fire on Missing Data" is checked, the invisible boundary trigger will fire based on missing eye data samples in addition to samples outside the specified triggering region. If unchecked, the invisible boundary will respond only to samples outside the triggering region, and not include missing data samples.
Triggered Data #	.triggeredData		If the invisible boundary trigger fires, the triggered data can be further accessed through the sub-attributes of this property.

If the Invisible Boundary Trigger fires, users can further check the triggered data (e.g., time when the trigger fires, eye position/velocity when the trigger fires). The sub-attributes of the TriggeredData attribute are listed in the following table. They can be used for attribute references.

Attribute	**Reference**	**Type**	**Content**
Time	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the triggering sample occurs.
NTP Time #	.ntpTime	Float	NTP server time when the triggering sample occurs.
EDF Time	.EDFTime	Integer	EDF time of the triggering sample.
Eyes Available	.eyesAvailable	Integer	Eyes available in recording (0 for left eye; 1 for right eye; 2 for both eyes).
Start Time	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the first sample appears in the region.
EDF Start Time	.EDFStartTime	Integer	EDF time (time since the EyeLink program started on the Host PC) when the first sample occurs in the region.
NTP Start Time #	.ntpStartTime	Float	NTP server time when the first sample appears in the region.

Triggered Eye	.triggeredEye	Integer	Eye (0 for left eye; 1 for right eye) whose data makes the current invisible boundary trigger fire.
PPD X, PPD Y	.PPDX, .PPDY	Float	Gaze resolution at the current position (in screen pixels per degree of visual angle) along the x-, or y-axis.
Left Gaze X, Right Gaze X, Average Gaze X	.leftGazeX, .right GazeX, .average GazeX [1]	Float	Gaze position of the triggering sample along the x-axis for the left eye, right eye and an average between the two.
Left Gaze Y, Right Gaze Y, Average Gaze Y	.leftGazeY, .right GazeY, .average GazeY [1]	Float	Gaze position of the triggering sample along the y-axis for the left eye, right eye and an average between the two.
Left Pupil Size, Right Pupil Size, Average Pupil Size	.leftPupilSize, .ri ghtPupilSize, .averagePupilSize [1]	Float	Left eye, right eye, or average pupil size (in arbitrary units, area or diameter as selected in the EyeLink device settings).
Left Velocity, Right Velocity, Average Velocity	.leftVelocity, .rightVelocity, .averageVelocity [1]	Float	Left eye, right eye, or average sample velocity (in degrees /second). [2]
Left Acceleration, Right Acceleration, Average Acceleration	.leftAcceleration, .rightAcceleratio n, .averageAccelerat ion [1]	Float	Left eye, right eye, or average sample acceleration (in degrees /second^2). [2]
Angle	.angle	Float	The angle of the eye movements when the trigger fires.
Target Distance	.targetDistance	Integer	Distance between the target and camera (10 times the measurement in millimeters). This option is for the EyeLink Remote mode only. Returns "MISSING_DATA" (-32768) if target is missing or if a remote tracking mode is not being used.
Target X, Target Y	.targetX, .targetY	Integer	X, Y position of the target in camera coordinates. This option is for the EyeLink Remote mode only. Returns "MISSING_DATA" (-32768) if target is missing or if a remote tracking mode is not being used
Target Flags	.targetFlags	Integer	Flags used to indicate target tracking status (0 if target tracking is ok; otherwise error code). This option is for the the EyeLink Remote mode only. Returns "MISSING_DATA" (-32768) a remote tracking mode is not being used
IA Labels	.IALabels	List	Provides a list of labels of the interest area(s) hit (i.e., gaze detected). Returns an empty list if the no interest areas is hit (e.g., if the triggering region is not interest area-based, or the trigger

			firing is not region-based).
IA IDs	.IALabels	List	Provides a list of IDs of the interest area(s) hit (i.e., gaze detected). Returns an empty list if the no interest ares hit (e.g., if the triggering region is not interest area-based, or the trigger firing is not region-based).
IA Label	.IALabel	String	Reports the label of the interest area hit. If multiple interest areas are hit, reports the label of the interest area with the lowest ID. Missing data if no interest area hit.
IA ID	.IAID	Integer	Reports the ID of the interest area hit. If multiple interest areas are hit, reports the lowest ID. Missing data if no interest area hit.
IA Location	.IALocation	Point	Location (top-left or center, based on preference) of the interest area hit. If multiple interest areas are hit, reports the location of the interest area with the lowest ID.
IA Width	.IAWidth	Integer	Width of the interest area hit. If multiple interest areas are hit, reports the width of the interest area with the lowest ID.
IA Height	.IAHeight	Integer	Height of the interest area hit. If multiple interest areas are hit, reports the height of the interest area with the lowest ID.

Note:
[1] Returns "MISSING_DATA" (-32768) for the untracked eye.
[2] For EyeLink I and II, the velocity and acceleration of the 2nd sample before the triggering sample are reported. For EyeLink 1000, 1000 Plus, and Portable Duo, the reported velocity and acceleration values belong to the nth sample (n = 2, 4 or 8, respectively, if a 5-, 9-, or 17- sample velocity/acceleration model is used) before the trigging sample.

The Invisible Boundary Trigger can be used to check whether the participant's gaze position crosses into a specified region and therefore is useful for experiments involving the boundary paradigm. For example, if a user wants to change the display immediately after the participant's left-eye gaze position is in a rectangular region (100, 384, 250, 818), the recording sequence can be programmed as follows:

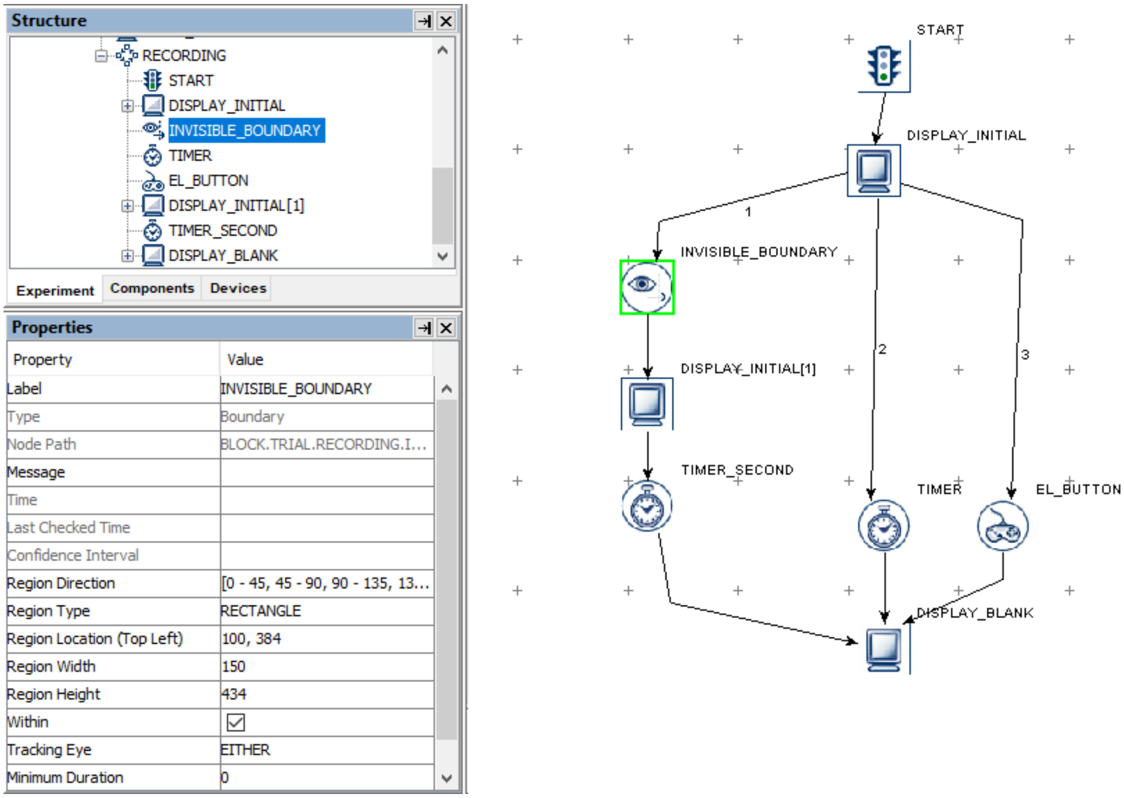


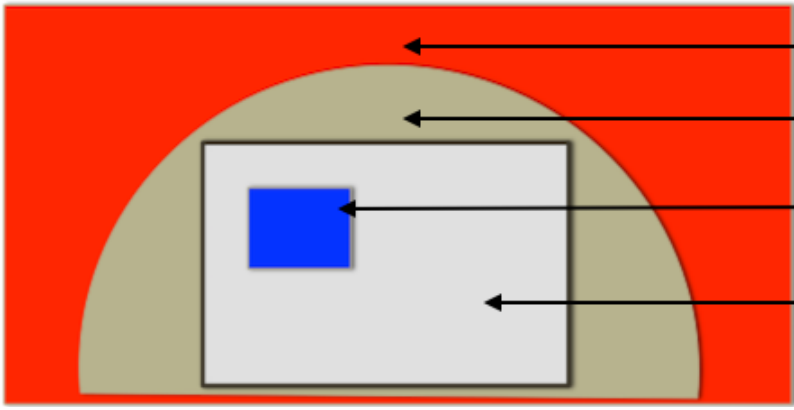
Figure 7-35. Using an Invisible Boundary Trigger.

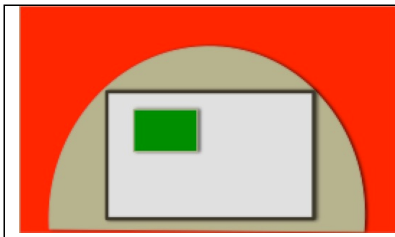
Since the invisible boundary trigger keeps monitoring the online recording data, this trigger type must be placed within a recording sequence (i.e., the "Record" property of the sequence is checked).

7.10.2.1 Configuring Triggering Options

Versions 2.1.512 and later of Experiment Builder provide greater flexibily in configuring the invisible boundary trigger when the “Within” property is disabled (i.e., when the trigger should fire when the gaze position is outside of the specified region). The “Enable Outer Boundary (Screen Bound)” option allows users to specify whether samples outside the region should be within the confines of the screen, and “Fire on Missing Data” allows users to specify whether missing data can cause the trigger to fire.

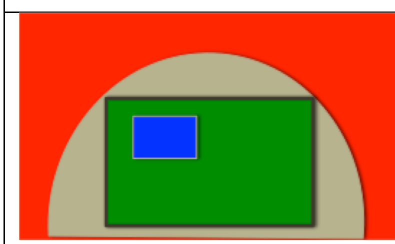
The following diagrams illustrate how these configuration options allow the user to define the region that will cause the trigger to fire: the blue region represents the trigger region defined in the trigger, the gray region is the screen boundary, the brown region represents the trackable range of the eye tracker, and red region represents missing data. The green area in each diagram represents the region based on which the invisible boundary trigger will fire based on the settings shown.





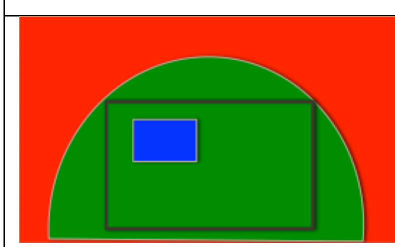
Samples inside the trigger region

Region Direction	[0 - 45, 45 - 90, 90 - 135, 135 - 180, -...
Region Type	INTEREST AREA
Interest Area Screen	DISPLAY_SCREEN
Interest Area Regions	[RECTANGLE_INTERESTAREA]
Within	☑
Tracking Eye	EITHER
Minimum Duration	0



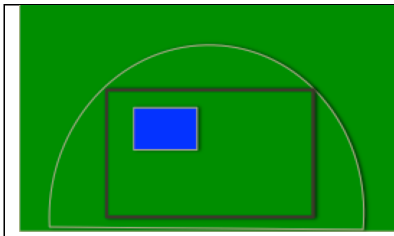
Samples outside of the trigger region but on screen

Region Direction	[0 - 45, 45 - 90, 90 - 135, 135 - 180, -...
Region Type	INTEREST AREA
Interest Area Screen	DISPLAY_SCREEN
Interest Area Regions	[RECTANGLE_INTERESTAREA]
Within	☐
Enable Outer Boundary (Screen Bound)	☑
Tracking Eye	EITHER
Minimum Duration	0

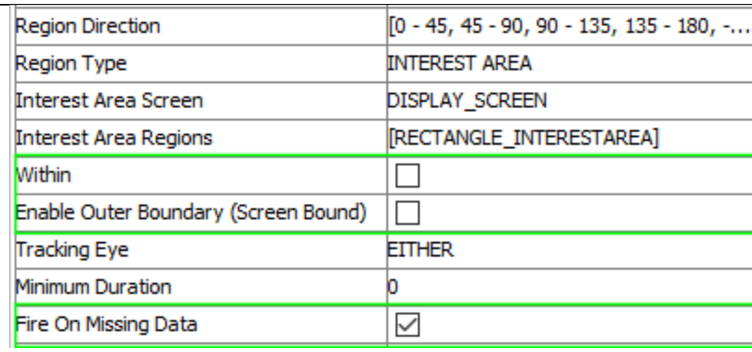


All valid samples outside of the trigger region

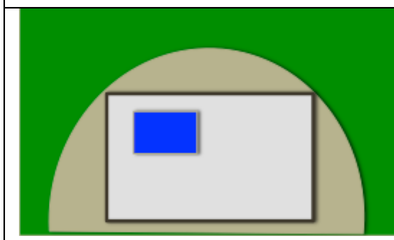
Region Direction	[0 - 45, 45 - 90, 90 - 135, 135 - 180, -...
Region Type	INTEREST AREA
Interest Area Screen	DISPLAY_SCREEN
Interest Area Regions	[RECTANGLE_INTERESTAREA]
Within	☐
Enable Outer Boundary (Screen Bound)	☐
Tracking Eye	EITHER
Minimum Duration	0
Fire On Missing Data	☐



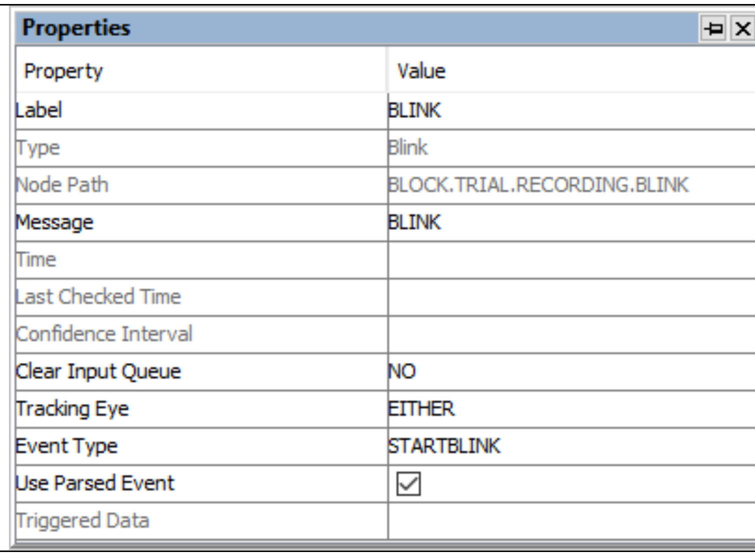
All samples outside of the trigger region



Region Direction	[0 - 45, 45 - 90, 90 - 135, 135 - 180, -...
Region Type	INTEREST AREA
Interest Area Screen	DISPLAY_SCREEN
Interest Area Regions	[RECTANGLE_INTERESTAREA]
Within	☐
Enable Outer Boundary (Screen Bound)	☐
Tracking Eye	EITHER
Minimum Duration	0
Fire On Missing Data	☑



Blink samples/event – use a Blink trigger instead!



Properties

Property	Value
Label	BLINK
Type	Blink
Node Path	BLOCK.TRIAL.RECORDING.BLINK
Message	BLINK
Time	
Last Checked Time	
Confidence Interval	
Clear Input Queue	NO
Tracking Eye	EITHER
Event Type	STARTBLINK
Use Parsed Event	☑
Triggered Data	

7.10.2.2 The Location Type of the Invisible Boundary Trigger

Please note that the Location Type of all location-based triggers (invisible boundary trigger, mouse trigger, fixation trigger, saccade trigger, and sample velocity trigger) is based on the top-left corner of the region, whereas the screen resources can be based on either the top-left corner or the center of the resource. (The screen resource/interest area location type can be set in the project Preferences under Screen). This means that references should be created differently depending on whether the region location of a trigger refers to a center-based resource or a top-left-based resource.

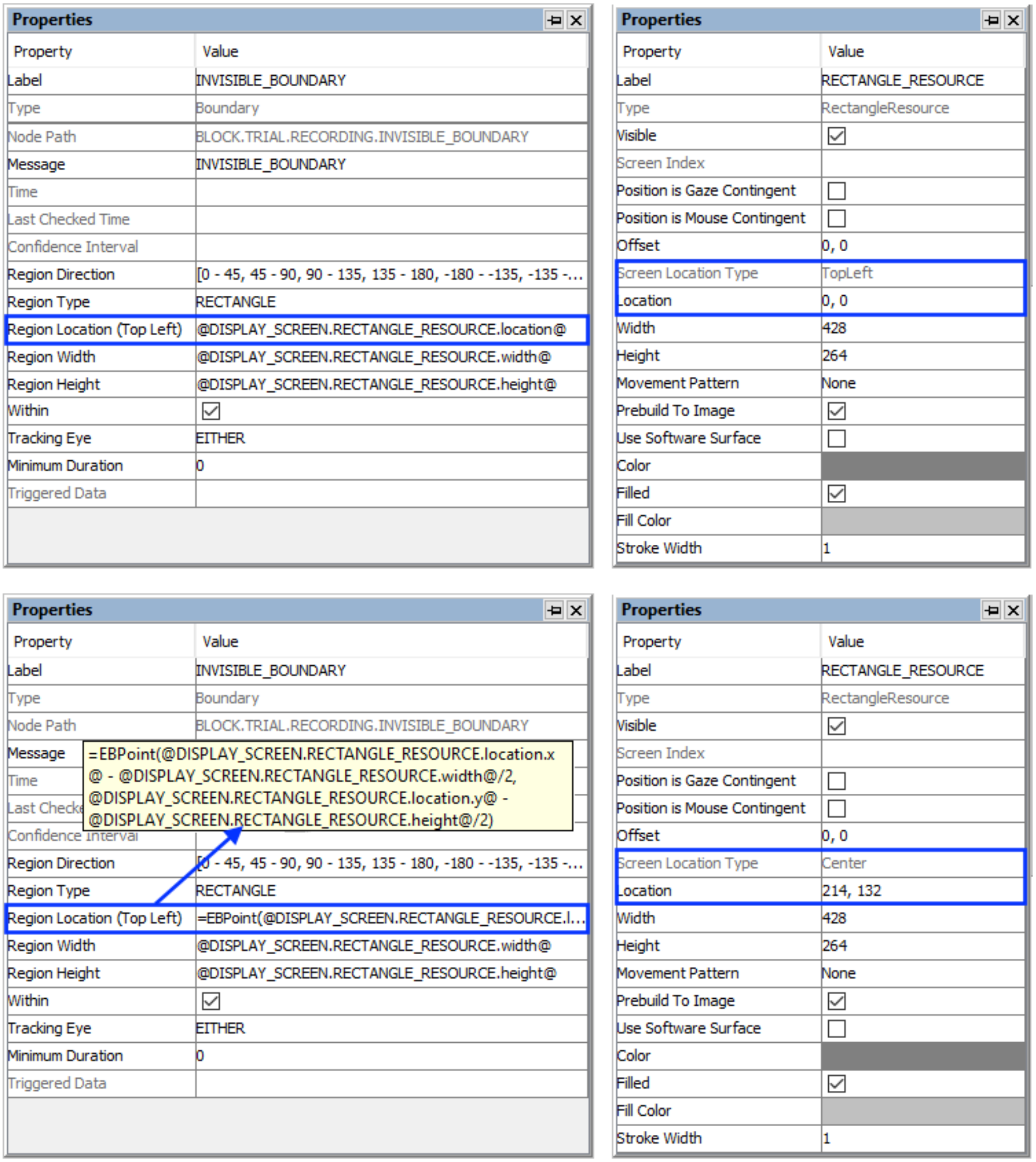


Figure 7-36. Using Invisible_Boundary Trigger with Top-left and Center Location Types.

Imagine that an invisible boundary trigger should fire when the gaze is within a rectangle resource (RECTANGLE_RESOURCE). The top-panel of the figure below illustrates creating the Region Location reference to the rectangle resource when the screen location type is TopLeft (@DISPLAY_SCREEN.RECTANGLE_RESOURCE.location@). The bottom panel of the figure illustrates creating a location equation when the location type is Center, by subtracting half the resource width from the x coordinate, and half the resource height from the y coordinate:
(=EBPoint(@DISPLAY_SCREEN.RECTANGLE_RESOURCE.location.x@ -

@DISPLAY_SCREEN.RECTANGLE_RESOURCE.width@/2,
@DISPLAY_SCREEN.RECTANGLE_RESOURCE.location.y@ -
@DISPLAY_SCREEN.RECTANGLE_RESOURCE.height@/2)).

7.10.2.3 How to Show the Triggering Region on the Host PC?

Sometimes it is useful to draw feedback graphics on the Host PC so the experimenter can monitor whether the participant's eye position is within the triggering region, or so the programmer can test the experiment code by running the eye tracker in mouse simulation mode. The user can draw graphics to the Host PC with an EyeLink_Command action before the recording sequence or as the first node in the recording sequence. The command should be added after the Prepare Sequence so the drawing is overlaid on top of the existing host graphics. The drawing command can be either "draw_box" or "draw_filled_box". The Text of the command must include the top, left, right, and bottom pixel positions of the triggering region, followed by the drawing color. This can be done either with string concatenation or string formatting. The top-left corner of the triggering region is (@INVISIBLE_BOUNDARY.regionLocation.x@, @INVISIBLE_BOUNDARY.regionLocation.y@) and the bottom-right corner of the triggering region is (@INVISIBLE_BOUNDARY.regionLocation.x@ + @INVISIBLE_BOUNDARY.regionWidth@, @INVISIBLE_BOUNDARY.regionLocation.y@ + @INVISIBLE_BOUNDARY.regionHeight@)

String Concatenation:

```
=str(@INVISIBLE_BOUNDARY.regionLocation.x@) + " "
+ str(@INVISIBLE_BOUNDARY.regionLocation.y@) + " "
+ str(@INVISIBLE_BOUNDARY.regionLocation.x@ + @INVISIBLE_BOUNDARY.regionWidth@) + " "
+ str(@INVISIBLE_BOUNDARY.regionLocation.y@ + @INVISIBLE_BOUNDARY.regionHeight@) + "
3"
```

String Formatting:

```
="%d %d %d %d 3" % (@INVISIBLE_BOUNDARY.regionLocation.x@,
@INVISIBLE_BOUNDARY.regionLocation.y@,
@INVISIBLE_BOUNDARY.regionLocation.x@ + @INVISIBLE_BOUNDARY.regionWidth@,
@INVISIBLE_BOUNDARY.regionLocation.y@ + @INVISIBLE_BOUNDARY.regionHeight@)
```

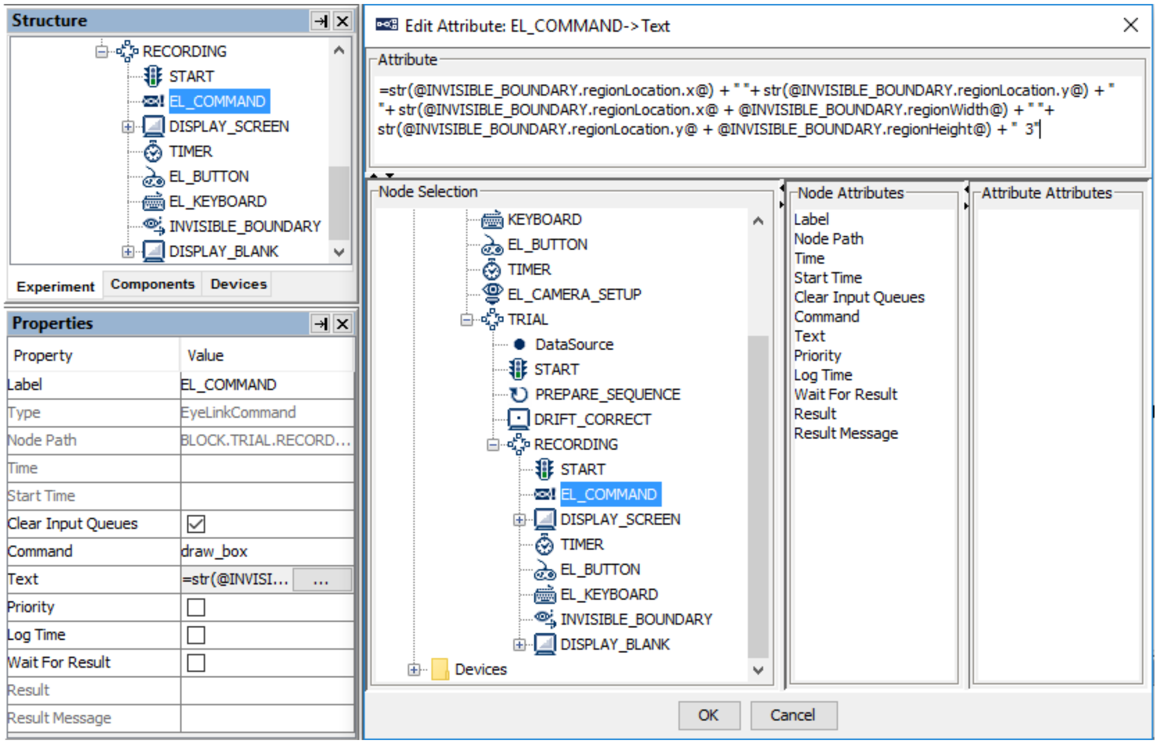


Figure 7-37. Drawing the Trigger Region on Host PC.

All of the drawing commands are documented in the "COMMANDS.INI" file under C:\EYELINK2\EXE or \ELCL\EXE directory of the host partition.

7.10.3 Conditional Trigger

A Conditional trigger () fires when one or two conditional evaluations are met. This is a useful way to implement branching in a sequence where several conditions are possible (see the Saccade example). In each conditional evaluation, users specify an attribute (the variable to be evaluated), a comparator (equals, less than, greater than, etc.), and the target value to which the attribute is being compared. Two conditional evaluations, connected with an "and", "or", "and not", or "or not" logical operator, can be made within the same trigger.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the conditional trigger. The default value is "CONDITIONAL".
Type #	NR		The Experiment Builder object type for this node (Conditional).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-

			EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the conditional trigger fires.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the trigger fires.
NTP Time #	.ntpTime	Float	NTP server time when the trigger fires.
Last Check Time #	.lastCheckTime	Float	This property can be used to retrieve the Display PC time (in milliseconds from the start of the experiment) when the trigger was checked for the last time.
Confidence Interval #	.confidenceInterval	Float	Time difference between the trigger time and last check time of the trigger. This indicates a window of uncertainty as the true trigger time could be between the last check time (.lastCheckedTime) and the reported trigger time (.time).
Attribute, Attribute 2	.attribute, .attribute2		The attribute whose value will be evaluated.
Comparator, ¶* Comparator 2 ¶*	.comparitor, .comparitor2	String	Dropdown list used to select possible comparison between the attribute and value. Possible values: "EQUALS" (default value), "GREATER THAN", "LESS THAN OR EQUALS", "CONTAINS", "NOT EQUALS", "LESS THAN", and "GREATER THAN OR EQUAL".
Value, Value 2	.value, .value2		The value used to evaluate the attribute. The data type of this field depends on the attribute used.
And Or Select ¶*	.andOrSelect	String	Connection between Evaluation 1 and Evaluation 2. Possible values are: "AND", "OR", "AND NOT", and "OR NOT".

In the previous example (section 7.10.2), users may want to further check whether the velocity and acceleration of the triggering sample in the invisible boundary trigger exceed a set of target values. The following figure illustrates the use of a conditional trigger to check the current values against the parser criteria. The “Attribute” field of the trigger is set to “@INVISIBLE_BOUNDARY.triggeredData.leftVelocity@” and the “Attribute 2” field of the trigger is set to “@INVISIBLE_BOUNDARY.triggeredData.leftAcceleration@”.

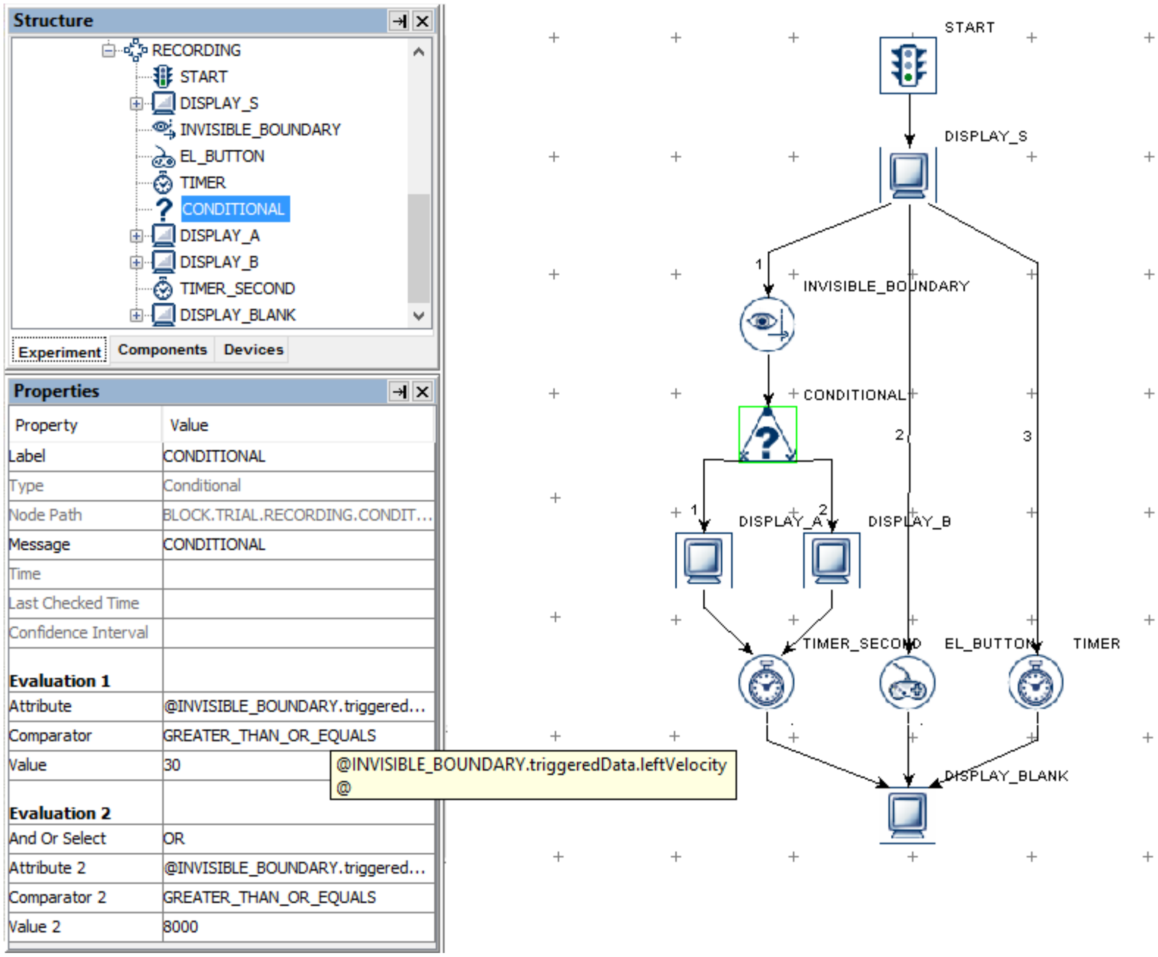


Figure 7-38. Using Conditional Trigger.

When performing a conditional evaluation, make sure the data type of the “Value” field matches that of the “Attribute” field (ditto for “Value 2” and “Attribute 2”). Conditional triggers support using String, Integer, Double, Boolean, List, and Color variables.

- When comparing strings, please note that the strings are case-sensitive (without quotes, see the “Saccade” template for the implementation of conditional evaluations with strings).
- If evaluating a Boolean value (e.g., checking whether the “Force Full Redraw” field of a DISPLAY_SCREEN action is checked or not), set the “Attribute” field of the conditional trigger by referring to the target attribute (e.g., @DISPLAY_A.forceFullRedraw@), choosing either “EQUALS” or “NOT EQUALS” as the Comparator, and typing in “true” or “false” in the Value field of the conditional trigger.
- Sometimes, users may want to evaluate attributes against missing values, for instance, to check whether a trigger has fired or whether a valid datum has been retrieved from an attribute. If the target attribute is a string type, set the “Value” field of the conditional trigger to “MISSING_DATA”. If the target attribute is an integer or float data, set the comparison Value to “-32768”.

- To clear a non-string value (eg. 3) set in the "Value" or "Value 2" attributes of a conditional trigger, users may first set the value to a string (e.g., "hello") and then delete the string.

Conditional triggers can connect to a maximum of two actions or triggers (forming two branches), and must connect to another node from at least one of its branches. If the firing of the conditional trigger exits the current sequence, users may attach some other node (e.g., a NULL_ACTION node, blank display screen action or a timer trigger, etc.) following this trigger. As an exception to the general linking rules (#6, Section 6.2.3 “Linking Rules”), a conditional trigger may connect to both an action on one branch and a trigger on the other.

It is possible to use multiple chained conditional triggers to do a series of evaluations. The following picture illustrates how to give out different instructions at the beginning of each block in a multi-block experiment.

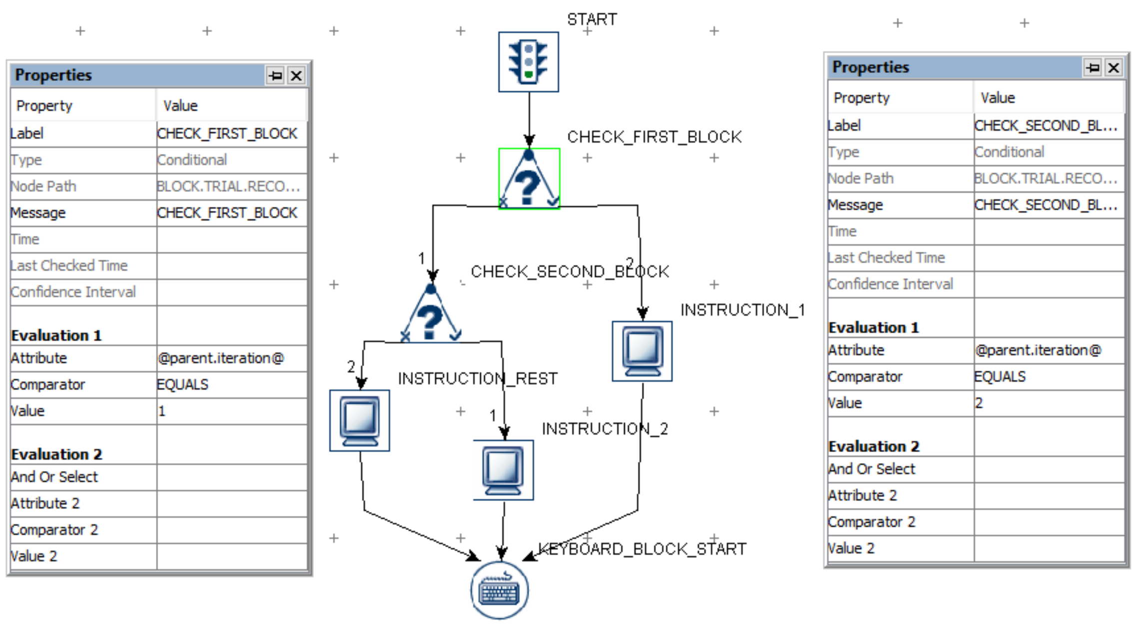


Figure 7-39. Displaying different instruction screens at the beginning of each block.

Important: If a conditional trigger does not have a connection from either its True or False branch, then the branch that does not have a connection is NOT evaluated. For example, if a Conditional trigger has a connection from its True branch, but no connection from its False branch, then the trigger will only fire if the conditional evaluates to True, and nothing will be done if it conditional evaluates to False. So if a Conditional trigger only has a connection on the True branch, the user may need to use other types of trigger in parallel to prevent the experiment from getting stuck if the trigger will not evaluate to True.

7.10.4 EyeLink Button Trigger

The EyeLink Button Trigger (), available only in an EyeLink experiment, fires when one of the buttons on a supported EyeLink button box device is pressed or released.

Note that the EyeLink button box should be attached to the Host PC, not to the Display PC. The button box will not work when running the project with dummy mode enabled.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the EyeLink button trigger. The default value is “EL_BUTTON”.
Type #	NR		The Experiment Builder object type for this node (EyeLinkButton).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file when the EyeLink button trigger fires.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the EyeLink button trigger is done (so the experiment flow is ready to move to the next node). **Note:** To check the time when the button was pressed/released, users should use @*.triggeredData.time@ instead of the current field.
NTP Time #	.ntpTime	Float	NTP server time when the processing of the EyeLink button trigger is done (so the experiment flow is ready to move to the next node).
Last Checked Time #	.lastCheckedTime	Float	This property can be used to retrieve the Display PC time (in milliseconds from the start of the experiment) when the trigger was checked for the last time.
Confidence Interval #	.confidenceInterval	Float	Time difference between the trigger time and last check time of the trigger. This indicates a window of uncertainty as the true trigger time could be between the last check time (.lastCheckedTime) and the reported trigger time (.time).
Clear Input Queue ¶	.clearInputQueue	Integer	Experiment Builder maintains an event queue so that multiple button events can be accessed over time. The “Clear Input Queue” option checks whether the button event(s) cached in the event queue should be cleared when the current trigger fires. (NO: no event clearing; EVENT: removes the current triggering event from the button event queue; LIST: all button events from event queue will be removed.)
Type #	.type	String	This identifies the type of EyeLink button box

			plugged to the host computer (specified through the EyeLink Button Box device).
Buttons	.buttons	List of Integers	List of buttons that may be pressed/released to make the trigger fire. Default value is [1, 2, 3, 4, 5, 6,7]. Multiple button selections can be made by holding down the Ctrl key in Windows or the command ⌘ key in macOS. **Note:** To check which button is actually pressed or released, use @*.triggeredData.button@ (i.e., the .button sub-attribute of the .triggeredData attribute).
Press Events †	.pressEvents	Boolean	Whether the trigger should fire when a button press event occurs. This is set to "True" (box checked) by default.
Release Events †	.releaseEvents	Boolean	Whether the trigger should fire when a button release event occurs. This is set to "False" (box unchecked) by default.
Triggered Data #	.triggeredData		If the EyeLink button trigger fires, the triggered data can be further accessed through the sub-attributes of this property.

To specify a list of button(s) used for response, click the value field of the "Buttons" property and select the desired buttons. Multiple buttons can be selected or unselected by holding down the "Ctrl" key in Windows or the Command ⌘ key in macOS. The buttons can also be set via attribute reference by double clicking on the right end of the "Buttons" value field.

When the button trigger fires, the triggered data can be further accessed. The sub-attributes of the Triggered Data field are listed in the following table.

Attribute	**Reference**	**Type**	**Content**
Button	.button	Integer	The ID of the button pressed/released that fired the trigger.
State	.state	Boolean	Whether the button is pressed (True) or released (False) when the trigger fires.
EDF Time	.EDFTime	Integer	EDF time when the button is pressed/released.
NTP Time #	.ntpTime	Float	NTP server time when the button is pressed/released.
Time	.time	Integer	Display PC time (in milliseconds from the start of the experiment) when the button is pressed/released.

The following figure illustrates the button settings for the EyeLink Button trigger if a user wants to end the trial by pressing button 1 or 4.

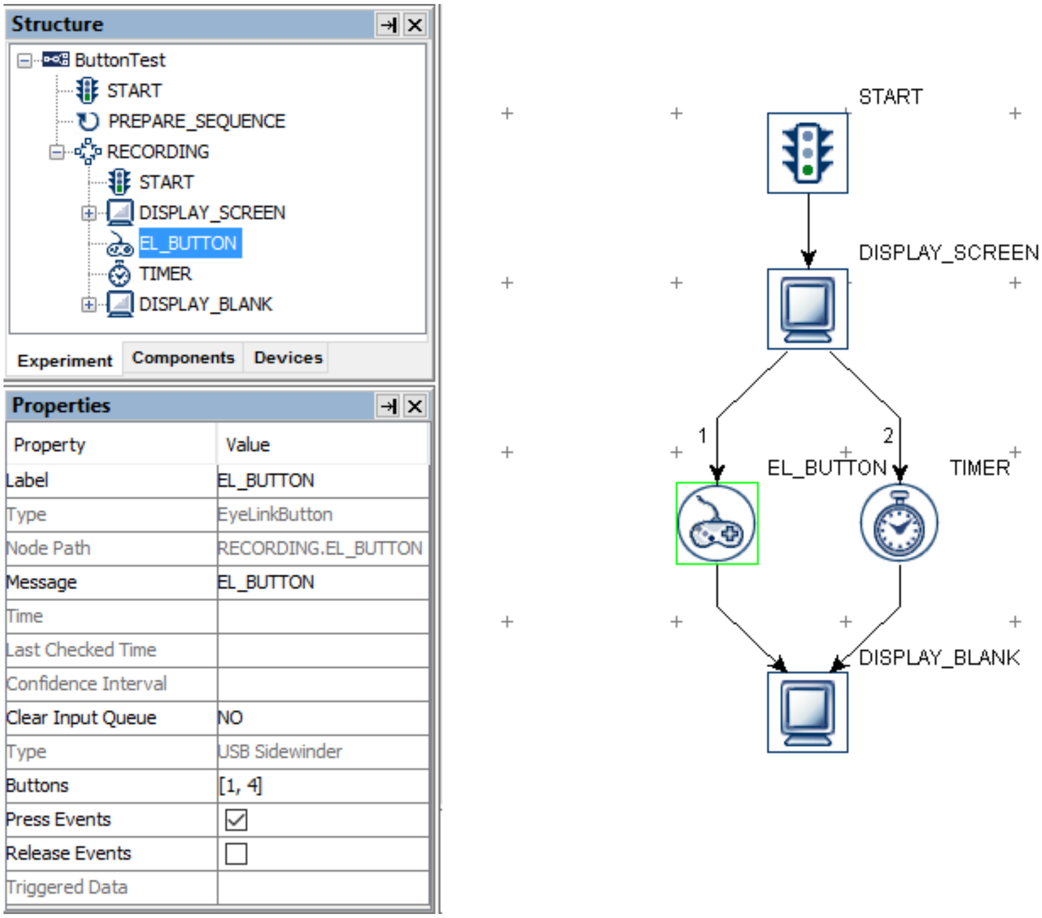


Figure 7-40. Using EyeLink Button Trigger.

The following section discusses some of the common applications of the EyeLink button trigger:

7.10.4.1 Calculating Response Time of a Button Press

EyeLink button responses can be retrieved by using the Update Attribute action. Typically, users can create variables to record the button pressed, the time or RT of the button press, and the accuracy of the button press. The ID of the button pressed may be retrieved as "@EL_BUTTON.triggeredData.button@". To determine the reaction time, the user must first determine the time of the button press by recording the "@EL_BUTTON.triggeredData.time@" attribute (see Figure 7-41). With the time of the button press, users can calculate the response time as =(@BUTTON_PRESS_TIME.value@ - @DISPLAY_ON_TIME.value@). In case the trial can end without the participant pressing a button, an UPDATE_ATTRIBUTE action should be used to reset the default values for the variables at the beginning of the trial so that the response data from the previous trial will not be carried over to the current trial.

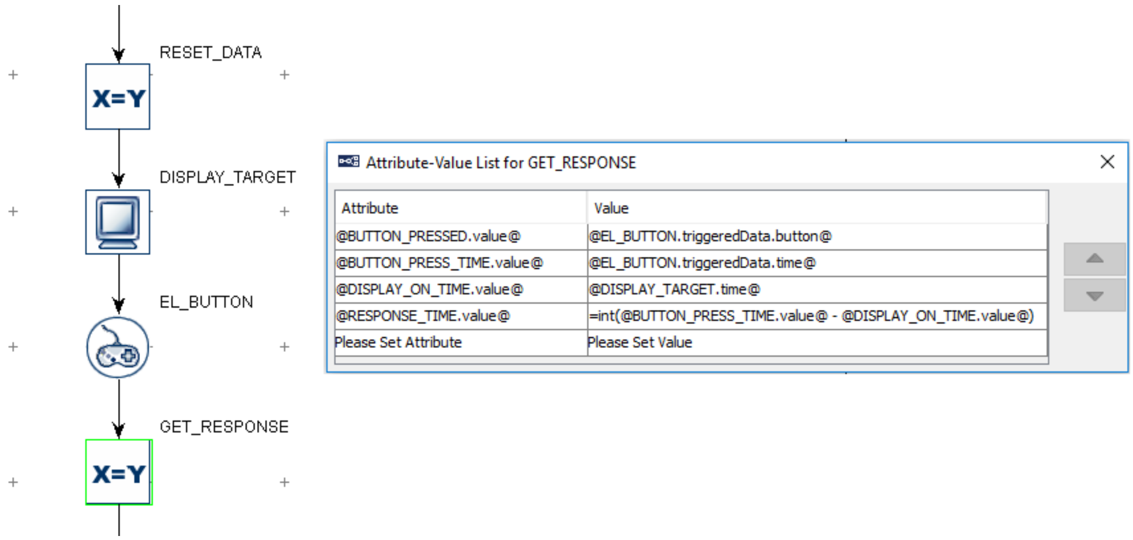


Figure 7-41. Collecting EyeLink Button Response Data.

To evaluate the accuracy of a button press, users will need to determine the expected button press for the trial. This can be encoded in the data source with a number column. Use a CONDITIONAL trigger to check whether the pressed button matches the expected button and then use an UPDATE_ATTRIBUTE action at each branch of the trigger to update the accuracy variable accordingly (check out the HTML version of this document for the complete example project).

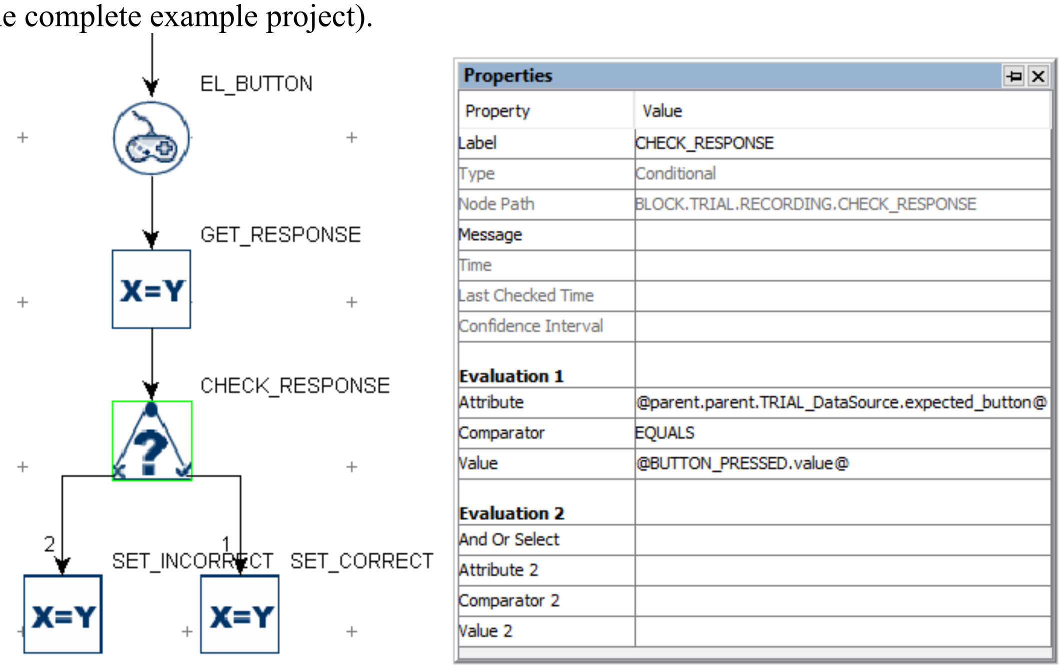


Figure 7-42. Checking EyeLink Button Response Accuracy.

7.10.4.2 Collecting Inputs from the EyeLink Button Box Without Ending the Trial

Sometimes the participant's button response should be recorded without ending the trial (e.g., the participant may be instructed to press a button whenever they detect a specific event in a video clip). This can be done by adding a Null Action node after the Display Screen and having the EyeLink Button trigger loop back to the Null Action—use an Update Attribute action following the button trigger to collect response data. All other triggers initially attached to the Display Screen action should be connected from the Null Action as well. If a Timer trigger is used to end the trial, the "Start Time" should be set to the .time property of the Display Screen so that the start time of the Timer trigger will not be reset when a button is pressed.

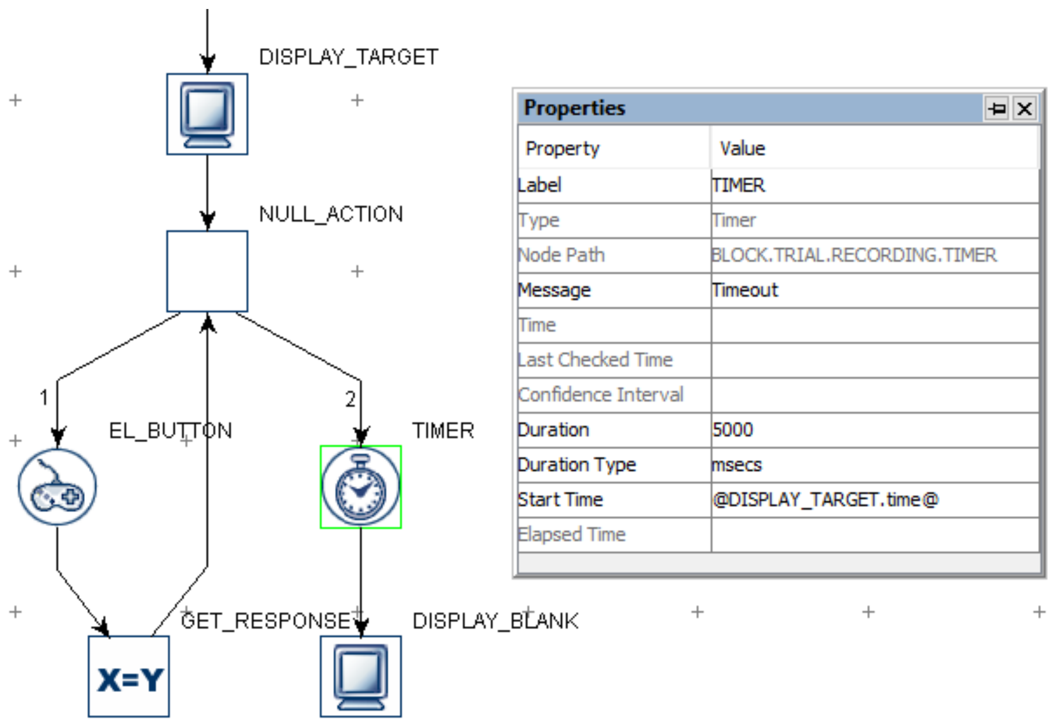


Figure 7-43. Using EyeLink Button Trigger Without Ending a Trial.

7.10.4.3 Knowing the ID of a Specific Button on the EyeLink Button Box

The supported EyeLink button box should be used on the host computer. The button box can be attached to a USB port (Microsoft SideWinder Plug and Play Gamepad for EyeLink II or EyeLink 1000, or Microsoft Xbox 360 and Logitech F310 button box for EyeLink 1000 Plus and EyeLink Portable Duo) or attached to the parallel port on the motherboard, or to the designated PCI-express parallel port adapter card on the host computer (SR Research Gamepad or ResponsePixx button box). The use of the parallel port-based button box on the designated PCI Express adapter card (LF811) requires running version 2.30 or later of the EyeLink II host software or 4.50 or later of the EyeLink 1000 host software. Users will also need to go to the Button Box Device Preferences to specify the particular button box used for the study so Experiment Builder can automatically configure the button mappings.

- Microsoft SideWinder Plug and Play gamepad: 'Y' → 1; 'X' → 2; 'B' → 3; 'A' → 4; Big D-pad on the left → 5; left back trigger → 6; right back trigger → 7.
- SR Research Gamepad: blue → 1; green → 2; yellow → 3; red → 4; big (purple) → 5. The other two side trigger buttons are non-functional.
- ResponsePixx Button Box (5-button handheld and 5-button desktop models): Yellow → 1; red → 2; blue → 3; green → 4; white → 5.
- Microsoft Xbox 360: 'Y' → 1; 'X' → 2; 'B' → 3; 'A' → 4; Big D-pad on the lower left → 5; left back trigger (top) → 6; right back trigger (top) → 7. The other buttons are not functional.
- Logitech F310: 'Y' → 1; 'X' → 2; 'B' → 3; 'A' → 4; Big D-pad on the left → 5; left back trigger (top) → 6; right back trigger (top) → 7. The other buttons are not functional.

7.10.5 Cedrus Button Trigger

The Cedrus Input trigger ( ) fires when one of the specified buttons on a Cedrus RB Series response pad (https://www.cedrus.com/rb_series/) or a Lumina fMRI Response Pad (https://www.cedrus.com/lumina/) is pressed or released. To use the Cedrus RB Series response pad, please follow the installation instructions provided by Cedrus (http://www.cedrus.com/support/rb_series; Experiment Builder only supports the response pads shipped after 2011). Users should also check the setting of the DIP switches located on the back of the response pad, to the left of where the USB cable plugs into the pad. Experiment Builder requires all the switches to be in the down (On) position. The Lumina Response Pad for fMRI doesn't require a driver installation.

The Cedrus Input trigger can also be used to detect Cedrus SV-1 Voice Key responses. The onset of a Voice Key trigger is represented as a button 1 down event; the offset of the voice key event is represented as a button 1 up event. Please follow https://www.sr-support.com/forums/showthread.php?t=56 for setup and example. Please note that only one Cedrus device can be connected to the experiment computer at a time.

In earlier versions of Experiment Builder (before 2.1.512), a "warning:2003 The IO node CEDRUS_INPUT is used in realtime Sequence RECORDING *** -> CEDRUS_INPUT" message may be seen if the Cedrus Input trigger is used in a sequence with the "Is Real Time" option checked. This warning means that the Cedrus Input trigger may not work when your sequence is running under the realtime mode; this typically only applies if using an old display computer. For most recent computers with dual core/multicore processors, the Cedrus Input (along with mouse and keyboard) will function properly in the real-time mode, so this message can be ignored.

Note: Make sure you use the Prepare Sequence action before each iteration of the sequence in which the Cedrus Input trigger is used—the Prepare Sequence action is used to re-establish the clock synchronization between the display computer and the built-in timer on the Cedrus response box. Failing to do so might result in a significant drift in the trigger time returned by the Cedrus response pad.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the Cedrus button trigger. The default value is "CEDRUS_INPUT".
Type #	NR		The Experiment Builder object type for this node (CedrusInput).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the Cedrus input trigger fires.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the Cedrus Input trigger is done (so the experiment flow is ready to move to the next node). **Note:** To check the time when the Cedrus Input was received, you should use @*.triggeredData.time@ instead.
NTP Time #	.ntpTime	Float	NTP server time when the processing of the Cedrus Input trigger is done (so the experiment flow is ready to move to the next node).
Last Checked Time #	.lastCheckedTime	Float	This property can be used to retrieve the Display PC time (in milliseconds from the start of the experiment) when the trigger was checked for the last time.
Confidence Interval #	.confidenceInterval	Float	Time difference between the trigger time and last check time of the trigger. This indicates a window of uncertainty as the true trigger time could be between the last check time (.lastCheckedTime) and the reported trigger time (.time).
Clear Input Queue ¶	.clearInputQueue	Integer	Experiment Builder maintains an event queue so that multiple Cedrus Input events can be accessed over time. The “Clear Input Queue” option checks whether the Cedrus event(s) cached in the event queue should be cleared when the trigger fires. (NO: no event clearing; EVENT: removes the current triggering event from the Cedrus event queue; LIST: all Cedrus events from event queue will be removed.)
Triggered Data #	.triggeredData		If the Cedrus input trigger fires, the triggered data can be further accessed through the sub-attributes of this property.
Press Events †	.pressEvents	Boolean	Whether the trigger should fire when a button press event occurs. This is set to “True” (box checked) by default.
Release Events †	.releaseEvents	Boolea	Whether the trigger should fire when a button

		n	release event occurs. Version 2.1.512 or later of the software sets this to “False” by default for newly added CEDRUS_INPUT triggers.
Buttons	.buttons	List of Integer s	List of buttons that may be pressed/released to fire the trigger. Default value is [1, 2, 3, 4, 5, 6, 7, 8]. Multiple button selections can be made by holding down the Ctrl key in Windows or the Command ⌘ key in macOS. Note: To check which button is actually pressed or released, use @*.triggeredData.button@ (i.e., the .button sub-attribute of the .triggeredData attribute) instead.

To set the button(s) used for response, click the value field of the “Buttons” property and select the desired buttons. Multiple buttons can be selected or unselected by holding down the "Ctrl" key in Windows or the Command ⌘ key in macOS. The buttons can also be set via attribute reference by double clicking the right end of the “Buttons” value field.

When the Cedrus Input trigger fires, the triggered data can be further accessed. The attributes of the TriggeredData attribute are listed in the following table.

Attribute	**Reference**	**Type**	**Content**
Button	.button	Integer	The ID of the pressed/released button that fires the trigger.
EDF Time	.EDFTime	Integer	EDF time when the button is pressed/released.
NTP Time #	.ntpTime	Float	NTP server time when the button is pressed/released.
Time	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the button is pressed/released.
Pressed	.pressed	Integer	Whether the triggering button is pressed (1) or released (0).

For example, if a user wants to end the trial by pressing Cedrus button 1 or 4, the properties of the button trigger can be set as shown in the figure below.

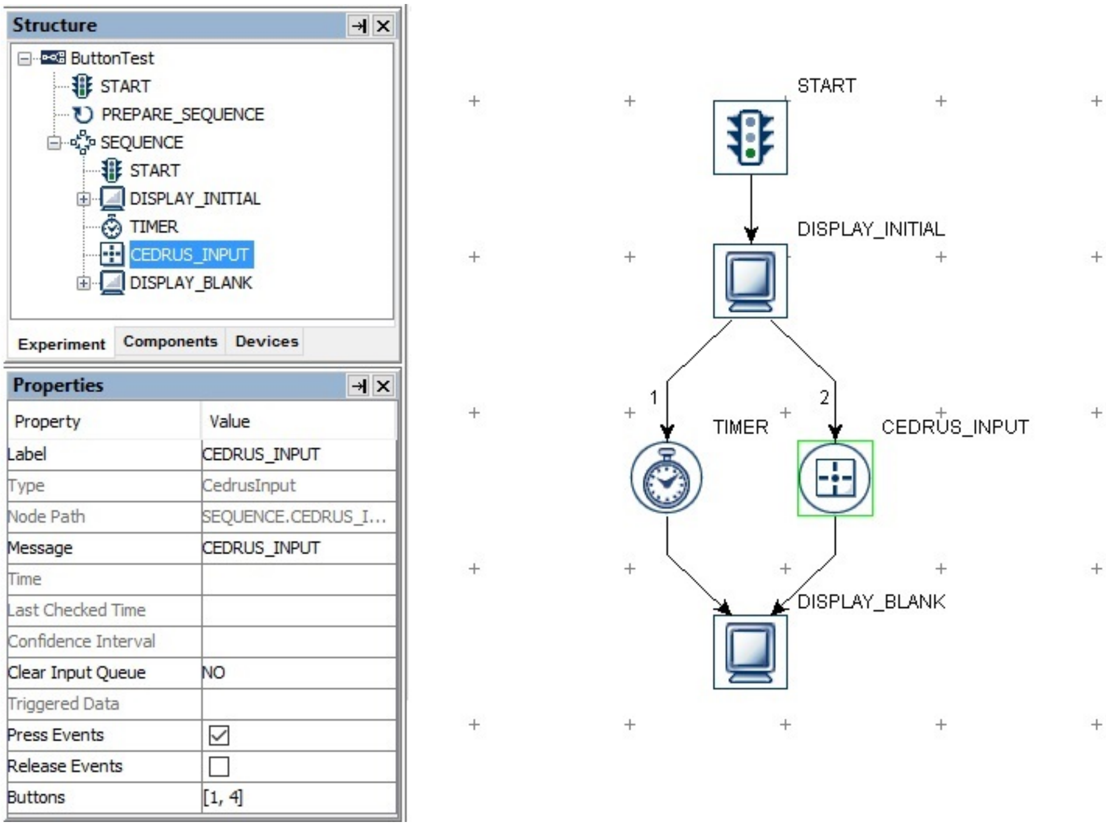


Figure 7-44. Using Cedrus Button Trigger.

The following section discusses some of the common applications of the Cedrus Input trigger:

7.10.5.1 Calculating Response Time of a Button Press

Cedrus button responses can be retrieved by using an Update Attribute action. Typically, users can use variables to record the button pressed, the time or RT of the button press, and the accuracy of the button press. The ID of the button pressed may be retrieved as "@CEDRUS_INPUT.triggeredData.button@". To determine the reaction time, the user must first determine the time of the button press by recording the "@CEDRUS_INPUT.triggeredData.time@" attribute (see Figure 7-45). With the time of the button press, the response time can be calculated as =(@BUTTON_PRESS_TIME.value@ - @DISPLAY_ON_TIME.value@). In case the trial can be ended without the participant pressing a button, the Update Attribute should be used to reset the default values for the variables at the beginning of the trial so that the response data from the previous trial will not be carried over to the following trial.

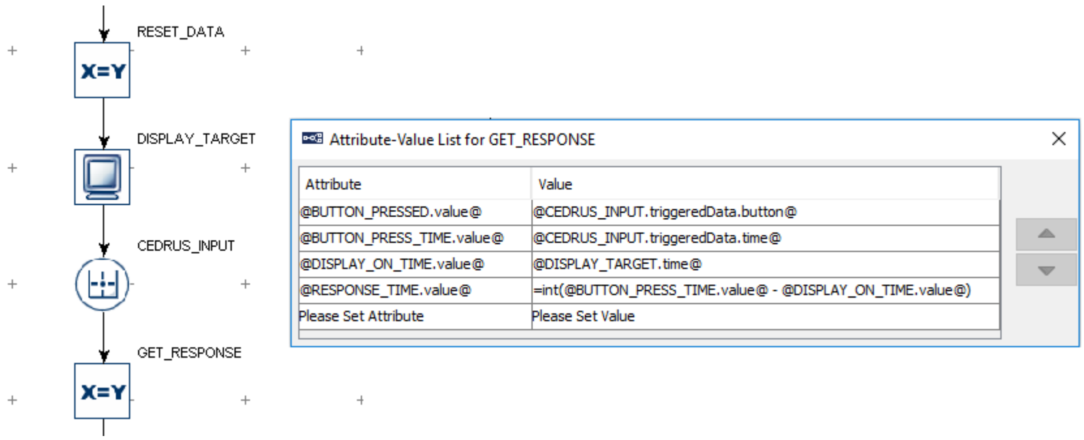


Figure 7-45. Collecting Cedrus Button Response Data.

To evaluate the accuracy of the button press, users will need to determine the expected button press for the trial. This can be encoded in the data source with a number column. Use a Conditional trigger to check whether the button pressed matches the expected button and then use an Update Attribute action at each branch of the trigger to update the accuracy variable accordingly. (Check the HTML version of this document for the complete example project.)

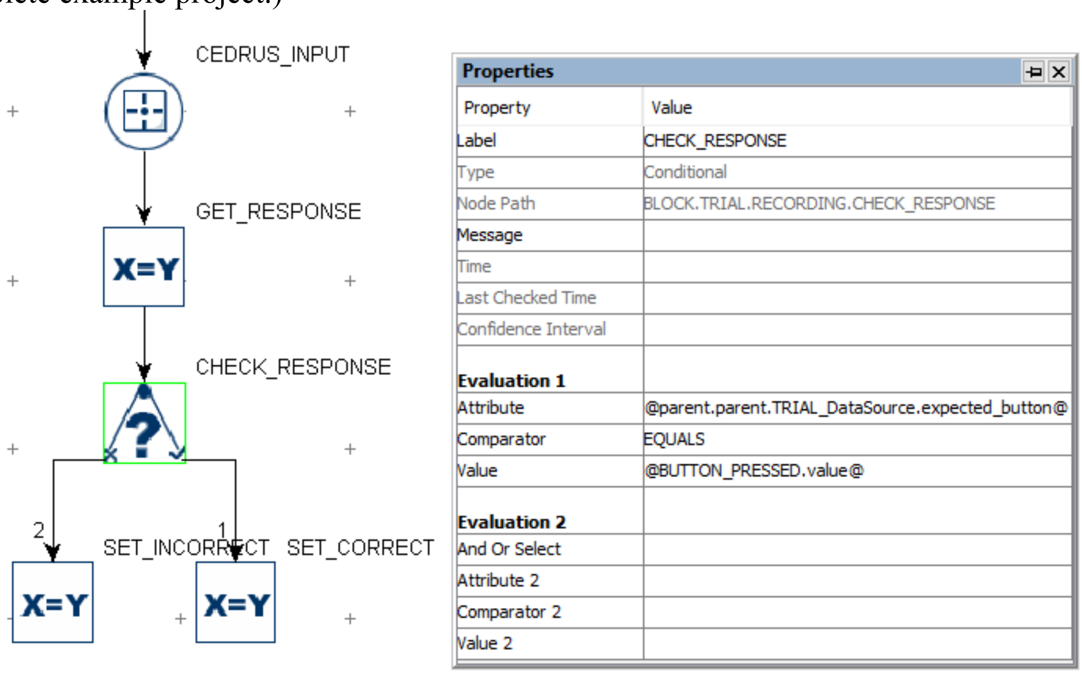


Figure 7-46. Checking Cedrus Button Response Accuracy.

7.10.5.2 Collecting Inputs from the Cedrus Button Box Without Ending the Trial

Sometimes the participant's button response should be recorded without ending the trial (e.g., the participant may be instructed to press a button whenever they detect a specific event in a video clip). This can be done by adding a Null Action node after the Display Screen and having the Cedrus Input trigger branch loop back to the Null Action—use an Update Attribute action following the button trigger to collect response data. All other triggers initially attached to the Display Screen action should be connected from the Null Action as well. If a Timer trigger is used to end the trial, the "Start Time" should be set to the .time attribute of the Display Screen so the start time of the Timer trigger will not be reset whenever a button is pressed.

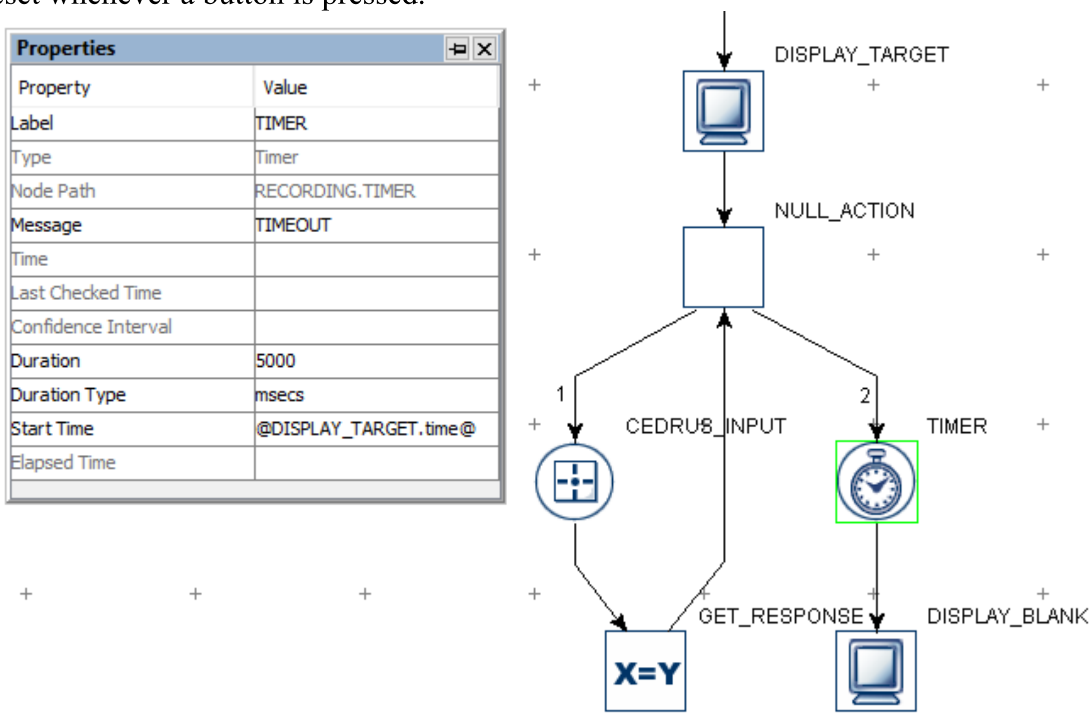


Figure 7-47. Using Cedrus Button Trigger Without Ending a Trial.

7.10.6 Keyboard Trigger

The Keyboard trigger ( ) responds to an input from the keyboard device attached to the display computer. (The host computer keyboard may be used as well, but some keys may not be used as they are designated in the host software.) Users can specify a list of possible key presses on the keyboard so that the trigger will fire. To set the key(s) used for response, click the value field of the "Keys" property and select the desired keys. Multiple keys can be selected or unselected by holding down the "Ctrl" key in Windows or the Command ⌘ key in macOS.

Keyboard devices are not recommended for collecting timing-critical responses due to large variability in response timing from keyboard devices in general. Some plug-and-play response boxes (e.g., the Millikey button box http://www.labhackers.com/millikey.html and BlackboxToolKit Response pad https://www.blackboxtoolkit.com/urp.html) can be connected to a USB port on the Display PC to collect responses with very low latency and variability. Pressing a button on the button box will generate a standard keyboard press event that can be checked with the KEYBOARD trigger.

In earlier versions of Experiment Builder (before 2.1.512), a "warning:2003 The IO node KEYBOARD is used in realtime Sequence RECORDING ***->KEYBOARD" message may be seen if the keyboard trigger is used in a sequence with the "Is Real Time" option checked. This warning means that the keyboard may not work when your sequence is running under the realtime mode; this typically only applies if using an old Display PC. For most recent computers with dual core/multicore processors, the keyboard trigger input (along with mouse and Cedrus Input) will function properly in the real-time mode, so this message can be ignored.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the keyboard trigger. The default label is "KEYBOARD".
Type #	NR		The Experiment Builder object type for this node (Keyboard).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the keyboard trigger fires.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the keyboard trigger is done (so the experiment flow is ready to move to the next node). **Note:** To check the time when the key was pressed, you should use @*.triggeredData.time@ instead.
NTP Time #	.ntpTime	Float	NTP server time when the processing of the keyboard trigger is done (so the experiment flow is ready to move to the next node).
Last Checked Time #	.lastCheckedTim e	Float	This property can be used to retrieve the Display PC time (in milliseconds from the start of the experiment) when the trigger was checked for the last time.
Confidence Interval #	.confidenceInterv al	Float	Time difference between the trigger time and last check time of the trigger. This indicates a window of uncertainty as the true trigger time could be between the last check time (.lastCheckedTime) and the reported trigger time (.time).
Clear Input Queue ¶	.clearInputQueue	Integer	Experiment Builder maintains an event queue so that multiple key press/release events can be accessed over time. The "Clear Input Queue"

			option checks whether the keyboard event(s) cached in the event queue should be cleared when the current trigger fires. (NO: no event clearing; Event: removes the current triggering event from the keyboard event queue; LIST: all key press events from event queue will be removed.)
Keys # ‡	.keys	List of Integers	Keys allowed for the trigger to fire. To select the desired key(s) from a dropdown list, double-click in the Value cell. Multiple button selections can be made by holding down the Ctrl key in Windows or the command ⌘ key in macOS. If using the attribute editor, keys should be specified as a list of keycodes (the internal numeric identifiers for each key on a keyboard). Note: To check which key is actually pressed or released, use the @*.triggeredData.key@ property.
Use Keyboard * ¶	.useKeyboard	String	Specifies the keyboard (Display PC, Tracker PC, or Either) used for response. If the "Enable Multiple Input" option is enabled, the keyboard options would be (Any, Tracker PC, KEYBOARD_1, KEYBOARD_2, ...).
Press Events †	.pressEvents	Boolean	Whether the trigger should fire when a key press event occurs. This is set to "True" (box checked) by default.
Release Events †	.releaseEvents	Boolean	Whether the trigger should fire when a key release event occurs. This is set to "False" by default.
Triggered Data #	.triggeredData		If the keyboard trigger fires, the triggered data can be further accessed through the sub-attributes of this property.

‡ The supported named keys in attribute editor are:

Any, Backspace, Tab, Clear, Enter, Pause, Escape, Space, Exclaim, Quotedbl, Hash, Dollar, Ampersand, Quote, Leftparen, Rightparen, Asterisk, Plus, Comma, Minus, Period, Slash, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, Colon, Semicolon, Less, Equals, Greater, Question, At, Leftbracket, Backslash, Rightbracket, Caret, Underscore, Backquote, a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z, Delete, NumPad-0, NumPad-1, NumPad-2, NumPad-3, NumPad-4, NumPad-5, NumPad-6, NumPad-7, NumPad-8, NumPad-9, NumPad-Period, NumPad-Divide, NumPad-Multiply, NumPad-Minus, NumPad-Plus, NumPad-Enter, NumPad-Equals, Up, Down, Right, Left, Insert, Home, End, Pageup, Pagedown, F1, F2, F3, F4, F5, F6, F7, F8, F9, F10, F11, F12, F13, F14, F15, Numlock, Capslock, Scrollock, Rshift, Lshift, Rctrl, Lctrl, Ralt, Lalt, Rmeta, Lmeta, Lsuper, Rsuper, Mode, Compose, Help, Print, Sysreq, Break, Menu, Power, Euro, Undo.

When a keyboard trigger fires, users can further access the triggered data. The sub-attributes of the TriggeredData for a keyboard trigger are listed in the following table.

Attribute	Reference	Type	Content
Keyboard	.keyboard	String	Keyboard on which the triggering key is pressed. If "Enable Multiple Input" option is enabled, this returns Tracker PC, KEYBOARD_1, KEYBOARD_2, ...; otherwise, this returns Display PC, or Tracker PC.
Key	.key	String	The key pressed that fired the trigger.
Key Code	.keyCode	Integer	The numeric code for the key pressed.
Unicode Key	.unicodeKey	String	Returns the Unicode key for the key(s) pressed. A MISSING_DATA will be returned if the system cannot translate the key sequence to a character.
Modifier	.modifier	Integer	A bit field enumeration for one or multiple modifier keys (Shift, Ctrl, and Alt) pressed.
Is Shift Pressed	.isShiftPressed	Boolean	Whether one of the SHIFT keys is pressed.
Is CTRL Pressed	.isCtrlPressed	Boolean	Whether one of the Ctrl keys is pressed.
Is ALT Pressed	.isAltPressed	Boolean	Whether one of the Alt keys is pressed.
EDF Time	.EDFTime	Integer	EDF time of the triggering key press.
NTP Time #	.ntpTime	Float	NTP server time when the triggering key is pressed.
Time	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the triggering key is pressed.

Using a keyboard trigger is very straightforward. For example, if a user wants to press the "ENTER" or "SPACEBAR" of the display computer to end a trial, the properties of the keyboard trigger can be set as shown in the following figure.

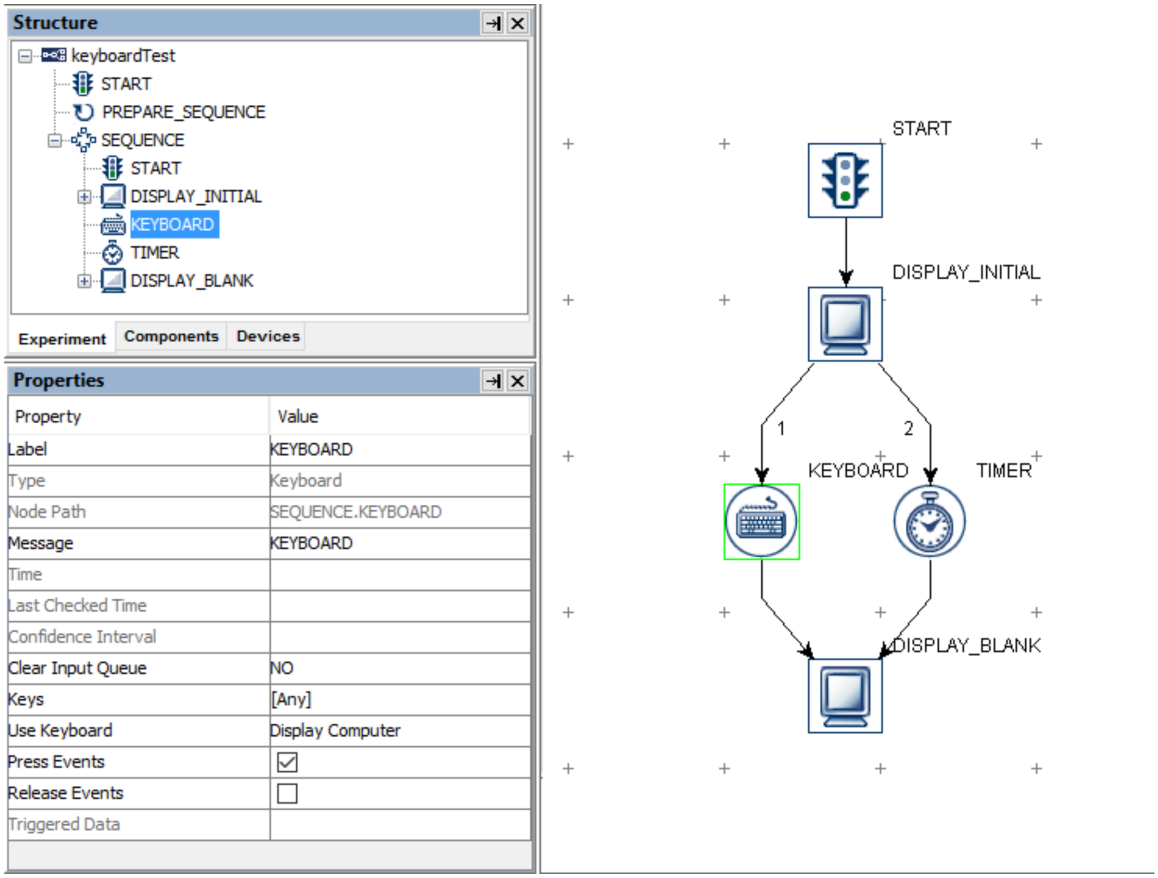


Figure 7-48. Using Keyboard Trigger.

To set the key(s) used for response, click the value field of the "Keys" property and select the desired keys. By holding down the "Ctrl" key in Windows or the Command ⌘ key in macOS, users can select or de-select multiple target keys from the dropdown list.

The following section discusses some of the common applications of the keyboard trigger:

7.10.6.1 Calculating Response Time from a Keyboard Input

Keyboard responses can be retrieved with an UPDATE_ATTRIBUTE action. Users can create variables to store the key pressed, the time or RT of the key press, and the accuracy of the key press. The key pressed may be retrieved as "@KEYBOARD.triggeredData.key@". To determine the reaction time, the user must first determine the time of the button press by recording the "@KEYBOARD.triggeredData.time@" attribute (see Figure 7-49). With the time of the button press, users can calculate the response time as (@KEY_PRESS_TIME.value@ - @DISPLAY_ON_TIME.value@). In case the trial can end without the participant pressing a key, the UPDATE_ATTRIBUTE can be used to reset the default values for the variables at the beginning of the trial so that the response data from the previous trial will not be carried over to the current trial.

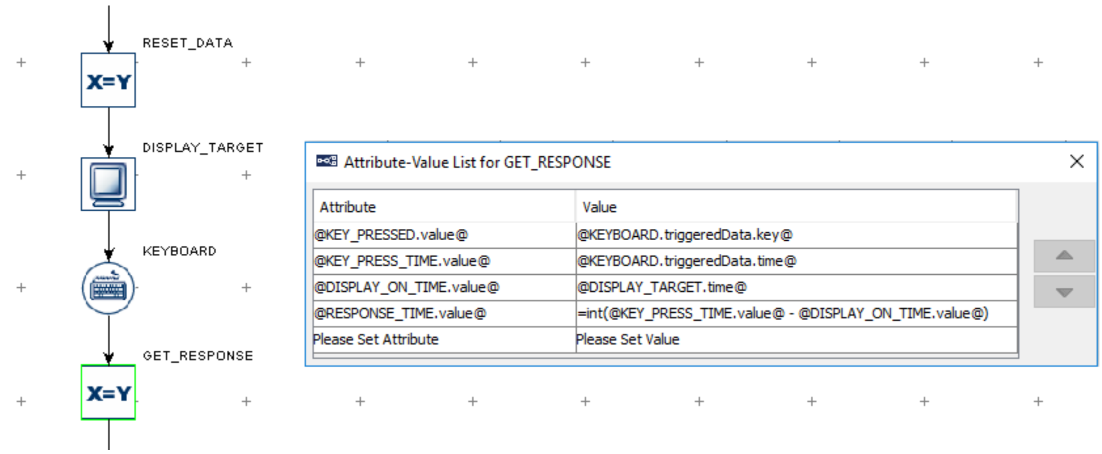


Figure 7-49. Collecting Keyboard Response Data.

To evaluate the accuracy of the key press, users will need to determine the expected key press for the trial. This can be encoded in the data source with a string column. Use a Conditional trigger to check whether the pressed key matches the expected key and then use an Update Attribute action at each branch of the trigger to update the accuracy variable accordingly (please check out the HTML version of this document for the complete example project).

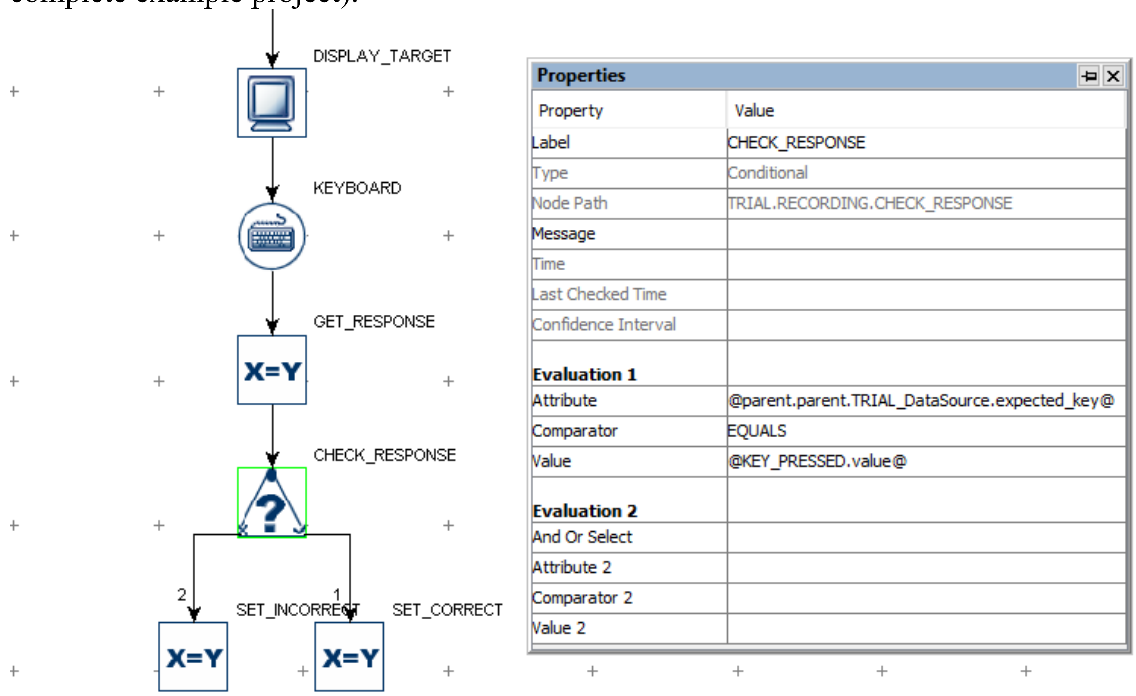
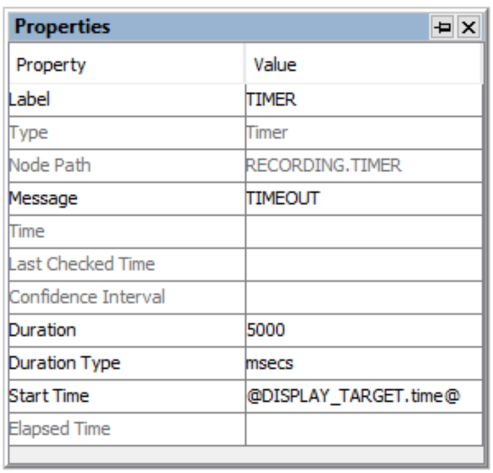


Figure 7-50. Checking Keyboard Response Accuracy.

To evaluate a keypress that may use non-ASCII characters (e.g., the spacebar), you may use the numeric "Key Code". In the "Attribute" field of the conditional trigger, use a reference to the triggeredData.keyCode of the KEYBOARD trigger, and in the "Value" field, enter the expected keycode for the character (e.g., 32 for the spacebar).

7.10.6.2 Collecting Inputs from the Keyboard Without Ending the Trial

Sometimes the participant's key response should be recorded without ending the trial (e.g., the participant may be instructed to press a button whenever they detect a specific event in a video clip). This can be done by adding a Null Action node after the Display Screen and having the keyboard trigger branch looping back to the Null Action—use an Update Attribute action following the keyboard trigger to collect response data. All other triggers initially attached to the Display Screen action should be connected from the Null Action as well. If a Timer trigger is used to end the trial, the "Start Time" should be reset to the .time attribute of the Display Screen so the start time of the Timer trigger will not be reset whenever a key is pressed.



Properties

Property	Value
Label	TIMER
Type	Timer
Node Path	RECORDING.TIMER
Message	TIMEOUT
Time	
Last Checked Time	
Confidence Interval	
Duration	5000
Duration Type	msecs
Start Time	@DISPLAY_TARGET.time@
Elapsed Time	

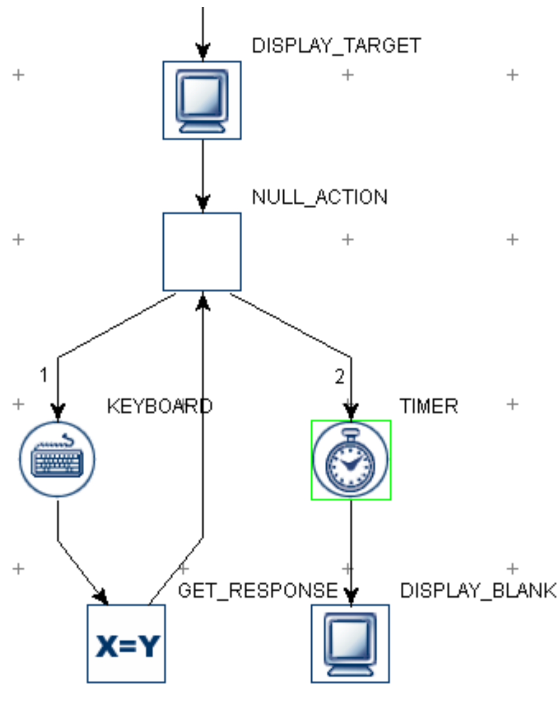


Figure 7-51. Using Keyboard Without Ending a Trial.

7.10.6.3 Enabling Multiple Keyboards

If multiple keyboards or mice are attached to the display computer, responses from all of the keyboards and mice are treated in the same way (e.g. as if the response is made on a single keyboard or mouse). In some applications, users may want to differentiate the responses from different keyboards or mice. This can be done by enabling multiple keyboard support. Presently, multiple input support is supported on Windows only.

1. First plug in all of the intended keyboards and mice to the display computer.
2. Install the keyboard and mouse driver that supports multiple keyboard/mouse inputs. Start the Windows Explorer. Go to the folder "C:\Program Files (x86)\SR Research\Experiment Builder\drivers\win10". Run the installer program

"EBDriversStarter.exe" in the folder. Follow the instructions provided to complete the installation.

3. Open the experiment project, click "Edit → Preferences → Experiment" to open the Experiment preference settings and tick the "Enable Multiple Input" option.
4. If multiple keyboards are used, go to the "KEYBOARD" device preferences, set the intended number of keyboards for the experiment project and assign distinct labels for the keyboards if you need to. If multiple mice are used, go to the "MOUSE" device preferences, set the intended number of mice for the experiment project and assign distinct labels for the mice if you need to.
5. Now for all of the keyboard triggers, the possible keyboards to be used are listed in the "Use Keyboard" property of the trigger.
6. When you run your experiment with multiple keyboards, you will now be asked to press the ENTER key on the intended keyboards in sequence so that Experiment Builder can map the keyboards labeled in the "KEYBOARD" device settings to the physical keyboard devices. The experiment will start after the keyboards and mice are identified.

7.10.6.4 Disabling / Re-enabling the Windows Logo Keys

Experiment Builder may fail to lock the drawing surface if the participants accidentally press the Windows logo key when using the keyboard. To prevent this from happening, users may disable the Windows logo keys (https://support.microsoft.com/en-us/kb/216893). Download the windowskey.zip file and unzip the files from the HTML version of this document.

- To disable the Windows logo keys, select the disable_both_windows_keys.reg file, click the right mouse button, and select the "Merge" option. Reboot the computer.
- To re-enable the Windows logo keys, select the enable_back_windows_key.reg file, click the right mouse button, and select the "Merge" option. Reboot the computer.

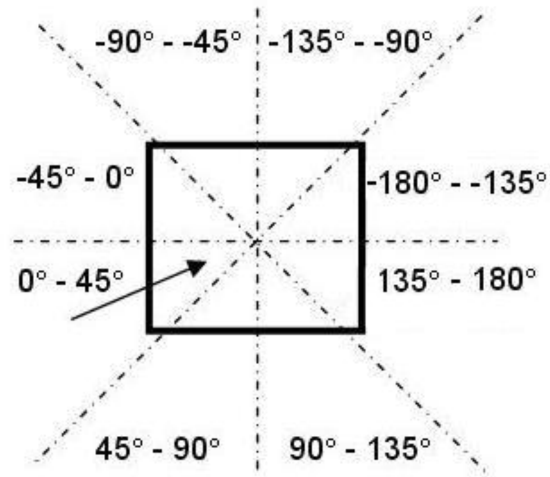
7.10.7 Mouse Trigger

A Mouse trigger ( ) fires by pressing or releasing a pre-specified mouse button. As with the invisible boundary trigger, users may specify a region for the mouse trigger to fire. The mouse trigger can also be used with a touchscreen monitor to detect the location of touches. Using a mouse as a response device is not recommended for timing-critical experiments because the temporal resolution of the mouse response is unknown (the delays introduced by Windows are highly variable) and the timing performance may vary across different types of mouse (USB vs. serial).

In earlier versions of Experiment Builder (before 2.1.512), a "WARNING: 2003 The IO node MOUSE is used in realtime Sequence ***->MOUSE" message will be reported if the mouse trigger is used in a sequence with the "Is Real Time" option checked. This warning means the mouse trigger may not work when your sequence is running under the realtime mode; this typically only applies if using an old Display PC. For most recent computers with a dual- or multicore processor, the Mouse trigger input (along with keyboard and Cedrus Input) will function properly in the real-time mode, so this message can be ignored.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the mouse trigger. The default value is "MOUSE".
Type #	NR		The Experiment Builder object type for this node (Mouse).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the mouse trigger fires.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the mouse trigger is done (so the experiment flow is ready to move to the next node). **Note:** To check the time when the mouse button is pressed/released or the mouse position falls within the triggering region, you should use @*.triggeredData.time@ (i.e., the .time sub-attribute of the .triggeredData attribute) instead.
NTP Time #	.ntpTime	Float	NTP server time when the processing of the mouse trigger is done (so the experiment flow is ready to move to the next node).
Last Checked Time #	.lastCheckedTime	Float	This property can be used to retrieve the Display PC time (in milliseconds from the start of the experiment) when the trigger was checked for the last time.
Confidence Interval #	.confidenceInterval	Float	Time difference between the trigger time and last check time of the trigger. This indicates a window of uncertainty as the true trigger time could be between the last check time (.lastCheckedTime) and the reported trigger time (.time).
Clear Input Queue ¶	.clearInputQueue	Integer	Experiment Builder maintains an event queue so multiple mouse press/release events can be accessed over time. The "Clear Input Queue" option checks whether the mouse event(s) cached in the event queue should be cleared when the current trigger fires. (NO: no event clearing; EVENT: removes the current triggering event from the mouse press/release event queue; LIST: all mouse events from event queue will be removed.)

Buttons	.buttons	List of Integers	List of Integers ([1, 2, 3, 4, 5] by default) specifying which buttons will be accepted for trigger firing. Button values 1, 2 , and 3 correspond to the mouse buttons (1: left button, 2: middle button, 3: right button), while values 4 and 5 correspond to the scroll wheel (scrolling up is coded as a press event of button 4, and scrolling down is coded as a release event of button 5).
Use Mouse *¶	.useMouse	String	Specifies the Mouse (Any, MOUSE_1, MOUSE_2, ...) used for response. This option will only be available if the "Enable Multiple Input" option in the Experiment Preferences ("Edit → Preferences") is enabled.
Press Events †	.pressEvents	Boolean	Whether the trigger should fire when a button press event occurs. This is set to "True" (box checked) by default.
Release Events †	.releaseEvents	Boolean	Whether the trigger should fire when a button release event occurs. This is set to "False" (box unchecked) in version 2.0 or later of Experiment Builder.
Position Triggered †	.positionTriggered	Boolean	Whether the mouse must be in a specific region to register as a response. This field is independent of the Press and Release Events options. If Press Events and/or Release Events are checked, with Position Triggered enabled, then the mouse trigger will only fire with a click or release event in the specified region; if Position Triggered is not enabled, the trigger will fire with a click or release on any part of the screen. If Position Triggered is checked while neither the Press Events nor Release Events field is checked, the mouse trigger will fire when the mouse enters the specified region without a press or release event (i.e., a mouseover event).
Region Direction	.regionDirection	List of Strings	A range of angles from a multiple-selection list ['0 - 45', '45 - 90', '90 - 135', '135 - 180', '-180 - -135', '-135 - -90', '-90 - -45', '-45 - 0'] used to restrict the direction in which the mouse trigger fires. For each angle range, the first value is inclusive and the second value is not inclusive.

			
Region Type ¶	.regionType	String	The type of triggering Region used: RECTANGLE (0), ELLIPSE (1), or INTEREST AREA (2). The "INTEREST AREA" option is only available when interest areas are defined in one of the display screens in the same recording sequence.
Region Location (Top Left)	.regionLocation	Point	Pixel coordinate of the top-left corner of the trigger region in (x, y) tuple. The default value is (0, 0). Note that the x, y coordinates of the region location can be further referred to individually as .regionLocation.x and .regionLocation.y, respectively. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Region Width	.regionWidth	Integer	Width (0 by default) of the triggering region in screen pixels. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Region Height	.regionHeight	Integer	Height (0 by default) of the triggering region in screen pixels. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Interest Area Screen *¶	NR .		The display screen on which target interest area regions are located. This property is only available when the "Region Type" property is set to INTEREST AREA.
Interest Area Regions ¶	NR		Target interest areas used to define the triggering region. This property is only available when the "Region Type" property is set to INTEREST AREA.
Within †	.within	Boolean	If set to "True" (default), the trigger will fire when the mouse is within the above-mentioned trigger region; if "False," the trigger fires when the mouse is outside of the region.

Triggered Data #	.triggeredData		If the mouse trigger fires, the triggered data can be further accessed through the sub-attributes of this property.

When a mouse trigger fires, users may further access the triggered Data. The sub-attributes of the TriggeredData attribute are listed in the following table:

Attribute	**Reference**	**Type**	**Content**
Time	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the mouse button was pressed/released.
NTP Time #	.ntpTime	Float	NTP server time when the mouse button was pressed/released.
EDF Time	.EDFTime	Integer	EDF time of the mouse button press/release.
Pressed	.pressed	Integer	Whether the mouse button is pressed (1) or released (0). When using the scrolling wheel on the mouse, scrolling up is associated with press event of button 4 and scrolling down is associated with the release event of button 5.
Button	.button	Integer	Specific button pressed/released for trigger firing. When using the scrolling wheel on the mouse, scrolling up is associated with press event of button 4 and scrolling down is associated with the release event of button 5.
X	.x	Float	Pixel coordinate of the mouse cursor along the x-axis when the trigger fired.
Y	.y	Float	Pixel coordinate of the mouse cursor along the y-axis when the trigger fired.
Offset	.offset	Point	The triggered mouse position relative to the top-left corner of the triggering region.
Angle	.angle	Float	The angle of the mouse movements when the trigger fired.
Mouse	.mouse	String	For a project with multiple input support, this reports the mouse device from which the response is collected. Otherwise, it reports "Display PC"
IA Labels	.IALabels	List	Provides a list of labels of the interest area(s) hit (i.e., clicked or moved into). Returns an empty list if no interest area is hit (e.g., if the triggering region is not interest area-based, or the trigger firing is not region-based).
IA IDs	.IALabels	List	Provides a list of IDs of the interest area(s) hit (i.e., clicked or moved into). Returns an empty list if no interest area is hit (e.g., if the triggering region is not interest area-based, or the trigger firing is not region-based).
IA Label	.IALabel	String	Reports the label of the interest area hit. If multiple interest areas are hit, reports the label of the interest area with the lowest ID. Missing data if no interest area hit.

IA ID	.IAID	Integer	Reports the ID of the interest area hit. If multiple interest areas are hit, reports the lowest ID if multiple interest areas are hit). Missing data if no interest area hit.
IA Location	.IALocation	Point	Location (top-left or center, based on preference) of the interest area hit. If multiple interest areas are hit, reports the location of the interest area with the lowest ID.
IA Width	.IAWidth	Integer	Width of the interest area hit. If multiple interest areas are hit, reports the width of the interest area with the lowest ID.
IA Height	.IAHeight	Integer	Height of the interest area hit. If multiple interest areas are hit, reports the height of the interest area with the lowest ID.

The following section discusses some of the common applications of the Mouse trigger:

7.10.7.1 Mouse Press, Release, Scroll, and Mouse Over

The Mouse trigger can be used to collect various behaviors with the mouse, such as clicks and releases of the mouse buttons, scroll wheel movements, and movements inside or outside of specified regions. The “Press Events” and “Release Events” attributes can be configured independently of the “Position Triggered” property to specify the types of mouse behavior that will cause the trigger to fire.

For example, to configure a sequence to end when the participant clicks any mouse button, regardless of position, set the properties of the mouse trigger as in the figure below. The "Position Triggered" attribute should be unchecked so the press event will be accepted anywhere on the screen.

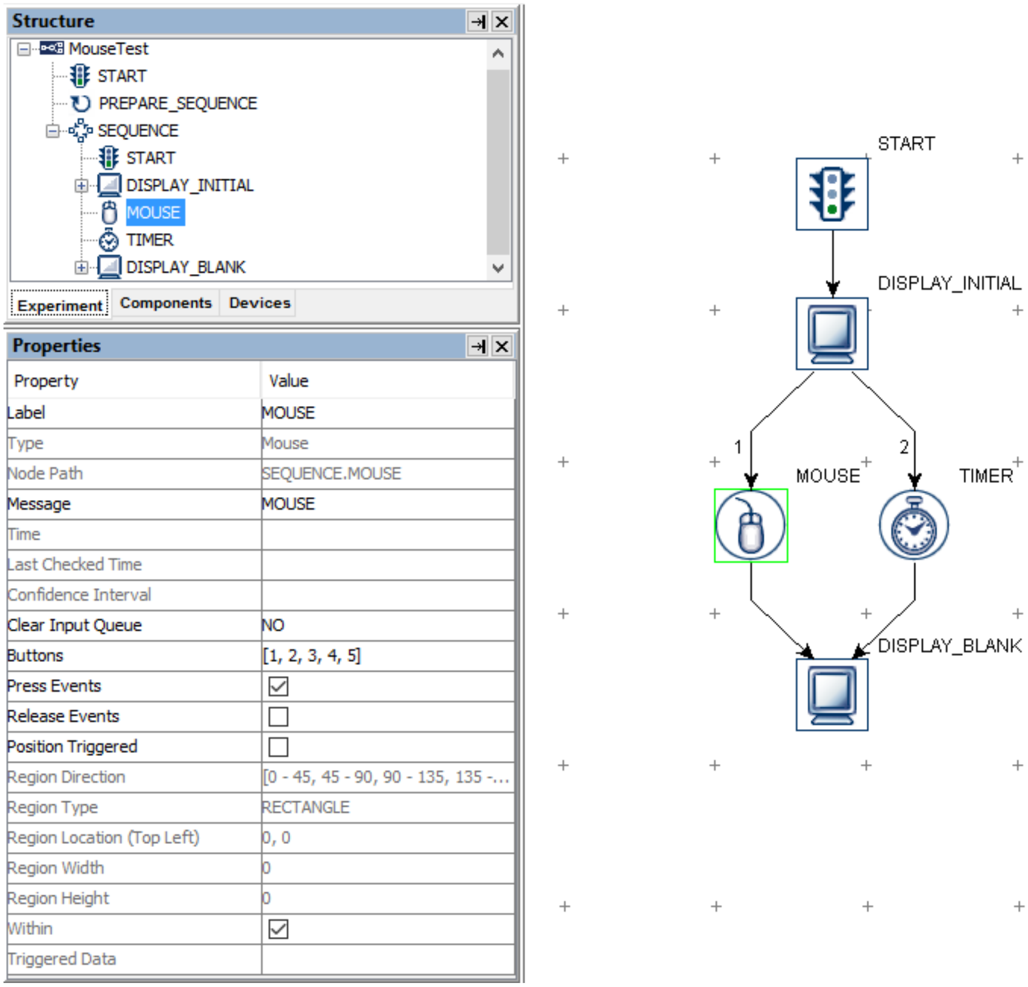


Figure 7-52. Using the Mouse Trigger.

To configure the Mouse trigger to fire only when the mouse is within (or outside of) a specified region (e.g., to click an onscreen button), check the box for the "Position Triggered" attribute. Then set the triggering region. The Region Type attribute can be specified as either a Rectangle, Ellipse, or Interest Area. If the Region Type is set to Interest Area, set the Interest Area Screen to the Display Screen action that includes the Interest Area(s) to be used, then choose the desired interest area(s) by clicking the value cell of the Interest Area Regions attribute. If the Region Type is set to either Rectangle or Ellipse, set the Region Location, Width and Height as desired (see the left panel of the following figure.)

If "Position Triggered" is enabled, it is often necessary to add a cursor onscreen so the participant knows where the mouse is. To add a cursor to a Display Screen, simply add a small image or shape resource to the screen and enable the "Position is Mouse Contingent" for the resource (see the right panel of the following figure). If using an image resource with a cursor, make sure the background pixels of the cursor image are set to the same color as the project Transparency Color.

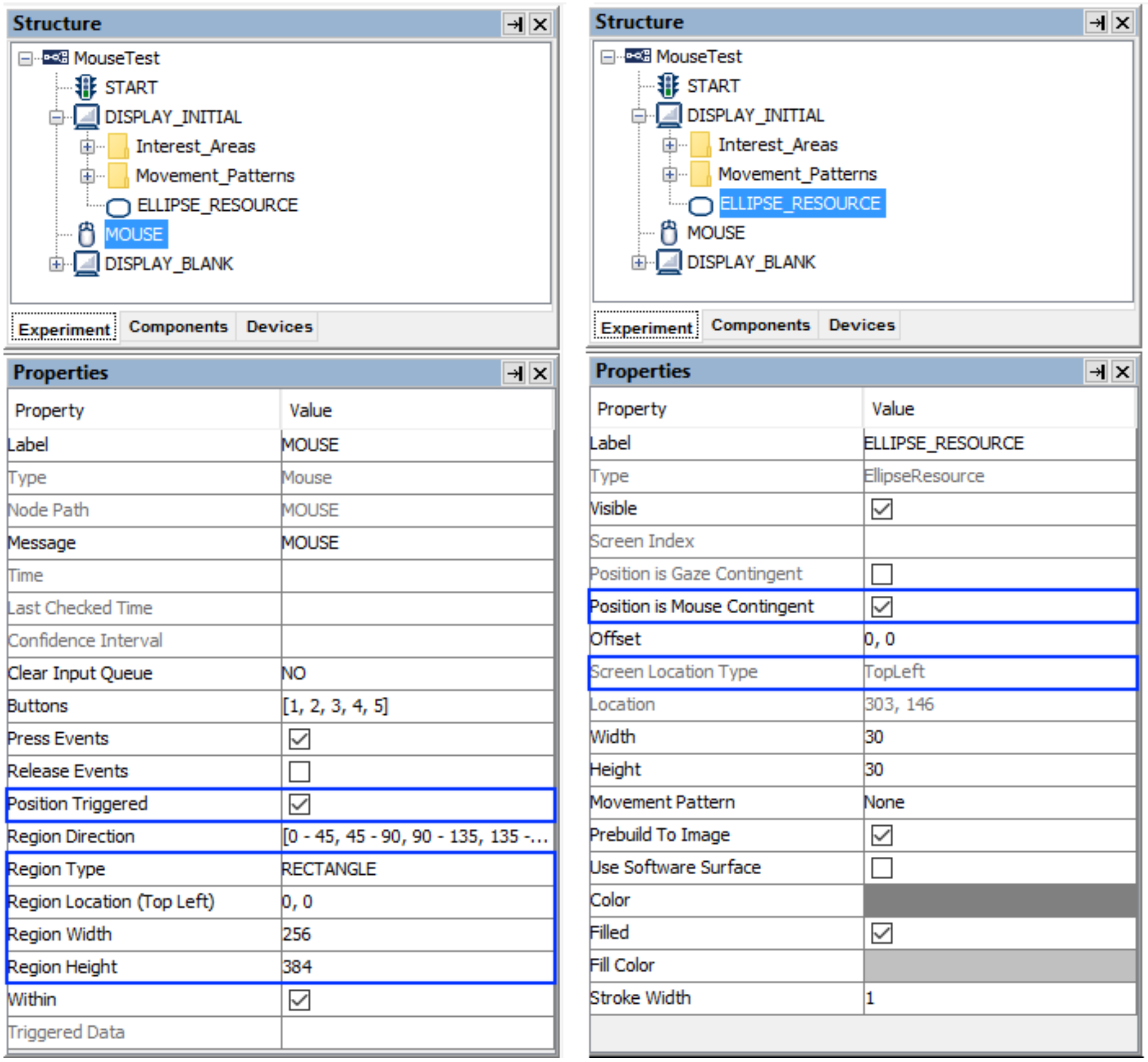


Figure 7-53. Setting the Mouse Triggering Region.

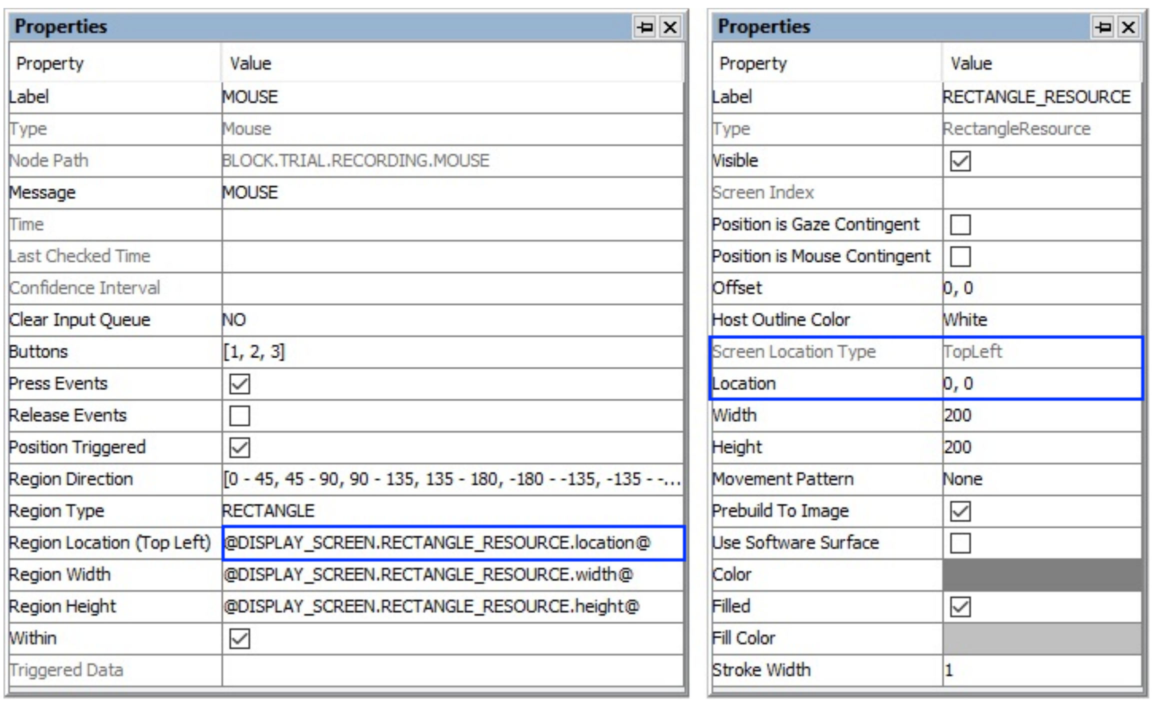
If "Position Triggered" is enabled, but both "Press Events" and "Release Events" are disabled, then the Mouse trigger will fire as soon as the mouse enters the triggering region. See "FAQ: Will mouse trigger fire when I use the 'Position Triggered' Option and do not check the Press/Release Event boxes?" in the HTML version of this document for more information.

The mouse trigger can also be used to detect scrolling events on the mouse wheel. Experiment Builder reports a press event on button 4 if the mouse wheel is rolled up, and a release event on button 5 when the mouse wheel is rolled down. To detect scrolling events, set the "Buttons" field to [4, 5] and check both the "Pressed Events" and "Release Events" attributes.

7.10.7.2 Center Location Type vs. Top-left Location Type.

The Location Type of all location-based triggers (invisible boundary trigger, mouse trigger, fixation trigger, saccade trigger, and sample velocity trigger) is based on the top-left corner of the region, whereas the screen resources can be based on either the top-left corner or the center of the resource. (The screen resource/interest area location type can be set in the project Preferences under Screen). This means that references should be created differently depending on whether the region location of a trigger refers to a center-based resource or a top-left-based resource.

Imagine that a mouse trigger should fire when the cursor is within a rectangle resource (RECTANGLE_RESOURCE). The top panel of the figure below illustrates creating the Region Location reference to the rectangle resource when the screen location type is TopLeft (@DISPLAY_SCREEN.RECTANGLE_RESOURCE.location@). The bottom panel of the figure illustrates creating a location equation when the location type is Center, by subtracting half the resource width from the x coordinate, and half the resource height from the y coordinate:
(=EBPoint(@DISPLAY_SCREEN.RECTANGLE_RESOURCE.location.x@ - @DISPLAY_SCREEN.RECTANGLE_RESOURCE.width@/2, @DISPLAY_SCREEN.RECTANGLE_RESOURCE.location.y@ - @DISPLAY_SCREEN.RECTANGLE_RESOURCE.height@/2)).



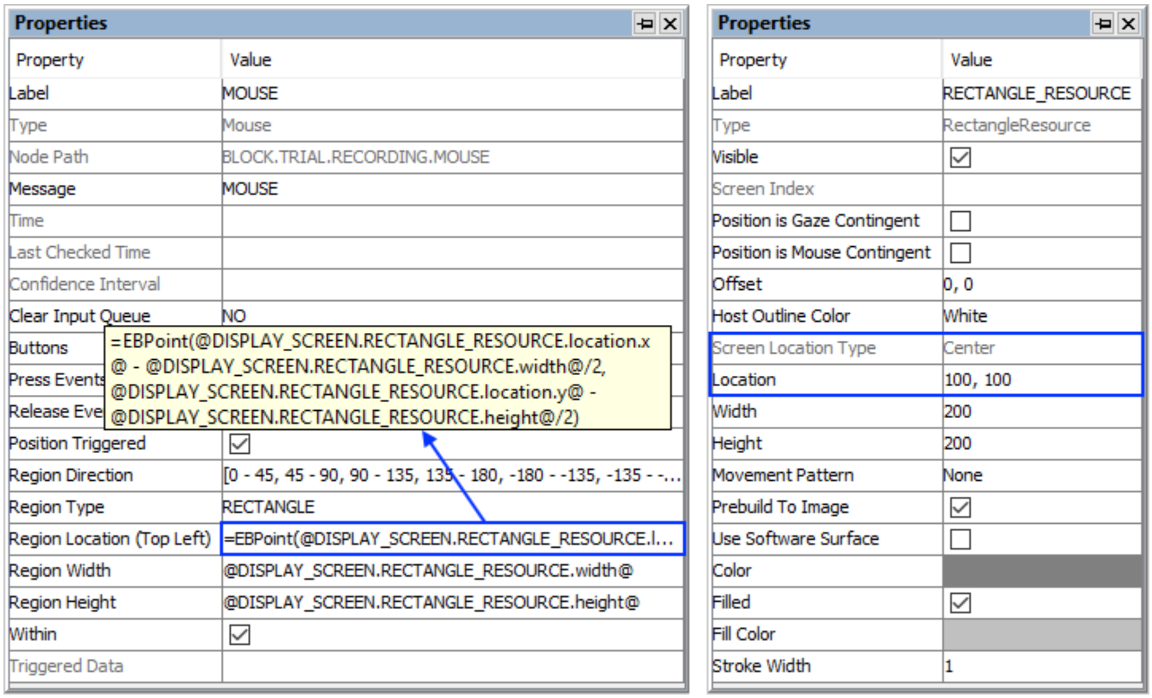


Figure 7-54. Using Mouse Trigger with Top-left and Center Location Types.

7.10.7.3 Calculating Response Time of a Mouse Click

To record information about the mouse response, users can create variables, e.g., to record which button was pressed, the time or RT of the button press, and the accuracy of the response. After the response, an Update Attribute action can be used to set the values of these variables. To record the button pressed, refer to the "@MOUSE.triggeredData.button@" attribute, and to record the time of the button press, refer to the "@MOUSE.triggeredData.time@" attribute (see the figure below). With the time of the mouse click, the response time can be calculated as (@BUTTON_PRESS_TIME.value@ - @DISPLAY_ON_TIME.value@). If the trial can be ended without the participant making a response (e.g., the trial times out after some period), use an Update Attribute action at the beginning of the trial to reset the default values for the variables to ensure the response data from the previous trial will not be carried over to the current trial.

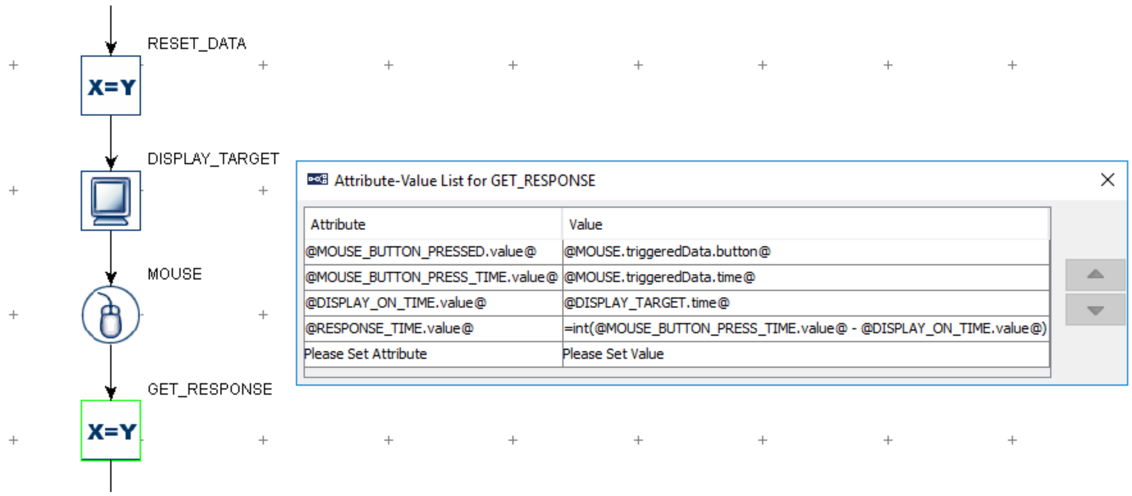


Figure 7-55. Collecting Mouse Response Data.

To evaluate the accuracy of the button press, users will need to determine the expected button press for the trial. This can be specified in the data source with a number column. Use a Conditional trigger to check whether the pressed button matches the expected button, then connect an Update Attribute action to each branch of the trigger to update the accuracy variable accordingly (check the HTML version of this document for the complete example project).

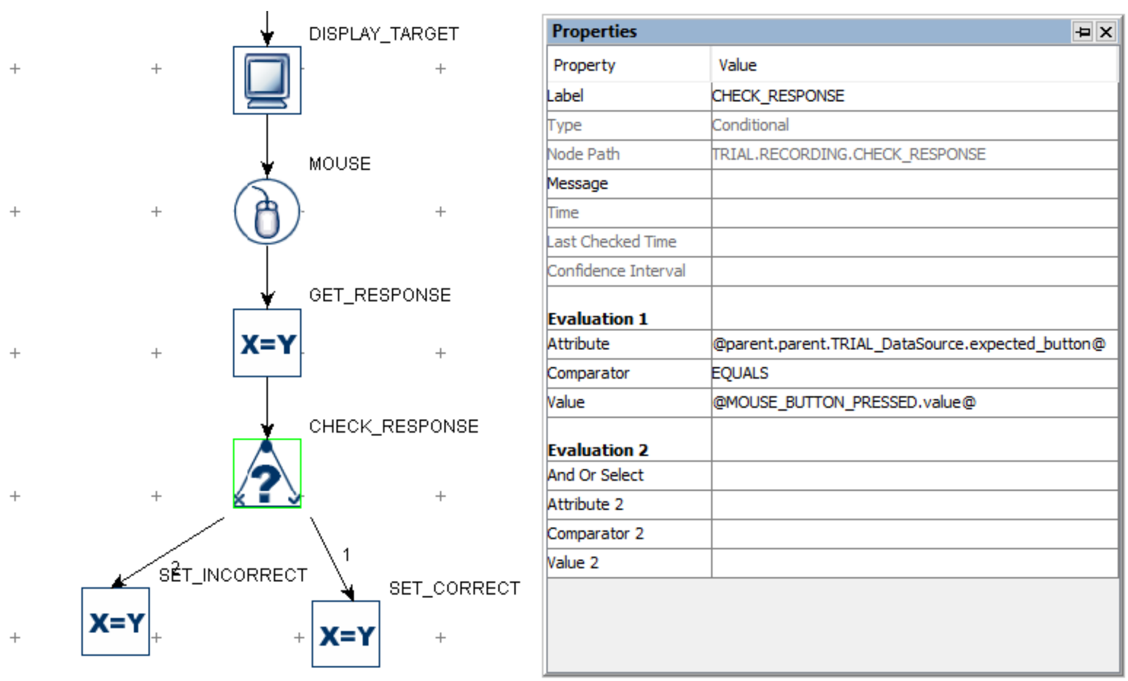


Figure 7-56. Checking Mouse Response Accuracy.

7.10.7.4 Collecting Inputs from the Mouse Without Ending the Trial

Sometimes the participant's mouse response should be recorded without ending the trial (e.g., the participant may be instructed to click the mouse whenever they detect a specific event in a video clip). This can be done by adding a Null Action node after the Display Screen and having the mouse trigger branch loop back to the Null Action—use an Update Attribute action following the mouse trigger to collect response data. All other triggers initially attached to the Display Screen action should be connected from the Null Action as well. If a Timer trigger is used to end the trial, the "Start Time" should be reset to the .time attribute of the Display Screen so the start time of the Timer trigger will not be reset whenever a button is pressed.

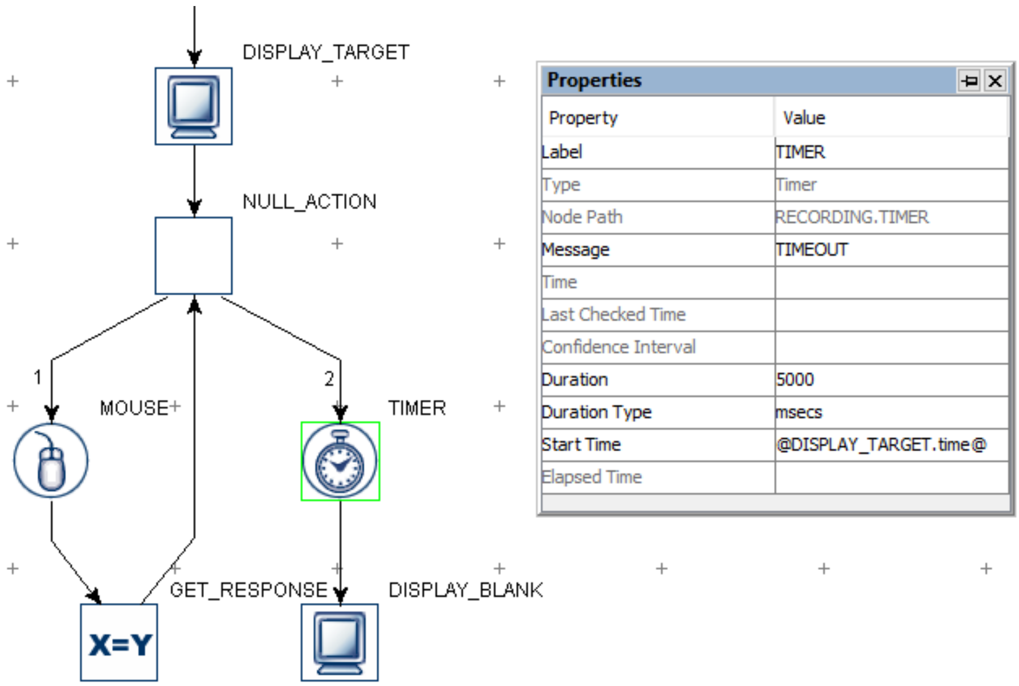


Figure 7-57. Using Mouse Trigger Without Ending a Trial.

7.10.7.5 Resetting the Initial Position of the Mouse Device

The initial position of a mouse-contingent resource can be reset by updating the "X Position" and "Y Position" of the mouse device to the intended values. See "FAQ: What should I do to reset the mouse position to a default position at the beginning of each trial?" in the HTML version of this document.

7.10.7.6 Enabling Multiple Mice

If multiple keyboards or mice are connected to the display computer, responses from all of the keyboards and mice are treated in the same way (e.g. as if the response is made to a single keyboard or mouse). For some applications, users may want to differentiate the responses from different keyboards or mice. This can be done by enabling multiple mouse support. Presently the multiple input support is supported on Windows only.

1. First plug in all of the intended keyboards and mice to the display computer.

2. Install the keyboard and mouse driver that supports multiple keyboard/mouse inputs. Start the Windows Explorer. Go to the folder "C:\Program Files (x86)\SR Research\Experiment Builder\drivers\win10". Run the installer program "EBDriversStarter.exe". Follow the instructions provided to complete the installation.
3. Open the experiment project, and click "Edit → Preferences → Experiment" to open the Experiment preference settings and tick the "Enable Multiple Input" option.
4. Go to the "MOUSE" device preferences, set the intended number of mice for the experiment project, and assign distinct labels for each of the mice if desired.
5. All Mouse triggers in the project will now have the "Use Mouse" property to specify which mouse (or "Any" mouse) to use.
6. When running an experiment with multiple mouse devices, Experiment Builder will prompt you to click the left button of the intended mice so that Experiment Builder can map the mice labeled in the "MOUSE" device to the physical mice. The experiment will start after the keyboards and mice are identified.

7.10.7.7 Recording Mouse Traces in a Data File

To save the mouse coordinates into an EDF file or to a results file, include the coordinates of the mouse in the Message field of the Display Screen action. (For a non-EyeLink experiment, make sure the "Save Messages" option of the topmost experiment node in the Structure panel is checked.) The message will be sent each time the screen is redrawn—i.e., each time the onscreen cursor resource moves. For example, enter a message like the following in the Display Screen resource:

```
="TRIAL\t" + str(@parent.parent.iteration@) + "\tMOUSE\tX\t" +
str(@CUSTOM_CLASS_INSTANCE.mouseX@) + "\tY\t" +
str(@CUSTOM_CLASS_INSTANCE.mouseY@)
```

The EDF file (or Messages.txt) will contain messages like:

13645.141	-16 TRIAL	2	MOUSE	X	512	Y	378
13661.688	-16 TRIAL	2	MOUSE	X	512	Y	370
13678.538	-16 TRIAL	2	MOUSE	X	512	Y	360
13695.127	-16 TRIAL	2	MOUSE	X	512	Y	348
13711.654	-16 TRIAL	2	MOUSE	X	512	Y	336
13728.289	-16 TRIAL	2	MOUSE	X	512	Y	327
13745.155	-16 TRIAL	2	MOUSE	X	512	Y	315
13761.735	-16 TRIAL	2	MOUSE	X	512	Y	305
13778.291	-16 TRIAL	2	MOUSE	X	512	Y	289
13795.179	-16 TRIAL	2	MOUSE	X	512	Y	284

The time at which the actual mouse/resource position was shown on screen will be the difference between the first two columns (i.e., 13661.141 for "13645.141 -16"). Note that the messages are only sent out when the mouse position changes, causing the screen to update based on the resource position change. For a continuous output, users will need to interpolate messages themselves for periods of time in which the mouse is not moving.

If recording the mouse position in an EDF file for use in Data Viewer, the mouse position traces can be displayed in the Temporal Graph View and included in the Sample Report by using a "TARGET_POS " message. Data Viewer reads these messages and interpolates the mouse position for an estimate of sample-level mouse position. Please see the HTML version of this document for an example project that demonstrates sending TARGET_POS messages.

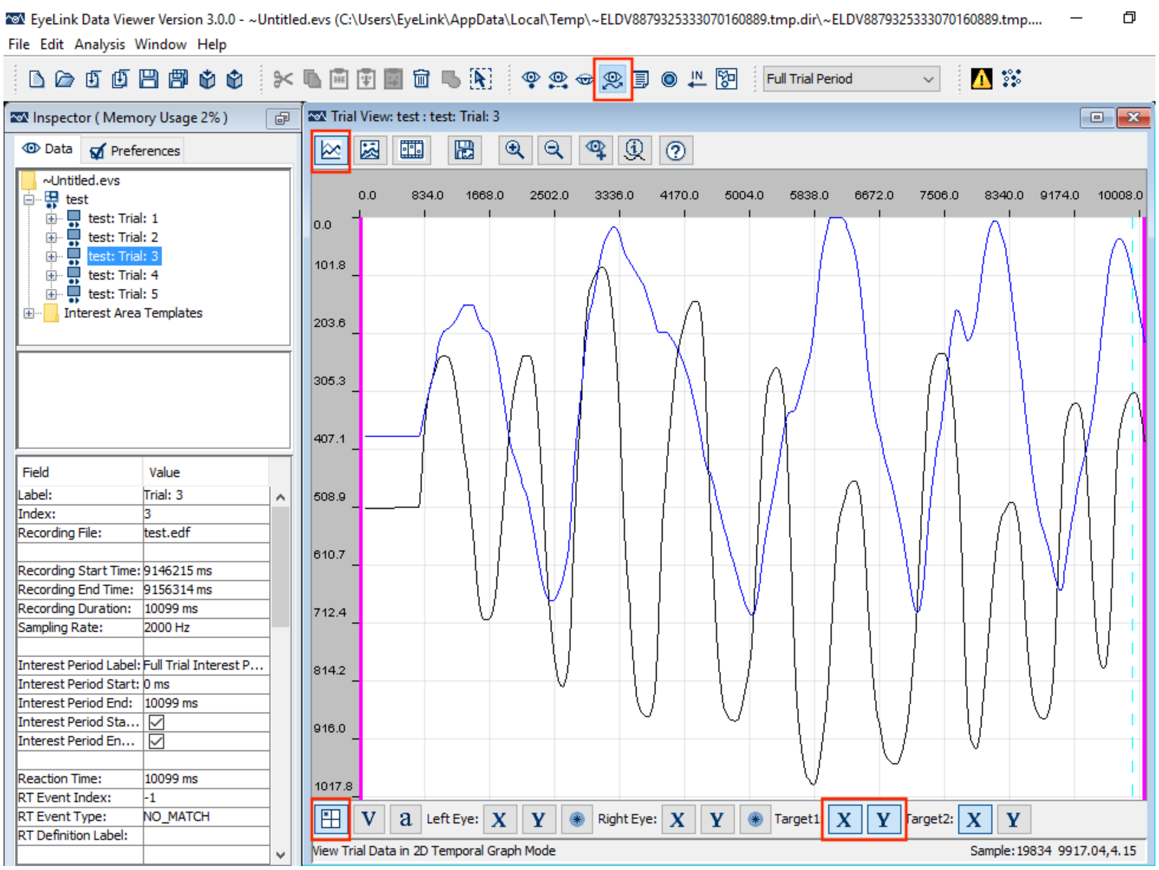


Figure 7-58. Viewing Mouse Traces in the Data Viewer Temporal Graph View.

7.10.8 TTL Input Trigger

The TTL Input trigger (TTL) is used to check for TTL signals sent to Display PC via a parallel port or supported USB device. A USB2TTL8 device from LabHackers can be used to receive TTL input signals in both Mac and Windows; the parallel port and the USB-1208 HS interface box are supported in Windows only.

When interfacing the parallel port on the PC, Experiment Builder automatically installs the driver for both 32-bit and 64-bit versions of Windows. If a parallel port is used, Experiment Builder will typically identify the base address of the parallel port automatically if the “Parallel Port Base Address” property of the “Parallel Port” Device is left as 0x0. In the rare cases where Experiment Builder cannot detect the parallel port base address, it may be set manually. First determine the base address through the Device Manager in Windows. In the Device Manager list, find the entry for the parallel port device under "Ports (COM & LPT)". (If using a PCI, PCI Express, or PCMCIA parallel port adapter card, you'll need to install a driver for the port before it is correctly recognized by Windows.) Click the port and select the "Resources" in the properties table. This should list the I/O address of the card. For the built-in LPT1 on a desktop computer, this is typically "0378-037F" (hex value). Once you have determined the parallel port address, open the Experiment Builder project, go to the "Parallel Port" device setting, and enter the hex value for the port reported by the device manager (e.g., 0x378 for "0378" you see in the device manager).

Version 2.2 of Experiment Builder adds support for the USB2TTL8 device from Labhackers http://www.labhackers.com/usb2ttl8.html. This USB Serial interface is plug-and-play on Windows 10 and macOS. If using Windows 7, please install the required USB Serial driver from www.labhackers.com/downloads.html. To receive TTL signals through the USB2TTL8, make sure the "USB2TTL8 Mode Selection" property of the USB2TTL8 device is set to "Read Mode".

Also supported on a Windows PC is the USB-1208HS box from Measurement Computing. No extra driver installation is required as long as you have installed the libusb-win32 component when you first run through the installation procedure in Windows (see Figure 3-1). If for any reason you have to install the device driver, please first connect the box to the Windows PC. When asked "Can Windows connect to Windows Update to search for software?", choose "No, not this time." When asked "What do you want the Wizard to do?", choose "Install from a list or specific location (Advanced)." On the "Please choose your search and installation options" screen, select the "Search for the best driver in these locations," check the "Include this location in the search" option only and browse to "C:\Program Files\SR Research\3rdparty\usb1208hs" in 32-bit Windows or "C:\Program Files(x86)\SR Research\3rdparty\usb1208hs" in 64-bit Windows).

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the TTL trigger. The default value is "TTL_INPUT".
Type #	NR		The Experiment Builder object type for this node (TTL).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the TTL trigger fires.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the TTL trigger is done (so the experiment flow is

			ready to move to the next node). **Note**: To check the time when the triggering TTL pulse was received, use @*.triggeredData.time@ (i.e., the .time sub-attribute of the .triggeredData attribute) instead.
NTP Time #	.ntpTime	Float	NTP server time when the processing of the TTL trigger is done (so the experiment flow is ready to move to the next node).
Last Checked Time #	.lastCheckedTime	Float	Display PC time (in milliseconds from the start of the experiment) of the previous check on the trigger.
Confidence Interval #	.confidenceInterval	Float	Time difference between the trigger time and last check time of the trigger. This indicates a window of uncertainty as the true trigger time could be between the last check time (.lastCheckTime) and the reported trigger time (.time).
Clear Input Queue ¶	.clearInputQueue	Integer	Experiment Builder maintains an event queue so that multiple TTL events can be accessed over time. The "Clear Input Queue" option checks whether the TTL event(s) cached in the event queues should be cleared when the trigger fires (NO: no event clearing; EVENT: removes the current triggering event from the TTL event queue; LIST: all TTL events from event queue will be removed).
Device ¶	.device	String	Which device (parallel port, USB2TTL8, or USB-1208 HS) is used to receive TTL signals.
Register ¶	.register	String	This is usually set to "STATUS" register (but please see Section 7.10.8.2 "TTL trigger and the type of cable used"). This option is only available in Windows when the device is set to a parallel port.
Mode *¶	.mode	String	Either "Word" mode (the decimal or hexadecimal value of the TTL input value) or "Pin" mode (status of each individual pin).
Data	.data	Integer	The byte value of the triggering input TTL signal. This can be a decimal or hexadecimal number. " If a decimal value is entered, it will be automatically translated into a hexadecimal value. This field is only available if the "Mode" property is set to "Word".
Pin0 Pin1 Pin2 Pin3 Pin4 Pin5 Pin6 Pin7	.pin0 .pin1 .pin2 .pin3 .pin4 .pin5 .pin6 .pin7	String	The desired state for each of the pins. The pin value can be either "ON" (high), "OFF" (low), or "EITHER" (the status of that pin and changes in the status of that pin are ignored). This field is only available if the "Mode" property is set to "Pin". For parallel port and USB2TTL8, eight pins are available. If using a USB-1208HS box, the available output pins can be configured

Pin8 Pin9 Pin10 Pin11 Pin12 Pin13 Pin14 Pin15 ¶	.pin8 .pin9 .pin10 .pin11 .pin12 .pin13 .pin14 .pin15		through the device preferences.
Triggered Data #	.triggeredData		If the TTL trigger fires, the triggered data can be further accessed through the sub-attributes of this property.

When the TTL trigger fires, the triggered data can be further accessed. The sub-attributes of the Triggered Data field are listed in the following table.

Attribute	**Reference**	**Type**	**Content**
Time	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the TTL trigger fires.
EDF Time	.EDFTime	Integer	EDF time when the TTL trigger fires.
NTP Time #	.ntpTime	Float	NTP server time when the TTL trigger fires.
Pin Data	.pinData	Integer	The byte value (a decimal number) of the current input TTL signal.

The following section discusses some of the common applications of the TTL trigger:

7.10.8.1 Setting the Pin Values

The TTL trigger fires when a TTL signal is received. To detect any change in the input signal, or if no specific trigger values are known, you may use the "PIN" mode and set all of the pin values to "EITHER". The trigger will then fire if the incoming TTL signal changes the status of any pin on the specified register of the TTL device being used. To configure the trigger to fire based only on a single pin, set the intended state of that pin ("ON" or "OFF") and leave the value of all other pins to "EITHER". If the exact trigger value is known, then specify it either in the PIN or WORD mode. For instance, if the trial should end when the parallel port receives the signal data 0x58, the properties of the TTL trigger can be set as the following:

- If the Mode is set to "PIN", set pin #3, 4, and 6 to "ON", with the rest of the pins set to "OFF" (see panel A).
- If the Mode is set to "WORD", enter either '0x58' (hexadecimal) or '88' (decimal) in the Data field. If a decimal number is entered, it will be automatically converted to a hexadecimal number (see panel B).

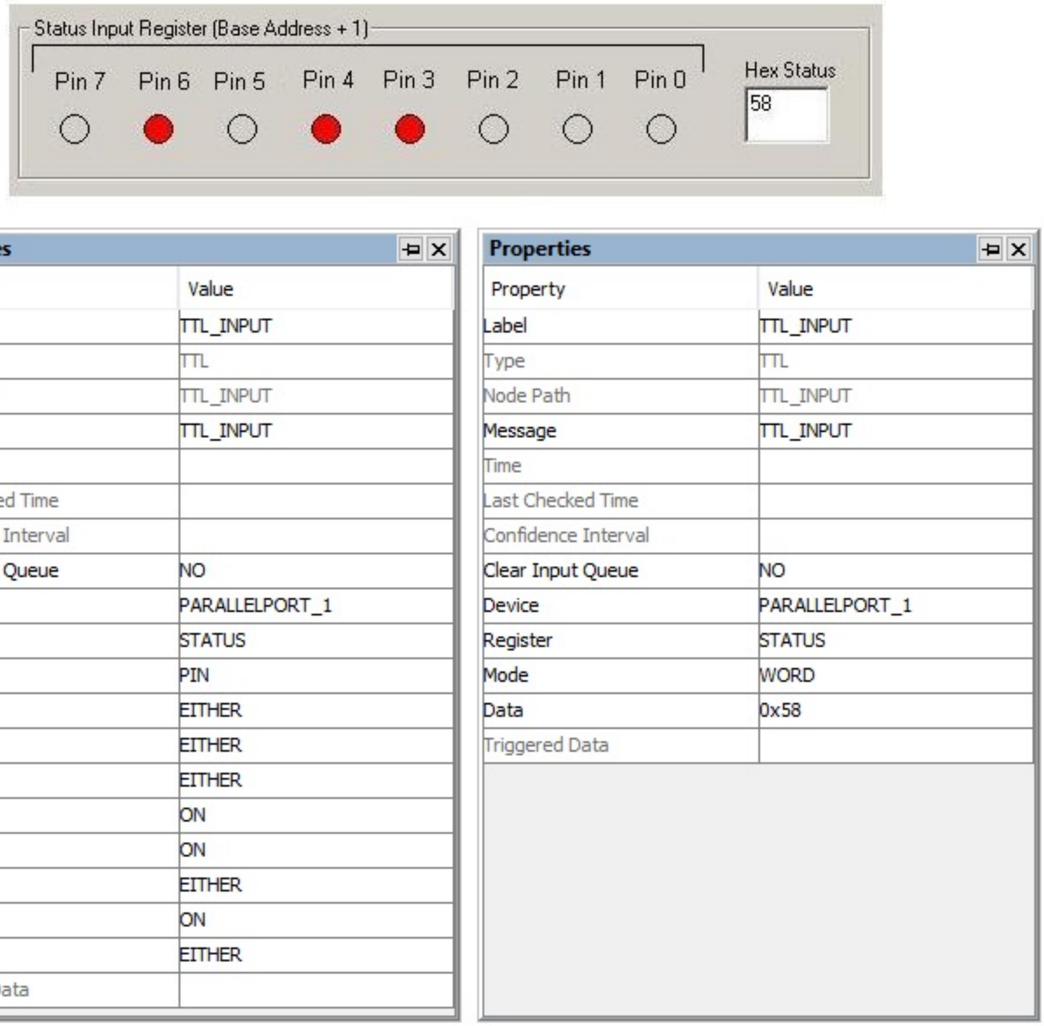


Figure 7-59. Using TTL Trigger.

7.10.8.2 TTL Trigger and the Type of Cable Used

When sending and receiving signals through the parallel port, make sure to determine the type of cable being used. Parallel port cables may either be straight-through (i.e., with a 1-to-1 pin mapping), or crossed (i.e., in which pins from the Data register on one end are wired to the Status register of the opposite end, and vice versa).

- If using a straight-through parallel port cable, data will be sent to the data register of the Display PC. To enable reading from the data register of the parallel port, first enable the bidirectional mode for the port.
    - Reboot your Display PC to go into the BIOS settings. Select the settings for "Parallel Port Mode" and make sure the the mode is set to either "PS/2", "EPP" or "Bidirectional Mode." (The BIOS settings are usually not available for add-on parallel port cards. It may be necessary to use a crossed cable with add-on cards.)

    - Next, enable the bidirectional mode for the parallel port in Experiment Builder. Add a Set TTL action at the very beginning of the experiment. Set the "Register" to "CONTROL", and set the “Data” to "0x20". (This toggles on pin 5 of the control register, which enables bidirectional mode).
    - Set the "Register" of the TTL Input trigger to "DATA". To simply check whether any new signal is received, choose the "Pin" mode and set all of the pin values to EITHER. Remember to fill out the "Message" property of TTL trigger to mark the event time in the EDF.
- If using a crossed parallel cable, data will be sent to the status register of the parallel port.
    - The parallel port can be set to any mode, so there is no need to configure the BIOS settings of the Display PC.
    - Make sure the bidirectional mode is disabled by toggling off pin 5 of the control register. Add a Set TTL action at the very beginning of the experiment. Set the "Register" to "CONTROL", and set the “Data” to "0x0".
    - Set the “Register” of the TTL Input trigger to “STATUS”.

7.10.9 Fixation Trigger

The fixation trigger ( ) fires when a fixation occurs within a specified region of the display for a certain amount of time. The “Event Type” attribute of the trigger determines whether the trigger will fire when the fixation starts (STARTFIXATION), ends (ENDFIXATION), or after the fixation exceeds a specified minimum duration (UPDATEFIXATION). This trigger is only available in an EyeLink experiment. Please note that when reading real-time data through the link, the start of the fixation event data will be delayed by about 35 milliseconds from the corresponding sample. This is caused by the velocity detection and event validation processing in the EyeLink tracker. The timestamps obtained from the event data, however, reflect the true sampletime for the start or end of the event.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the fixation trigger. The default value is “FIXATION”.
Type #	NR		The Experiment Builder object type for this node (Fixation).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file when the fixation trigger fires.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the fixation trigger is done (so the experiment flow is ready to move to the next node). **Note:** To check the start and end time of the triggering fixation, use @*.triggeredData.startTime@ and

			@*.triggeredData.endTime@ (i.e., the .startTime and .endTime sub-attributes of the .triggeredData attribute).
NTP Time #	.ntpTime	Float	NTP server time when the processing of the fixation trigger is done (so the experiment flow is ready to move to the next node).
Last Checked Time #	.lastCheckedTim e	Float	This property can be used to retrieve the Display PC time (in milliseconds from the start of the experiment) when the trigger was checked for the last time.
Confidence Interval #	.confidenceInterv al	Float	Time difference between the trigger time and last check time of the trigger. This indicates a window of uncertainty as the true trigger time could be between the last check time (.lastCheckedTime) and the reported trigger time (.time).
Clear Input Queue ¶	.clearInputQueue	Integer	Experiment Builder maintains an event queue so multiple fixation events (start of a fixation, fixation updates, and end of a fixation) can be accessed over time. The “Clear Input Queue” option checks whether the fixation event(s) cached in the event queue should be cleared when the trigger fires (NO: no event clearing; EVENT: removes the current triggering event from the fixation event queue; LIST: all fixation events from event queue will be removed).
Region Type ¶	.regionType	String	The type of triggering Region used: RECTANGLE (0), ELLIPSE (1), or INTEREST AREA (2). The "INTEREST AREA" option is only available when interest areas are defined in one of the display screens in the same recording sequence.
Region Location (Top Left)	.regionLocation	Point	Pixel coordinates of the top-left corner of the trigger region in (x, y) tuple. The default value is (0, 0). Note that the x, y coordinates of the region location can be further referred to individually as .regionLocation.x and .regionLocation.y, respectively. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Region Width	.regionWidth	Integer	Width (0 by default) of the trigger region in screen pixels. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Region Height	.regionHeight	Integer	Height (0 by default) of the trigger region in screen pixels. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
InterestArea	NR		The display screen on which target interest area

Screen *			regions are located. This property is only available when the "Region Type" property is set to INTEREST AREA.
InterestArea Regions	NR		Target interest areas used to define the trigger region. This property is only available when the "Region Type" property is set to INTEREST AREA.
Within †	.within	Boolean	If set to "True," the trigger should fire when the fixation is within the target region. If "False," the trigger will fire when the fixation is outside of the target region.
Tracking Eye ¶	.trackingEye	String	Determines which eye's data is used for the fixation trigger. The default value is "EITHER," can also be LEFT or RIGHT.
Minimum Duration	.minimumDuration	Integer	Minimum duration (0 by default) of a fixation in the specified region to cause the trigger to fire. This property is available only if the Event Type is set as "UPDATEFIXATION" or "ENDFIXATION."
Event Type ¶	.eventType	String	The type of fixation event used for triggering. If set to "STARTFIXATION," This trigger fires when the start of a fixation is detected, and if set to "ENDFIXATION," when the end of a fixation is detected. If set to "UPDATEFIXATION", Experiment Builder checks for the fixation update event (i.e., summary data of the fixation), which is sent from the tracker at a constant interval (50 ms by default); the trigger will fire after a pre-specified amount of time into a fixation is accumulated. If the "Minimum Duration" of the "UPDATEFIXATION" event is set to 0 (or any value within one fixation update interval), the trigger will fire after receiving one fixation update event.
Triggered Data #	.triggeredData		If the fixation trigger fires, the triggered data can be further accessed through the sub-attributes of this property.

When a fixation trigger fires, users can access the triggered data by using the "TriggeredData" field. The sub-attributes of the TriggeredData attribute are listed in the following table.

Attribute	**Reference**	**Type**	**Content**
Start Time	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the triggering fixation or fixation update event starts.
End Time	.endTime *	Float	Display PC time (in milliseconds from the start of the experiment) when the triggering fixation or fixation update event ends (-32768 if eye event is set to "STARTFIXATION").

EDF Start Time	.EDFStartTime	Integer	EDF time (time since the EyeLink program started on the Host PC) when the triggering fixation starts.
EDF End Time	.EDFEndTime *	Integer	EDF time when the triggering fixation or fixation update event ends (-32768 if eye event is set to "STARTFIXATION").
NTP Start Time #	.ntpStartTime	Float	NTP server time when the triggering fixation or fixation update event starts.
NTP End Time #	.ntpEndTime	Float	NTP server time when the triggering fixation or fixation update event ends (-32768 if eye event is set to "STARTFIXATION").
Eyes Available	.eyesAvailable	Integer	This attribute is depreciated; it will always return the same value as the "Triggered Eye" property. To retrieve the eye(s) used in the recording, check the "Eye Used" property (.eyeUsed) of the EyeLink Device.
Triggered Eye	triggeredEye	Integer	Returns the eye (0 for the left eye; 1 for the right eye) whose data makes the current fixation trigger fire.
Duration	.duration *	Integer	Duration of the triggering fixation or fixation update event.
Average Gaze X, Average Gaze Y	.averageGazeX* .averageGazeY *	Float	Average X/Y gaze position of the triggering fixation or fixation update event.
Average Pupil Size	.averagePupilSize *	Float	Average pupil size of the triggering fixation or fixation update event.
Start Gaze X, Start Gaze Y	.startGazeX .startGazeY	Float	X/Y gaze position when the triggering fixation or fixation update event started.
Start Pupil Size	.startPupilSize	Float	Pupil size when the triggering fixation or fixation update event started.
End Gaze X, End Gaze Y	.endGazeX * .endGazeY *	Float	X/Y gaze position when the triggering fixation or fixation update event ended.
End Pupil Size	.endPupilSize *	Float	Pupil size when the triggering fixation or fixation update event ended.
Start PPD X, Start PPD Y	.startPPDX .startPPDY	Float	Angular X/Y resolution when triggering fixation or fixation update event starts (in screen pixels per degree of visual angle, PPD).
End PPD X, End PPD Y	.endPPDX * .endPPDY *	Float	Angular X/Y resolution when the triggering fixation or fixation update event ends (in screen pixels per degree of visual angle, PPD).
IA Labels	.IALabels	List	Provides a list of labels of the interest area(s) hit (i.e., fixated). Returns an empty list if no interest area is hit (e.g., if the triggering region is not interest area-based, or the trigger firing is not region-based).
IA IDs	.IALabels	List	Provides a list of IDs of the interest area(s) hit (e.g., fixated). Returns an empty list if the no interest ares hit (e.g., if the triggering region is not interest area-based, or the trigger firing is not region-based).
IA Label	.IALabel	String	Reports the label of the interest area hit. If

			multiple interest areas are hit, reports the label of the interest area with the lowest ID. Missing data if no interest area hit.
IA ID	.IAID	Integer	Reports the ID of the interest area hit. If multiple interest areas are hit, reports the interest area with the lowest ID. Missing data if no interest area hit.
IA Location	.IALocation	Point	Location (top-left or center, based on preference) of the interest area hit. If multiple interest areas are hit, reports the location of the interest area with the lowest ID.
IA Width	.IAWidth	Integer	Width of the interest area hit. If multiple interest areas are hit, reports the width of the interest area with the lowest ID.
IA Height	.IAHeight	Integer	Height of the interest area hit. If multiple interest areas are hit, reports the height of the interest area with the lowest ID.

Note: * -32768 if the Event Type is set to “STARTFIXATION”.

The fixation trigger may be configured to fire based on various fixation behaviors. For example, to end the display after the participant looks at a target region for a minimum duration of 300 milliseconds, the "Event Type" may be configured as "UPDATEFIXATION" as in the figure below:

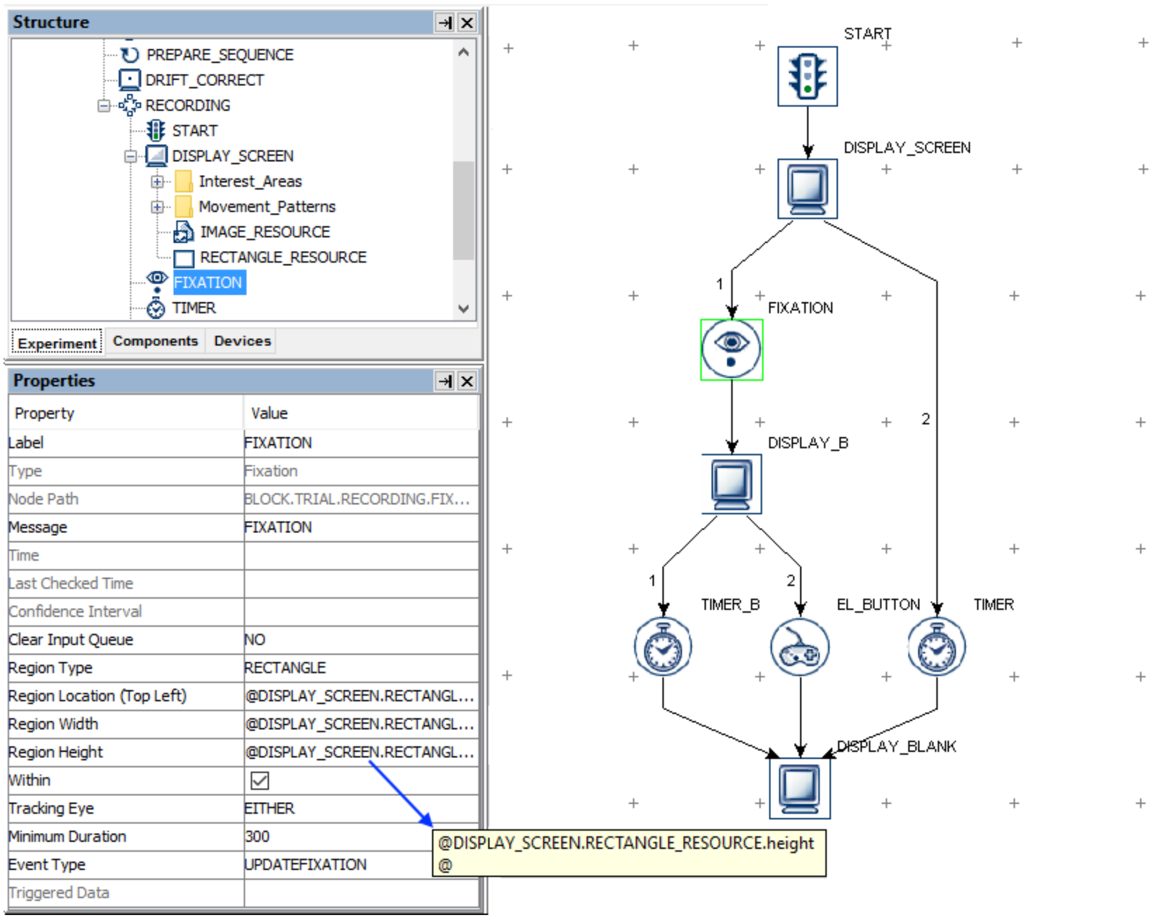


Figure 7-60. Using Fixation Trigger.

If the fixation trigger should fire regardless of where the participant is fixating, the trigger region may be set as the whole screen (i.e., for a 1024 × 768 screen resolution, set Region Location as (0,0), Region Width as 1024, and Region Height as 768). Alternatively, keep the default region settings and uncheck the "Within" button.

Since the fixation trigger monitors the online eye data, it must be placed within a recording sequence (i.e., the "Record" property of the sequence is checked). If you see a "This node type cannot be added to this sequence" error message, please check whether the sequence in which the trigger is being added has the “Record” property enabled.

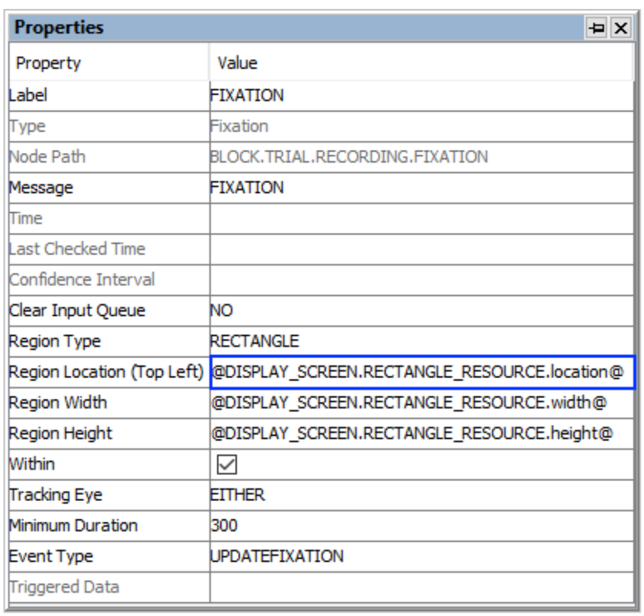
7.10.9.1 Optimal Triggering Duration

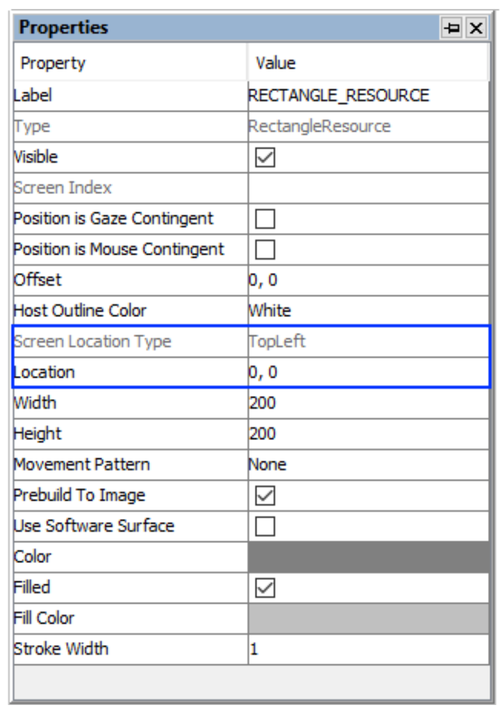
If the UPDATEFIXATION event is used, the fixation trigger doesn't work well if the duration is set to 0 or a very short value, as mis-triggering can occur during the start and end of a fixation. A duration around 250-350 ms will generally work much better with non-patient participants. If the required duration is longer than 1000 ms, try using the INVISIBLE_BOUDARY trigger instead with the identical triggering region and duration settings, as it is difficult for participants to maintain a single fixation for more than a few hundred ms.

7.10.9.2 Top-left vs. Center Triggering Location Type

The Location Type of all location-based triggers (invisible boundary trigger, mouse trigger, fixation trigger, saccade trigger, and sample velocity trigger) is based on the top-left corner of the region, whereas the screen resources can be based on either the top-left corner or the center of the resource. (The screen resource/interest area location type can be set in the project Preferences under Screen). This means that references should be created differently depending on whether the region location of a trigger refers to a center-based resource or a top-left-based resource.

Imagine that a fixation trigger should fire when the gaze position is within a rectangle resource (RECTANGLE_RESOURCE). The top panel of the figure below illustrates creating the Region Location reference to the rectangle resource when the screen location type is TopLeft (@DISPLAY_SCREEN.RECTANGLE_RESOURCE.location@). The bottom panel of the figure illustrates creating a location equation when the location type is Center, by subtracting half the resource width from the x coordinate, and half the resource height from the y coordinate: (=EBPoint(@DISPLAY_SCREEN.RECTANGLE_RESOURCE.location.x@ - @DISPLAY_SCREEN.RECTANGLE_RESOURCE.width@/2, @DISPLAY_SCREEN.RECTANGLE_RESOURCE.location.y@ - @DISPLAY_SCREEN.RECTANGLE_RESOURCE.height@/2)).





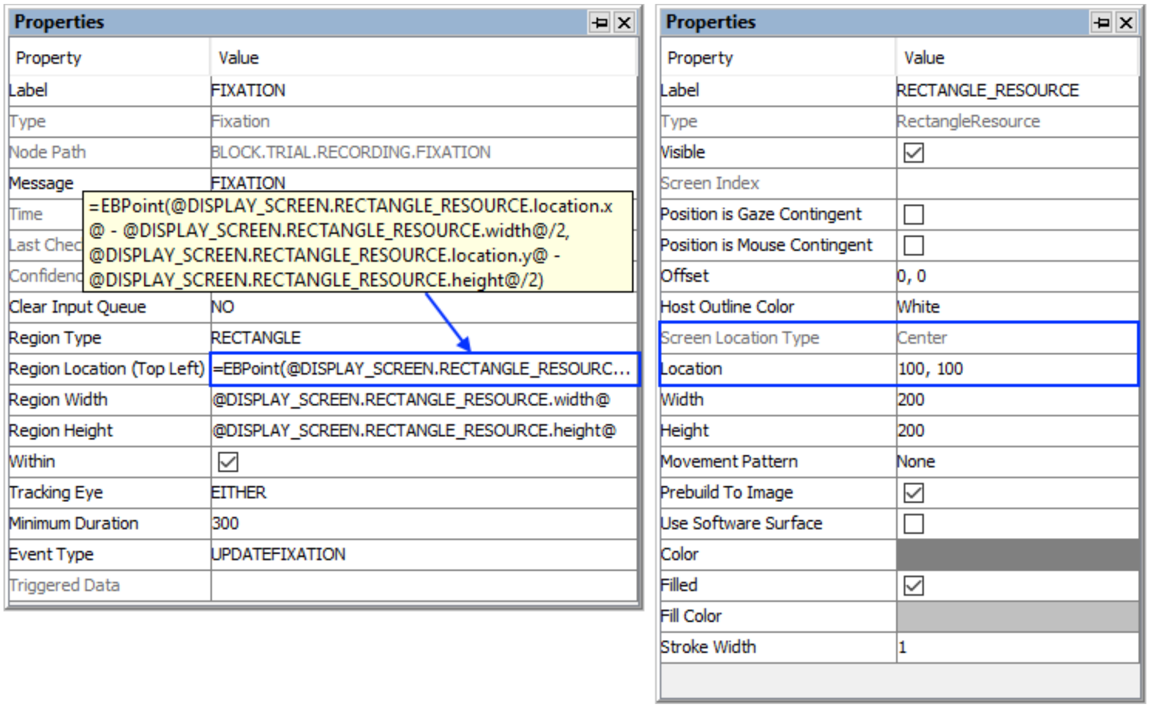


Figure 7-61. Using Fixation Trigger with Top-left and Center Location Types.

7.10.9.3 How to Show the Triggering Region on the Host PC

Sometimes it is useful to draw feedback graphics on the Host PC so the experimenter can monitor whether the participant's eye position is within the triggering region, or so the programmer can debug the experiment code by running the eye tracker in the mouse simulation mode. Drawing on the Host PC screen can be done by using an EyeLink Command action either before the recording sequence (immediately after the Prepare Sequence node) or as the first node in the recording sequence, so the drawing is overlaid on top of the existing host PC graphics. The drawing command can be either "draw_box" or "draw_filled_box". The Text of the command must include tracker of the top, left, right, and bottom pixel position of the triggering region, followed by the drawing color. This can be done either with string concatenation or string formatting. The top left corner of the triggering region is (@FIXATION.regionLocation.x@, @FIXATION.regionLocation.y@) and the bottom right corner of the triggering region is (@FIXATION.regionLocation.x@ + @FIXATION.regionWidth@, @FIXATION.regionLocation.y@ + @FIXATION.regionHeight@)

String Concatenation:

```
=str(@FIXATION.regionLocation.x@) + " "
+ str(@FIXATION.regionLocation.y@) + " "
+ str(@FIXATION.regionLocation.x@ + @FIXATION.regionWidth@) + " "
+ str(@FIXATION.regionLocation.y@ + @FIXATION.regionHeight@) + "  3"
```

String Formatting:

```
="%d %d %d %d 3" % (@FIXATION.regionLocation.x@, @FIXATION.regionLocation.y@,
@FIXATION.regionLocation.x@ + @FIXATION.regionWidth@,
```

@FIXATION.regionLocation.y@ + @FIXATION.regionHeight@)

All of the drawing commands are documented in the "COMMANDS.INI" file under C:\EYELINK2\EXE or \ELCL\EXE directory of the host PC.

7.10.10 Saccade Trigger

The saccade trigger ( ), available only in EyeLink experiments, fires following the detection of a saccade into a specified region on the display. This trigger waits for an "ENDSACC" online parser signal from the tracker. If the timing of saccade onset is critical, users may use the sample velocity trigger instead. Since the saccade trigger monitors the online eye data, this trigger type must be placed within a recording sequence (i.e., the "Record" property of the sequence is checked). If you see a "This node type cannot be added to this sequence" error message, please check whether the sequence in which the trigger is being added has the “Record” property enabled.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the saccade trigger. The default value is “SACCADE”.
Type #	NR		The Experiment Builder object type for this node (Saccade).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file when the saccade trigger fires.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the saccade trigger is done (so the experiment flow is ready to move to the next node). **Note:** To check the start and end time of the triggering saccade, use @*.triggeredData.startTime@ and @*.triggeredData.endTime@ (i.e., the .startTime and .endTime sub-attributes of the .triggeredData attribute).
NTP Time #	.ntpTime	Float	NTP server time when the processing of the saccade trigger is done (so the experiment flow is ready to move to the next node).
Last Checked Time #	.lastCheckedTime	Float	This property can be used to retrieve the Display PC time (in milliseconds from the start of the experiment) when the trigger was checked for the last time.
Confidence Interval #	.confidenceInterval	Float	Time difference between the trigger time and last check time of the trigger. This indicates a window of uncertainty as the true trigger time could be between the last check time (.lastCheckedTime) and the reported trigger time (.time).
Clear Input	.clearInputQueue	Integer	Experiment Builder maintains an event queue so

Queue ¶			multiple saccade events can be accessed over time. The “Clear Input Queue” option checks whether the saccade event(s) cached in the event queue should be cleared when the trigger fires (NO: no event clearing; EVENT: removes the current triggering event from the saccade event queue; LIST: all saccade events from event queue will be removed).
Region Direction	.regionDirection	List	A range of eye angles from a multiple-selection list ['0 - 45', '45 - 90', '90 - 135', '135 - 180', '-180 - -135', '-135 - -90', '-90 - -45', '-45 - 0'] used to restrict the direction in which the saccade trigger fires. For each angle range, the first value is inclusive and the second value is not inclusive.
Region Type ¶	.regionType	String	The type of triggering Region used: RECTANGLE (0), ELLIPSE (1), or INTEREST AREA (2). Note that the "INTEREST AREA" option is only available when interest areas are defined in one of the display screens in the same recording sequence.
Region Location (Top Left)	.regionLocation	Point	Pixel coordinates of the top-left corner of the trigger region in (x, y) tuple. The default value is (0, 0). Note that the x, y coordinates of the region location can be further referred to individually as .regionLocation.x and .regionLocation.y, respectively. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Region Width	.regionWidth	Integer	Width (0 by default) of the trigger region in screen pixels. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Region Height	.regionHeight	Integer	Height (0 by default) of the trigger region in screen pixels. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Interest Area Screen *¶	NR		The display screen on which target interest area regions are located. This property is only available when the "Region Type" property is set to INTEREST AREA.
Interest Area Regions ¶	NR		Target interest areas used to define the triggering region. This property is only available when the "Region Type" property is set to INTEREST AREA.
Within †	.within	Boolean	If "True" (default), the trigger will fire when the saccade lands within the target region. If "False," the trigger fires when the saccade ends outside the region.

Tracking Eye ¶	.trackingEye	String	Determines which eye's data is used for the saccade trigger. The default value is "EITHER," can also be LEFT or RIGHT.
Minimum Amplitude	.minimumAmplitude	Float	Minimum amplitude (0 by default) of the triggering saccade.
Triggered Data #	.triggeredData		If the saccade trigger fires, the triggered data can be further accessed through the sub-attributes of this property.

Users can further get access to the triggered data if a saccade trigger fires. The sub-attributes of the Triggered Data field are listed in the following table.

Reference	**Attribute**	**Type**	**Content**
Start Time	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the triggering saccade starts.
End Time	.endTime	Float	Display PC time (in milliseconds from the start of the experiment) when the triggering saccade ends.
EDF Start Time	.EDFStartTime	Integer	EDF time (time since the EyeLink program started on the Host PC) when the triggering saccade starts.
EDF End Time	.EDFEndTime	Integer	EDF time when the triggering saccade ends.
NTP Start Time #	.ntpStartTime	Float	NTP server time when the triggering saccade starts.
NTP End Time #	.ntpEndTime	Float	NTP server time when the triggering saccade ends.
Eyes Available	.eyesAvailable	Integer	This attribute is depreciated; it will always return the same value as the "Triggered Eye" property. To retrieve the eye(s) used in the recording, please check the "Eye Used" property (.eyeUsed) of the EyeLink Device.
Triggered Eye	.triggeredEye	Integer	Returns the eye (0 for the left eye; 1 for the right eye) whose data makes the current fixation trigger fire.
Duration	.duration	Integer	Duration of the triggering saccade.
Start Gaze X	.startGazeX	Float	X gaze position when the triggering saccade started.
Start Gaze Y	.startGazeY	Float	Y gaze position when the triggering saccade started.
End Gaze X	.endGazeX	Float	X gaze position when the triggering saccade ended.
End Gaze Y	.endGazeY	Float	Y gaze position when the triggering saccade ended.
Start PPD X	.startPPDX	Float	Angular X resolution at the start of saccade (in screen pixels per visual degree, PPD).
Start PPD Y	.startPPDY	Float	Angular Y resolution at the start of saccade (in screen pixels per visual degree, PPD).
End PPD X	.endPPDX	Float	Angular X resolution at the end of saccade (in

			screen pixels per visual degree, PPD).
End PPD Y	.endPPDY	Float	Angular Y resolution at the end of saccade (in screen pixels per visual degree, PPD).
Average Velocity	.averageVelocity	Float	Average gaze velocity (in degrees/second) of the current saccade.
Peak Velocity	.peakVelocity	Float	Peak value of gaze velocity (in degrees/second) of the current saccade.
Amplitude	.amplitude	Float	Amplitude of the current saccade in degrees of visual angle.
Angle	.angle	Float	The angle of the saccade movement when the trigger fires.
IA Labels	.IALabels	List	Provides a list of labels of the interest area(s) hit (i.e., saccade into). Returns an empty list if the no interest area is hit (e.g., if the triggering region is not interest area-based, or the trigger firing is not region-based).
IA IDs	.IALabels	List	Provides a list of IDs of the interest area(s) hit (i.e., saccade into). Returns an empty list if the no interest ares hit (e.g., if the triggering region is not interest area-based, or the trigger firing is not region-based).
IA Label	.IALabel	String	Reports the label of the interest area hit. If multiple interest areas are hit, reports the label of the interest area with the lowest ID. Missing data if no interest area hit.
IA ID	.IAID	Integer	Reports the ID of the interest area hit. If multiple interest areas are hit, reports the interest area with the lowest ID. Missing data if no interest area hit.
IA Location	.IALocation	Point	Location (top-left or center, based on preference) of the interest area hit. If multiple interest areas are hit, reports the location of the interest area with the lowest ID
IA Width	.IAWidth	Integer	Width of the interest area hit. If multiple interest areas are hit, reports the width of the interest area with the lowest ID
IA Height	.IAHeight	Integer	Height of the interest area hit. If multiple interest areas are hit, reports the height of the interest area with the lowest ID

An example of using the Saccade trigger is illustrated below. To end a sequence after the participant makes a saccade towards the target region from (212, 334) to (312, 434), set the "Region Location" as (212, 334), "Region Width" as 100, and "Region Height" as 100. Users may further configure the minimum amplitude, triggering eye, etc., as desired.

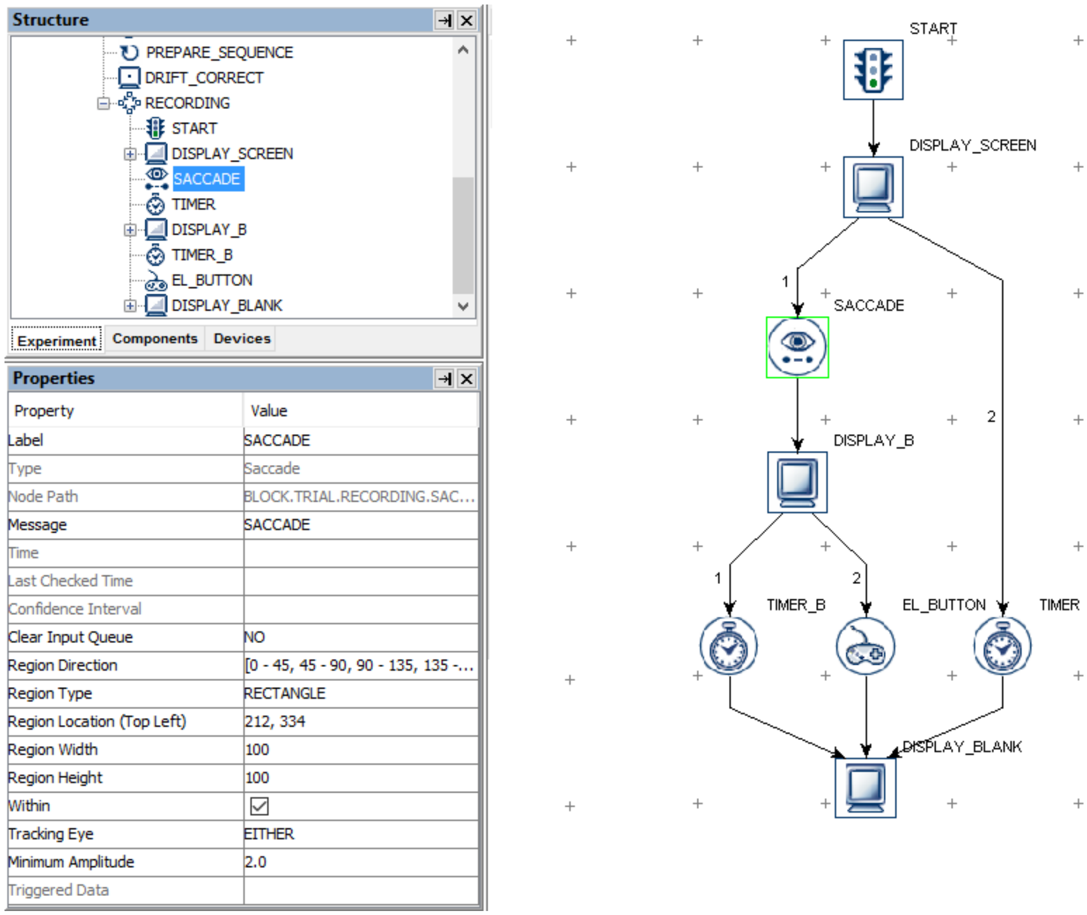


Figure 7-62. Using the Saccade Trigger.

If the saccade trigger should fire regardless of the saccade end position, the trigger region may be set as the whole screen (i.e., for a 1024 × 768 screen resolution, set Region Location as (0,0), Region Width as 1024, and Region Height as 768). Alternatively, keep the default region settings and uncheck the "Within" button.

7.10.10.1 Top-left vs. Center Triggering Location Type

The Location Type of all location-based triggers (invisible boundary trigger, mouse trigger, fixation trigger, saccade trigger, and sample velocity trigger) is based on the top-left corner of the region, whereas the screen resources can be based on either the top-left corner or the center of the resource. (The screen resource/interest area location type can be set in the project Preferences under Screen). This means that references should be created differently depending on whether the region location of a trigger refers to a center-based resource or a top-left-based resource.

Imagine that a saccade trigger should fire when the gaze position is within a rectangle resource (RECTANGLE_RESOURCE). The top panel of the figure below illustrates creating the Region Location reference to the rectangle resource when the screen location type is TopLeft (@DISPLAY_SCREEN.RECTANGLE_RESOURCE.location@). The bottom panel of the figure illustrates creating a location equation when the location type is Center, by subtracting half the resource width from the x coordinate, and half the resource height from the y coordinate: (=EBPoint(@DISPLAY_SCREEN.RECTANGLE_RESOURCE.location.x@ - @DISPLAY_SCREEN.RECTANGLE_RESOURCE.width@/2, @DISPLAY_SCREEN.RECTANGLE_RESOURCE.location.y@ - @DISPLAY_SCREEN.RECTANGLE_RESOURCE.height@/2)).

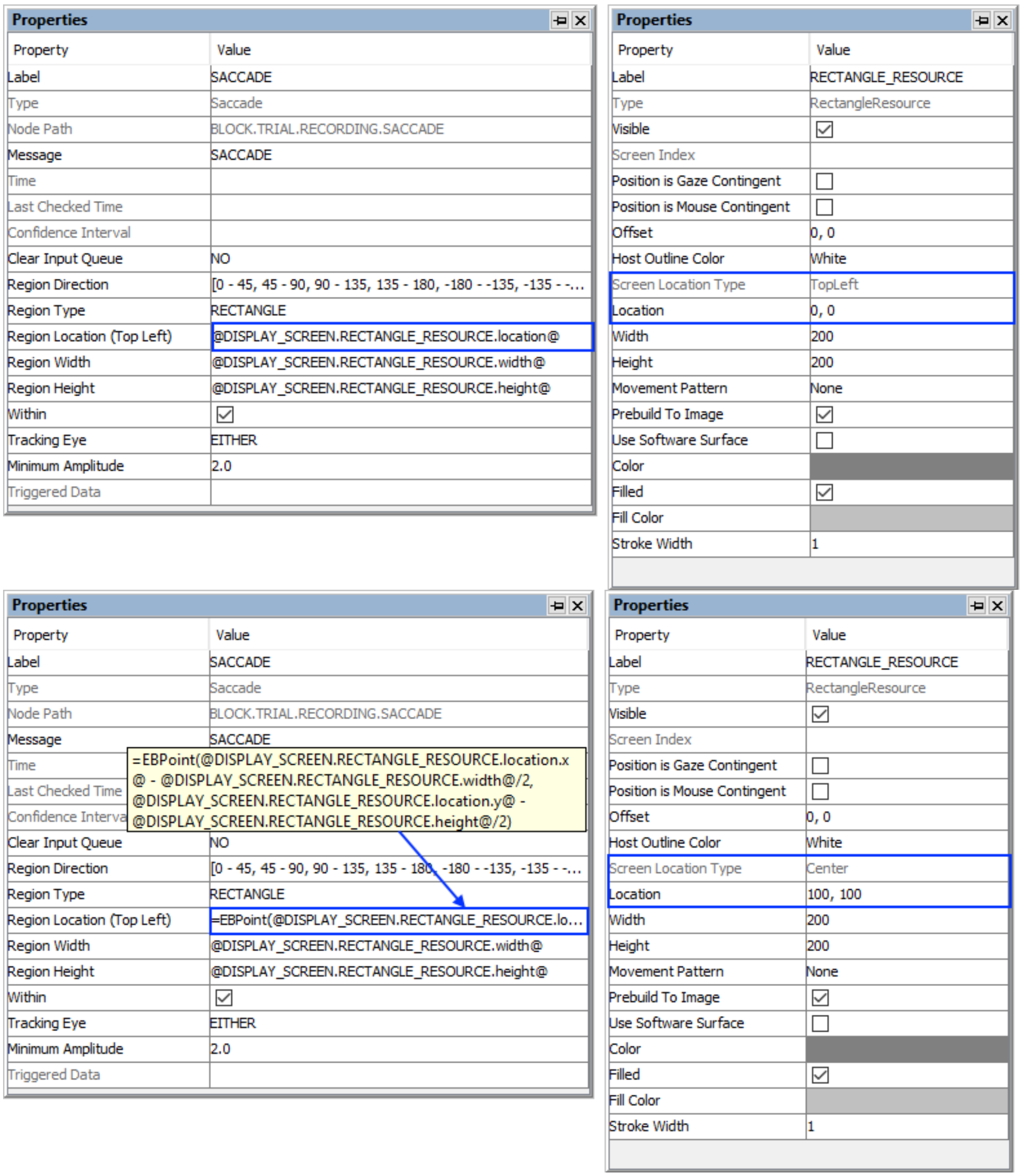


Figure 7-63. Using Saccade Trigger with Top-left and Center Location Types.

7.10.10.2 How to Show the Triggering Region on the Host PC

Sometimes it is useful to draw feedback graphics on the Host PC so the experimenter can monitor whether the participant's eye position is within the triggering region, or so the programmer can debug the experiment code by running the eye tracker in the mouse simulation mode. Drawing on the Host PC screen can be done by using an EyeLink Command action either before the recording sequence (immediately after the Prepare Sequence node) or as the first node in the recording sequence, so the drawing is overlaid on top of the existing host PC graphics. The drawing command can be either "draw_box" or "draw_filled_box". The Text of the command must include tracker of the top, left, right, and bottom pixel position of the triggering region, followed by the drawing color.

This can be done either with string concatenation or string formatting. The top-left corner of the triggering region is (@SACCADE.regionLocation.x@, @SACCADE.regionLocation.y@) and the bottom right corner of the triggering region is (@SACCADE.regionLocation.x@ + @SACCADE.regionWidth@, @SACCADE.regionLocation.y@ + @SACCADE.regionHeight@)

String Concatenation:

```
=str(@SACCADE.regionLocation.x@) + " "
+ str(@SACCADE.regionLocation.y@) + " "
+ str(@SACCADE.regionLocation.x@ + @SACCADE.regionWidth@) + " "
+ str(@SACCADE.regionLocation.y@ + @SACCADE.regionHeight@) + "  3"
```

String Formatting:

```
="%d %d %d %d 3" % (@SACCADE.regionLocation.x@, @SACCADE.regionLocation.y@,
@SACCADE.regionLocation.x@ + @SACCADE.regionWidth@,
@SACCADE.regionLocation.y@ + @SACCADE.regionHeight@)
```

All of the drawing commands are documented in the "COMMANDS.INI" file under C:\EYELINK2\EXE or C:\ELCL\EXE directory of the host partition. See the “change” template for an example.

7.10.11 Blink Trigger

The Blink trigger ( ), available only in EyeLink experiments, fires when a blink event (start or end of the blink) is detected. The start of a blink event can be detected either by counting missing data on a sample-by-sample basis or by using the parsed blink event generated by the eye tracker.

As with all other eye-based trigger types, a sample velocity trigger must be used in a Recording sequence.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the blink trigger. The default value is "BLINK".
Type #	NR		The type of Experiment Builder object ("Blink")

			the current node belongs to.
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be written to the EDF file when the blink trigger fires.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the blink trigger is done (so the experiment flow is ready to move to the next node). Note: To check the start and end time of the triggering blink event, use @.triggeredData.startTime@ and @.triggeredData.endTime@ (i.e., the .startTime and .endTime sub-attributes of the .triggeredData attribute).
NTP Time #	.ntpTime	Float	NTP server time when the processing of the blink trigger is done (so the experiment flow is ready to move to the next node).
Last Checked Time #	.lastCheckedTime	Float	This property can be used to retrieve the Display PC time (in milliseconds from the start of the experiment) when the trigger was checked for the last time.
Confidence Interval #	.confidenceInterval	Float	Time difference between the trigger time and last check time of the trigger. This indicates a window of uncertainty as the true trigger time could be between the last check time (.lastCheckedTime) and the reported trigger time (.time).
Clear Input Queue ¶	.clearInputQueue	Integer	Experiment Builder maintains an event queue so multiple blink events can be accessed over time. The "Clear Input Queue" option checks whether the blink event(s) cached in the event queue should be cleared when the trigger fires (NO: no event clearing; EVENT: removes the current triggering event from the blink event queue; LIST: all blink events from event queue will be removed).
Tracking Eye ¶	.trackingEye	String	Determines which eye's data will be used for the detection of the blink event. The default value is "EITHER," can also be LEFT or RIGHT.
Event Type ¶	.eventType	String	The type of blink event used for triggering. If set to "STARTBLINK", the trigger fires when the start of a blink is detected. If set to "ENDBLINK," the trigger fires when the end of a blink is detected.
Use Parsed Event † *	.useParsedEvent	Boolean	This option is only available when the "Event Type" is set to "STARTBLINK". If true, the trigger will fire when a STARTBLINK event is received from the Host PC, and the event data from the eye tracker will be used. If false, Experiment Builder will perform the blink

			detection online by checking each sample for missing data, and the trigger will fire when the eye has been missing for the duration specified in the "Minimum Missing Samples" property.
Minimum Missing Samples	.minimumMissingSamples	Integer	The number of missing samples required for the detection of the start of a blink event when Use Parsed Event is disabled.
Reset Threshold (msec)	.resetThreshold	Integer	When Use Parsed Event is disabled, the Blink trigger works by accumulating missing samples until the Minimum Missing Samples value is met. The Reset Threshold determines how many continuous valid (non-missing) samples are required to reset the blink detection. When a longer Minimum Missing Samples value is specified, this prevents the blink detection from resetting if a small number of valid samples occurs within a larger period of missing data. If set to 0, blink triggering will be reset whenever a sample with non-missing eye data is detected within missing data.
Triggered Data #	.triggeredData		Data of the blink trigger if fired (see the following table).

If the blink trigger fires, users can further access the triggered data. The attributes of the Triggered Data field are listed in the following table.

Reference	**Attribute**	**Type**	**Content**
Start Time	.startTime	Float	Display PC time (in milliseconds from the start of the experiment) when the triggering blink starts.
End Time	.endTime *	Float	Display PC time (in milliseconds from the start of the experiment) when the triggering blink ends.
EDF Start Time	.EDFStartTime	Integer	EDF time (time since the EyeLink program started on the Host PC) when the triggering blink starts.
EDF End Time	.EDFEndTime *	Integer	EDF time when the triggering blink ends.
NTP Start Time	.ntpStartTime	Float	NTP server time when the triggering blink starts.
NTP End Time	.ntpEndTime	Float	NTP server time when the triggering blink ends.
Eyes Available	.eyesAvailable	Integer	This attribute is depreciated; it will always return the same value as the "Triggered Eye" property. To retrieve the eye(s) used in the recording, please check the "Eye Used" property (.eyeUsed) of the EyeLink Device.
Triggered Eye	triggeredEye	Integer	Returns the eye (0 for the left eye; 1 for the right eye) whose data makes the current blink trigger fire.
Duration	.duration *	Integer	Duration of the triggering blink.

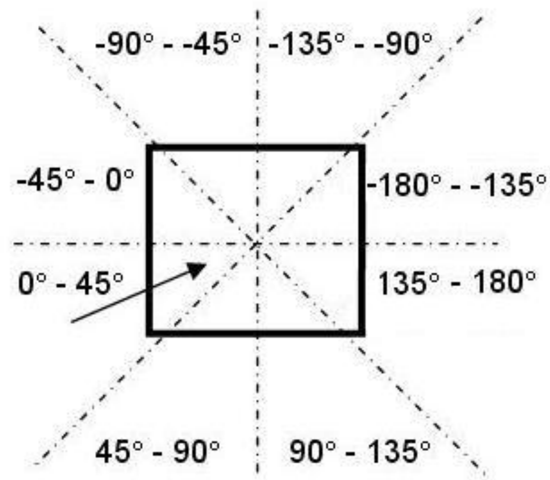
7.10.12 Sample Velocity Trigger

The Sample Velocity trigger (), available only in EyeLink experiments, implements a saccade or fixation detection algorithm by checking the velocity (and acceleration if desired) on a sample-by-sample basis.

This trigger will fire much more quickly than the Saccade trigger and therefore may be used when a saccade needs to be detected as quickly as possible, e.g., so a display change can be implemented. Please note that how quickly the trigger will fire is influenced by the tracker heuristic filter setting and the velocity/acceleration model used for the calculations (applicable to EyeLink 1000, 1000 Plus, and Portable Duo only). Occasionally, there may be "misses" and "false alarms" in saccade detection compared to the "slower" saccade trigger, because the Sample Velocity trigger skips the velocity and event validation processing by the EyeLink tracker for the fixation or saccade triggers.

As with all other eye-based trigger types, a sample velocity trigger must be used in a Recording sequence.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the sample velocity trigger. The default label is “SAMPLE_VELOCITY”.
Type #	NR		The Experiment Builder object type for this node (SampleVelocity).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file when the sample velocity trigger fires.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the sample velocity trigger is done (so the experiment flow is ready to move to the next node). **Note:** To check the time when the triggering sample occurs, you should use @*.triggeredData.time@ instead.
NTP Time #	.ntpTime	Float	NTP server time when the processing of the sample velocity trigger is done (so the experiment flow is ready to move to the next node).
Last Checked Time #	.lastCheckedTime	Float	This property can be used to retrieve the Display PC time (in milliseconds from the start of the experiment) when the trigger was checked for the last time.
Confidence Interval #	.confidenceInterval	Float	Time difference between the trigger time and last check time of the trigger. This indicates a window of uncertainty as the true trigger time could be between the last check time

			(.lastCheckedTime) and the reported trigger time (.time).
Region Type ¶	.regionType	String	The type of triggering Region used: RECTANGLE (0), ELLIPSE (1), or INTEREST AREA (2). The "INTEREST AREA" option is only available when interest areas are defined in one of the display screens in the same recording sequence.
Region Direction	.regionDirection	List of Strings	A range of eye angles from a multiple-selection list ['0 - 45', '45 - 90', '90 - 135', '135 - 180', '-180 - -135', '-135 - -90', '-90 - -45', '-45 - 0'] used to restrict the direction in which the sample velocity trigger fires. For each angle range, the first value is inclusive and the second value is not inclusive. 
Region Location (Top Left)	.regionLocation	Point	Pixel coordinates of the top-left corner of the trigger region in (x, y) tuple. The default value is (0, 0). Note that the x, y coordinates of the region location can be further referred to individually as .regionLocation.x and .regionLocation.y, respectively. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Region Width	.regionWidth	Integer	Width (0 by default) of the trigger region in screen pixels. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Region Height	.regionHeight	Integer	Height (0 by default) of the trigger region in screen pixels. This property is only available when the "Region Type" property is set to either RECTANGLE or ELLIPSE.
Interest Area Screen *¶	NR		The display screen on which target interest area regions are located. This property is only available when the "Region Type" property is set to INTEREST AREA.

Interest Area Regions ¶	NR		Target interest areas used to define the triggering region. This property is only available when the "Region Type" property is set to INTEREST AREA.
Within †	.within	Boolean	If "True" (default), the trigger will only fire when the eye position is within the target region. If "False," the trigger will fire when the eye position is outside the region.
Tracking Eye ¶	.trackingEye	String	Determines which eye's data is used for the velocity calculation. The default value is "EITHER," can also be LEFT or RIGHT.
Trigger Above Threshold †	.triggerAboveThreshold	Boolean	If "True" (default), the trigger will fire when the current velocity and acceleration values exceed the threshold values. If "False," the trigger will fire when velocity and acceleration are below the threshold values.
Velocity Threshold	.velocityThreshold	Integer	Sets the velocity threshold of the online saccade detector: usually 30 (°/sec) for cognitive research, 22 (°/sec) for pursuit and neurological work. The default is 30. This setting is different from the "Saccade Sensitivity" setting in the EyeLink device, which is used for the parsing of the events to be saved to the EDF file.
Use Acceleration †	.useAcceleration	Boolean	Whether the acceleration value should be used for the online saccade detection. If unchecked, only the velocity data is used. **Note:** Version 2.0 or later of the Experiment Builder software has this option turned off by default.
Acceleration Threshold	.accelerationThreshold	Integer	Sets the acceleration threshold of the online saccade detector: usually 8000 (°/sec/sec) for cognitive research, 3800 (°/sec/sec) for pursuit and neurological work. The default value is 8000. This setting is different from the "Saccade Sensitivity" setting in the EyeLink device, which is used for the parsing of the events to be saved to the EDF file.
Triggered Data #	.triggeredData		If the sample velocity trigger fires, the triggered data can be further accessed through the sub-attributes of this property.

If the Sample Velocity trigger fires, users can further access the triggered data. The attributes of the Triggered Data field are listed in the following table.

Reference	**Attribute**	**Type**	**Content**
Time	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the trigger fires.
EDF Time	.EDFTime	Integer	EDF time of the triggering sample.
NTP Time #	.ntpTime	Float	NTP server time of the triggering sample.
Eyes Available	.eyesAvailable	Integer	This attribute is depreciated; it will always return the same value as the "Triggered Eye"

			property. To retrieve the eye(s) used in the recording, check the "Eye Used" property (.eyeUsed) of the EyeLink Device.
Triggered Eye	.triggered Eye	Integer	Returns the eye (0 for the left eye; 1 for the right eye) whose data makes the current fixation trigger fire.
PPD X, PPD Y	.PPDX, .PPDY	Float	Angular resolution at the current gaze position in screen pixels per degree of visual angle along the x-, or y-axis.
Left Gaze X, Right Gaze X, Average Gaze X	.leftGazeX, .right GazeX, .average GazeX [1]	Float	Gaze position of the triggering sample along the x-axis for the left eye, right eye and the average between the two eyes.
Left Gaze X, Right Gaze X, Average Gaze Y	.leftGazeY, .right GazeY, .average GazeY [1]	Float	Gaze position of the triggering sample along the y-axis for the left eye, right eye and the average between the two eyes.
Left Pupil Size, Right Pupil Size, Average Pupil Size	.leftPupilSize, .ri ghtPupilSize, .averagePupilSize [1]	Float	Left eye, right eye, or average pupil size (in arbitrary units, area or diameter).
Left Velocity, Right Velocity, Average Velocity	.leftVelocity, .rightVelocity, .averageVelocity [1]	Float	Left eye, right eye, or average velocity (in degrees /second).
Left Acceleration, Right Acceleration, Average Acceleration	.leftAcceleration, .rightAcceleratio n, .averageAccelerat ion [1]	Float	Left eye, right eye, or average acceleration (in degrees /second²).
Angle	.angle	Float	The angle of the eye movements when the trigger fires.
Target Distance	.targetDistance	Integer	Distance between the target sticker and camera (10 times the measurement in millimeters). This option is available only when the eye tracker is operating in the Remote mode. Returns "MISSING_DATA" (-32768) if target is missing or if a remote tracking mode is not being used.
Target X, Target Y	.targetX, .targetY	Integer	X, Y position of the target sticker in camera coordinates. This option is available only when the eye tracker is operating in the Remote mode. Returns "MISSING_DATA" (-32768) if target is missing or if a remote tracking mode is not being used.
Target Flags	.targetFlags	Integer	Flags used to indicate target tracking status (0 if target tracking is ok; otherwise error code). This option is available only when the eye tracker is operating in the Remote mode. Returns "MISSING_DATA" (-32768) if target is missing or if a remote tracking mode is not

			being used.
IA Labels	.IALabels	List	Provides a list of labels of the interest area(s) hit (e.g., gaze and velocity detected). Returns an empty list if no interest area is hit (e.g., if the triggering region is not interest area-based, or the trigger firing is not region-based).
IA IDs	.IALabels	List	Provides a list of IDs of the interest area(s) hit (e.g., gaze and velocity detected). Returns an empty list if the no interest ares hit (e.g., if the triggering region is not interest area-based, or the trigger firing is not region-based).
IA Label	.IALabel	String	Reports the label of the interest area hit. If multiple interest areas were hit, reports the label of the interest area with the lowest ID. Missing data if no interest area hit.
IA ID	.IAID	Integer	Reports the ID of the interest area hit. If multiple interest areas were hit, reports the interest area with the lowest ID. Missing data if no interest area hit.
IA Location	.IALocation	Point	Location (top-left or center, based on preference) of the interest area hit. If multiple interest areas were hit, reports the location of the interest area with the lowest ID..
IA Width	.IAWidth	Integer	Width of the interest area hit. If multiple interest areas were hit, reports the width of the interest area with the lowest ID.
IA Height	.IAHeight	Integer	Height of the interest area hit. If multiple interest areas were hit, reports the height of the interest area with the lowest ID.

Note:
[1] Returns "MISSING_DATA" (-32768) for the untracked eye.

An example of using the Sample Velocity trigger is illustrated below. To end a sequence when the participant makes a saccade within the target region from (212, 334) to (312, 434), set the "Region Location" as (212, 334), "Region Width" as 100, and "Region Height" as 100. Users may further configure the velocity threshold, triggering eye, etc., as desired.

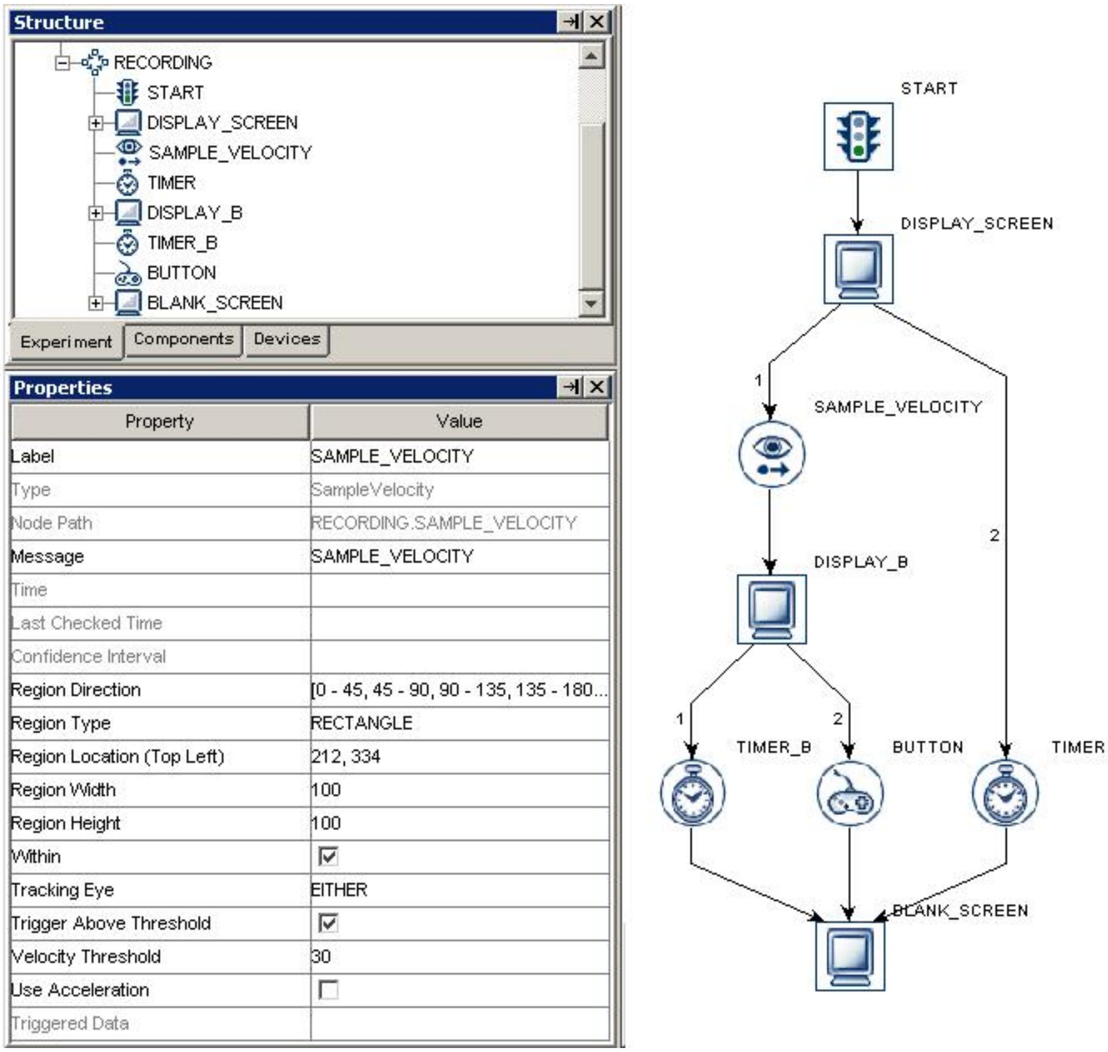


Figure 7-64. Using Sample Velocity Trigger.

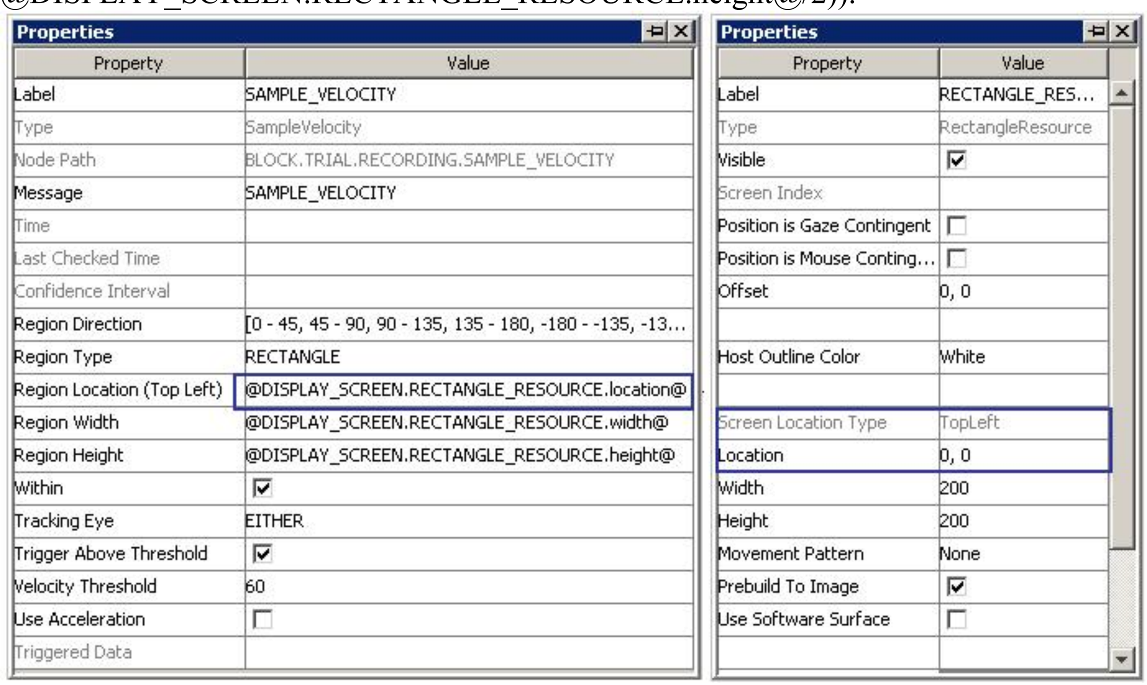
The sample velocity trigger can be used when a saccade needs to be detected as quickly as possible so that a display change can be implemented. Please note that how quickly the trigger will fire is influenced by the tracker heuristic filter setting and the velocity/acceleration model used for calculation (applicable to EyeLink 1000, EyeLink 1000 Plus and EyeLink Portable Duo only). To detect a saccade, instantaneous velocity and acceleration values are calculated for each sample and compared to the threshold values. For cognitive experiments, the velocity threshold is typically set to 30 degrees/sec (and the acceleration threshold to 8000 degrees/sec^2, if using) to detect saccades of 0.5 degrees of visual angle or greater. For psychophysical studies, the threshold values are typically lower to make the parser more sensitive.

The sample velocity trigger is location-based and fires only when the eyes are within or outside of a specified region. To make the trigger fire regardless of current eye position, the trigger region may be set as the whole screen (i.e., for a 1024 x 768 screen resolution, set Region Location as (0,0), Region Width as 1024, and Region Height as 768). Alternatively, keep the default region settings and uncheck the "Within" button.

7.10.12.1 Top-left vs. Center Triggering Location Type

The Location Type of all location-based triggers (invisible boundary trigger, mouse trigger, fixation trigger, saccade trigger, and sample velocity trigger) is based on the top-left corner of the region, whereas the screen resources can be based on either the top-left corner or the center of the resource. (The screen resource/interest area location type can be set in the project Preferences under Screen). This means that references should be created differently depending on whether the region location of a trigger refers to a center-based resource or a top-left-based resource.

Imagine that a sample velocity trigger should fire only when the gaze position is within a rectangle resource (RECTANGLE_RESOURCE). The top panel of the figure below illustrates creating the Region Location reference to the rectangle resource when the screen location type is TopLeft (@DISPLAY_SCREEN.RECTANGLE_RESOURCE.location@). The bottom panel of the figure illustrates creating a location equation when the location type is Center, by subtracting half the resource width from the x coordinate, and half the resource height from the y coordinate:
(=EBPoint(@DISPLAY_SCREEN.RECTANGLE_RESOURCE.location.x@ - @DISPLAY_SCREEN.RECTANGLE_RESOURCE.width@/2, @DISPLAY_SCREEN.RECTANGLE_RESOURCE.location.y@ - @DISPLAY_SCREEN.RECTANGLE_RESOURCE.height@/2)).



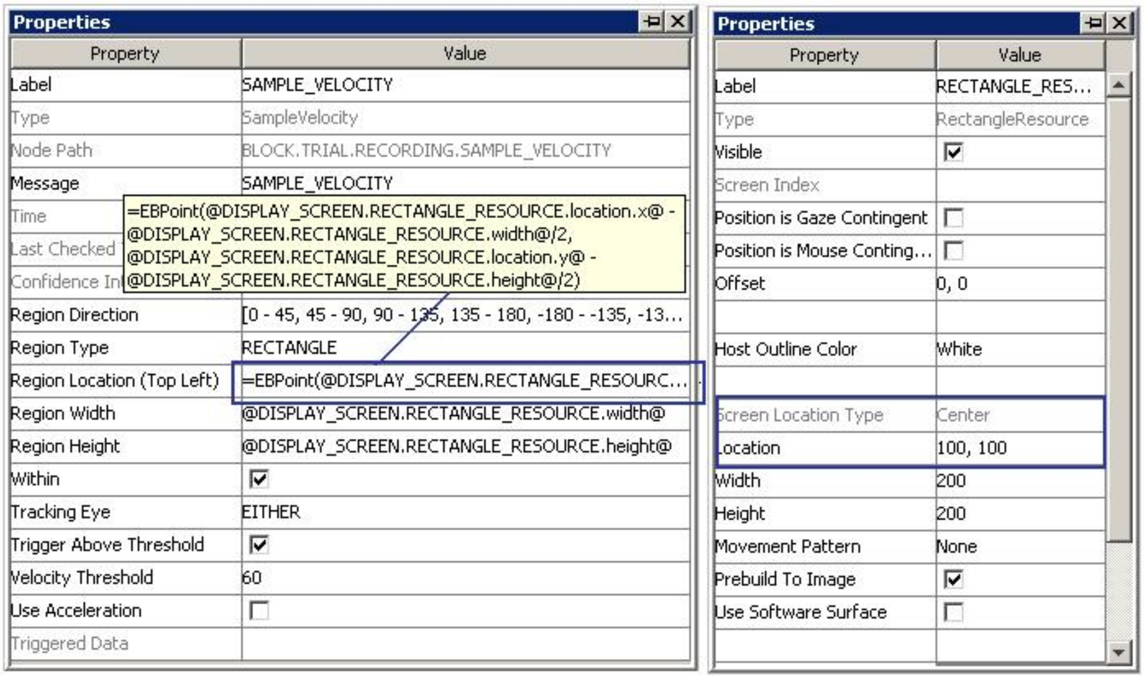


Figure 7-65. Using Sample Velocity Trigger with Top-left and Center Location Types.

7.10.12.2 How to Show the Triggering Region on the Host PC

Sometimes it is useful to draw feedback graphics on the Host PC so the experimenter can monitor whether the participant's eye position is within the triggering region, or so the programmer can debug the experiment code by running the eye tracker in the mouse simulation mode. Drawing on the Host PC screen can be done by using an EyeLink Command action either before the recording sequence (immediately after the Prepare Sequence node) or as the first node in the recording sequence, so the drawing is overlaid on top of the existing host PC graphics. The drawing command can be either "draw_box" or "draw_filled_box". The Text of the command must include tracker of the top, left, right, and bottom pixel position of the triggering region, followed by the drawing color. This can be done either with string concatenation or string formatting. The top-left corner of the triggering region is (@SAMPLE_VELOCITY.regionLocation.x@, @SAMPLE_VELOCITY.regionLocation.y@) and the bottom right corner of the triggering region is (@SAMPLE_VELOCITY.regionLocation.x@ + @SAMPLE_VELOCITY.regionWidth@, @SAMPLE_VELOCITY.regionLocation.y@ + @SAMPLE_VELOCITY.regionHeight@)

String Concatenation:

```
=str(@SAMPLE_VELOCITY.regionLocation.x@) + " "
+ str(@SAMPLE_VELOCITY.regionLocation.y@) + " "
+ str(@SAMPLE_VELOCITY.regionLocation.x@ + @SAMPLE_VELOCITY.regionWidth@) + " "
+ str(@SAMPLE_VELOCITY.regionLocation.y@ + @SAMPLE_VELOCITY.regionHeight@) + "  3"
```

String Formatting:

```
="%d %d %d %d 3" % (@SAMPLE_VELOCITY.regionLocation.x@,
@SAMPLE_VELOCITY.regionLocation.y@,
```

@SAMPLE_VELOCITY.regionLocation.x@ + @SAMPLE_VELOCITY.regionWidth@,
@SAMPLE_VELOCITY.regionLocation.y@ + @SAMPLE_VELOCITY.regionHeight@)

All of the drawing commands are documented in the "COMMANDS.INI" file under C:\EYELINK2\EXE or \ELCL\EXE directory of the host partition.

7.10.13 Voice Key Trigger

Note this section is only applicable to the Windows version with a recommended ASIO sound card and the AUDIO device set to the "ASIO" driver, or macOS when running Version 2.0 or later of the Experiment Builder software.

The Voice Key trigger ( ) fires when the audio input exceeds a specified threshold level. The voice key can be used to detect whether a participant has made a response, to trigger the end of a trial, etc. A voice key will typically respond to the "voiced" parts of vowels and some consonants, and therefore it may not represent the actual onset time of speech. To determine the actual speech onset time, users may record the entire audio recording of the trial and use a third-party audio editing tool to analyze the recorded audio. On macOS, the voice key only works while the audio recording is ongoing. An error will be displayed if a voice key trigger is used but no Record Sound node is found in the project.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the voice key trigger. The default value is "VOICE_KEY".
Type #	NR		The Experiment Builder object type for this node (VoiceKey).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Message	.message	String	Message to be sent to the EDF file (in an EyeLink experiment) or messages.txt (in a non-EyeLink experiment with the "Save Messages" attribute of the Experiment node checked) when the voice key trigger fires.
Time #	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the processing of the voicekey trigger is done (so the experiment flow is ready to move to the next node). **Note:** To check the time when the input voice level exceeds the threshold, use @*.triggeredData.time@ (i.e., the .time sub-attribute of the .triggeredData attribute) instead.
NTP Time #	.ntpTime	Float	NTP server time when the processing of the voicekey trigger is done (so the experiment flow is ready to move to the next node).
Last Checked Time #	.lastCheckedTime	Float	Experiment Builder checks for the status of the trigger about every 1 msec. This property can be used to retrieve the Display PC time (in

			milliseconds from the start of the experiment) when the trigger was checked for the last time.
Confidence Interval #	.confidenceInterval	Float	Time difference between the trigger time and last check time of the trigger. This indicates a window of uncertainty as the true trigger time could be between the last check time (.lastCheckedTime) and the reported trigger time (.time).
Clear Input Queue ¶	.clearInputQueue	Integer	Experiment Builder maintains an event queue so that multiple voicekey events can be accessed over time. The "Clear Input Queue" option checks whether the voice key event(s) cached in event queue should be cleared when the trigger fires (NO: no event clearing; EVENT: removes the current triggering event from the voicekey event queue; LIST: all voicekey events from event queue will be removed).
Threshold #	.threshold	Float	Value from 0.0 to 1.0 to set the voicekey trigger level, with 1.0 being the maximum audio level. The threshold should be set high enough to reject noise and prevent false triggering, but low enough to trigger quickly on speech. A threshold of 0.05 to 0.10 is typical.
Below Threshold	.belowThreshold	Boolean	If "False" (default), the voice key trigger will fire when the audio threshold exceeds the specified threshold level. If "True", the trigger will fire when the audio level drops below the threshold level.
Triggered Data #	.triggeredData		If the voice key trigger fires, the triggered data can be further accessed (see the following table).

When the voice key trigger fires, the triggered data can be further accessed. The sub-attributes of the TriggeredData field are listed in the following table.

Reference	Attribute	Type	Content
Time	.time	Float	Display PC time (in milliseconds from the start of the experiment) when the voicekey trigger fires.
EDF Time	.EDFTime	Integer	EDF time when the voice key trigger fires.
NTP Time #	.ntpTime	Float	NTP server time when the voicekey trigger fires.
Level	.level	Float	Returns the voice key audio level (in the same units as the voice key threshold) when the voice key trigger fires, with 0.0 being silence and 1.0 being the maximum audio level.

The following discusses some of the common applications of the voice key trigger. You may check out the HTML version of this document for the complete example project.

7.10.13.1 How to Calculate the Voice Key RT Online

To record information about the voice key response, users can create variables,to store the time of the display event and the time of the voice key trigger. After the response, an Update Attribute action can be used to set the values of these variables, referring to the "@VOICE_KEY.triggeredData.time@" attribute to record the time of the voice key response (see the figure below). With the time of the voice key response, the response time can be calculated as (@voicekey_time.value@ - @display_onset_time.value@). If the trial can be ended without the participant making a response (e.g., the trial times out after some period, or the voice key fails to trigger), use an Update Attribute action at the beginning of the trial to reset the default values for the variables to ensure the response data from the previous trial will not be carried over to the current trial.

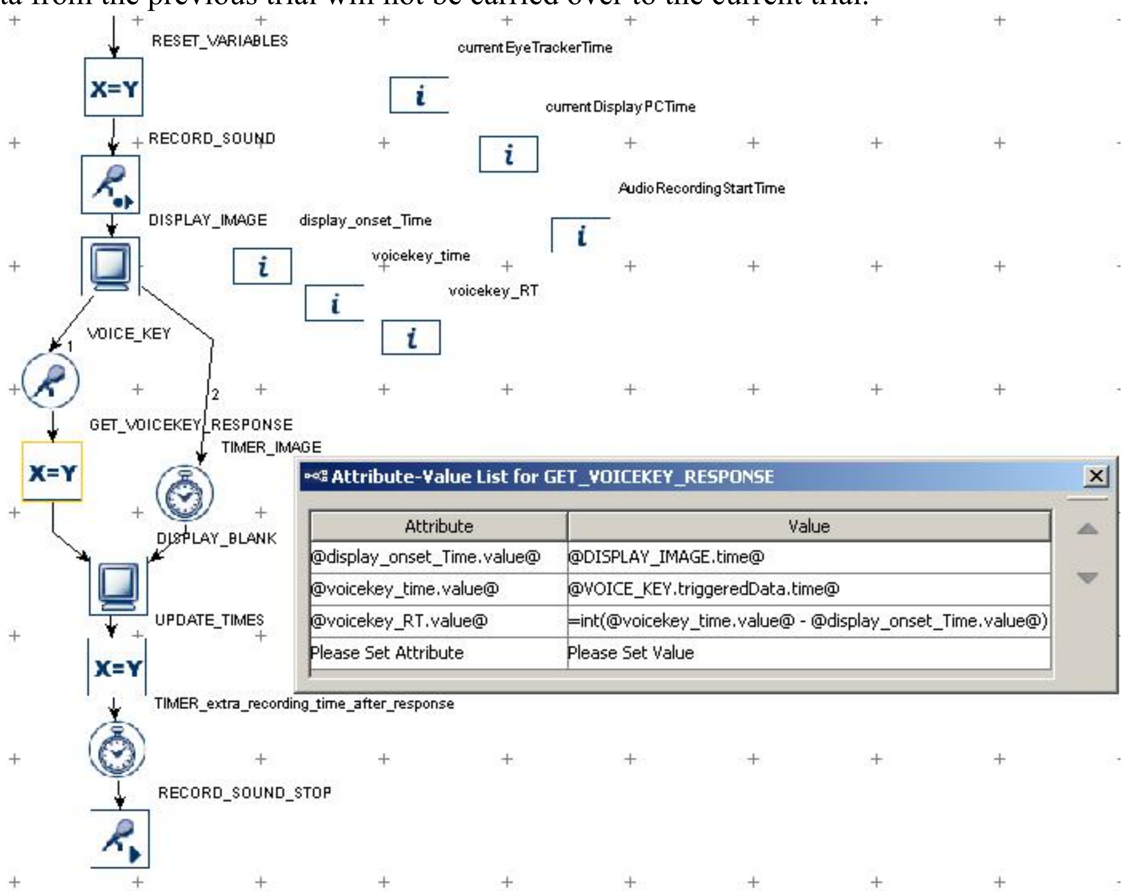


Figure 7-66. Collecting the Voicekey Response Data.

7.10.13.2 How to Align the Recordings in the Audio File and Eye Tracker Event Time

To verify the accuracy of the vocal response, it is best to record the audio on every trial using a Record Sound node. Adding a brief Timer trigger at the end of the trial, before the Record Sound Control action, ensures that the entire vocal response can be captured.

In an experiment in which both eye movements and speech/voice key are recorded simultaneously, it is important that users are able to examine the temporal relationship between the two data streams (ideally, to compare the two streams of data in the same time scale). In Experiment Builder and Data Viewer, the time stamps for the eye movement data and messages (i.e., EDF file time) are based on a different clock than the time fields for the actions and triggers (i.e., EB run time). The EDF file time runs on the host PC clock, with the 0-ms being the time when the EyeLink host program started. The EB run time is based on the display computer clock, with 0-ms being the time when the experiment project starts. To align the eye movement data and the recorded speech data, add the following variables to the experiment project:

- currentEyeTrackerTime - used to retrieve the current time on the eye tracker clock.
- currentDisplayPCTime - used to retrieve the current time on the display computer clock when the currentEyeTrackerTime value is updated.
- AudioRecordingStartTime - used to retrieve the time when the audio recording starts.

Use an UPDATE_ATTRIBUTE action to update these three variables while the audio recording is still ongoing.

- @currentEyeTrackerTime.value@ - the "Current Time" field of the EyeLink device
- @currentDisplayPCTime.value@ - the "Current Time" field of the Display Device
- @AudioRecordingStartTime.value@ - the "Record Start Time" attribute of the Record Sound action.

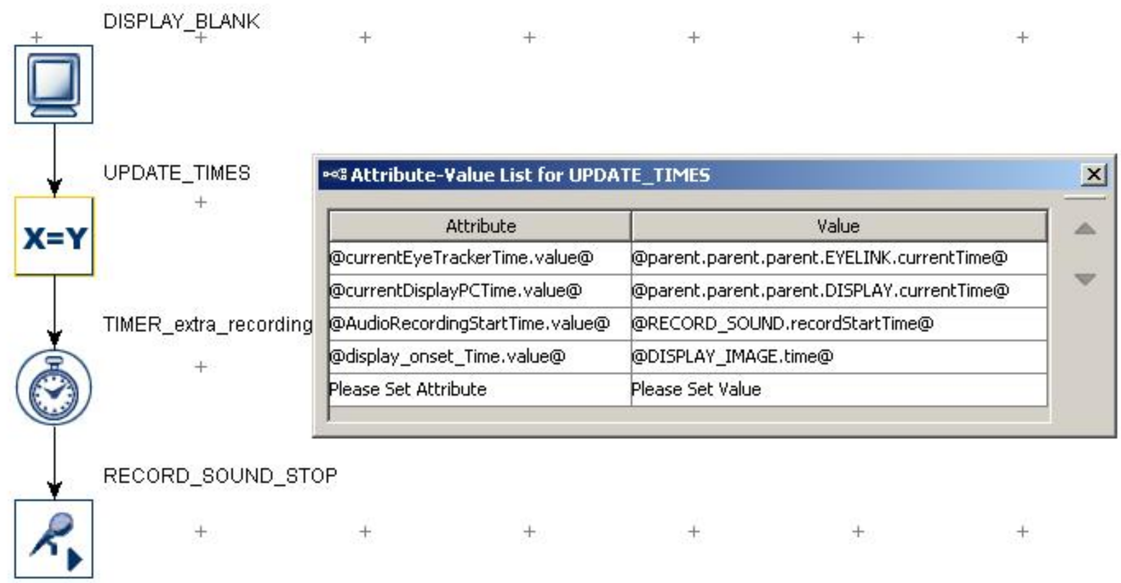


Figure 7-67. Aligning Audio Recording Times.

The onset of the audio recording in the EDF file (eye tracker) time in each trial can then be calculated as (currentEyeTrackerTime + AudioRecordingStartTime - currentDisplayPCTime).

In Data Viewer, please note that the timing of all eye movement measures is reported relative to the start of the trial if no reaction time period definition is applied to the session, or to the start of the reaction time period if one is applied. The 0-point for the eye recording in a trial will be the TRIAL_START_TIME output variable in Data Viewer. The EDF file time for the start of a fixation can then be calculated from the Fixation Report as (CURRENT_FIX_START + TRIAL_START_TIME).

7.11 Other Building Components

This section lists other types of components for experiment building: the Variable, Results File, and Accumulator nodes (see Figure 7-68).

Figure 7-68. Other Components Implemented in Experiment Builder.

7.11.1 Variable

Users can create a variable ()to keep track of important information during run time (e.g., the iteration status in a loop, or a participant's response). To create a new variable, open the "Other" tab of the Component Toolbox, then click and drag the Variable into the work area. The label of a variable must be a string starting with a letter between 'a' and 'z' or 'A' and 'Z' and consisting of alphanumerical characters ('A' - 'Z', 'a' - 'z', '0' - '9', or '_'); any space entered is converted to an underscore. The new variable label shouldn't duplicate the name of any existing data source columns, variable labels, or any of these reserved words: "EYELINK", "DISPLAY", "AUDIO", "TTL", and "CEDRUS". Note that the variable object does not connect to other items in a graph like action and trigger nodes. Users can update the value of the variable by assigning a value directly, referring to the attribute of another item, or by equation. When setting the variable to a reference or equation, it is best to use an Update Attribute to update the value of the variable. The variable can then be output as a trial variable in the EDF and/or in the Results File. (Note that in Experiment Builder 2.0, all newly-added variable nodes are automatically included in Results Files and in the EyeLink DV Variables attribute of the topmost experiment node in the Structure panel.)

Version 2.1.512 implements three built-in variables for the experiment projects: "Session_Name_", "Trial_Index_", and "Trial_Recycled_". The "Session_Name_" variable reports the name of the recording session entered in the dialog box when the experiment starts. The "Trial_Index_" variable counts the number of trials tested so far in the recording session. The "Trial_Recycled_" variable reports the data line recycling status of the current trial (i.e., whether a TRIAL_RECYCLE action has been performed in the trial). These three built-in variables are automatically added to the "EyeLink DV Variables" list of the top-most experiment node (see section 7.5) and the results file (see section 7.10.2).

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the variable. The default value is "VARIABLE".
Type #	NR		The Experiment Builder object type for this node (Variable).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Type #	NR		The data type of the variable ("String", "Integer", "Float", "Point", "Boolean", "Color", or "List").
Value	.value		The value of the variable.

Imagine an experiment in which the visual stimulus presentation alternates between two screens and the trial ends after a certain number of alternations. In this experiment it could help to create a counter to keep track of the number of loops. To create a counting variable, first add a Variable node to the graph (see Figure 7-69) and set its initial value to 0 (see Panel A of Figure 7-70). Then add an Update Attribute action in the loop to increase the value of the variable by 1 for each loop. Open the Attribute-Value List and set the "Attribute" cell as "@VARIABLE.value@", and the "Value" field as "=@VARIABLE.value@ + 1" (see Panel B of Figure 7-70). Finally, add a Conditional trigger to check whether the VARIABLE value equals 5. Then connect the next action to the “True” branch of the Conditional trigger to exit the loop after 5 repetitions (see Panel C of Figure 7-70).

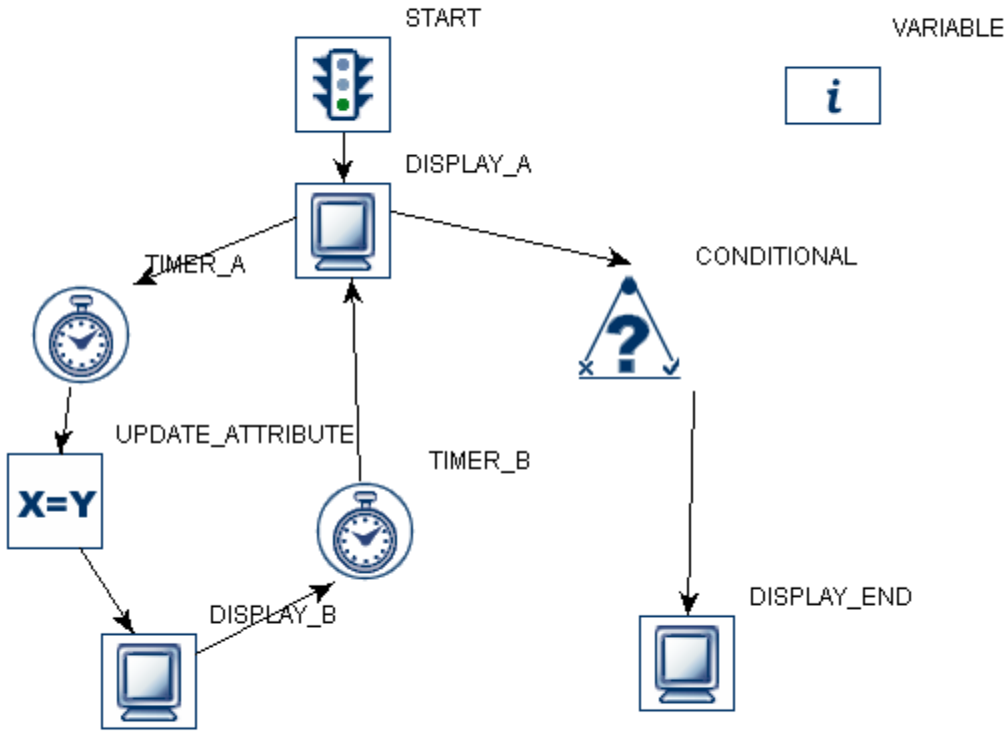


Figure 7-69. Using a Variable.

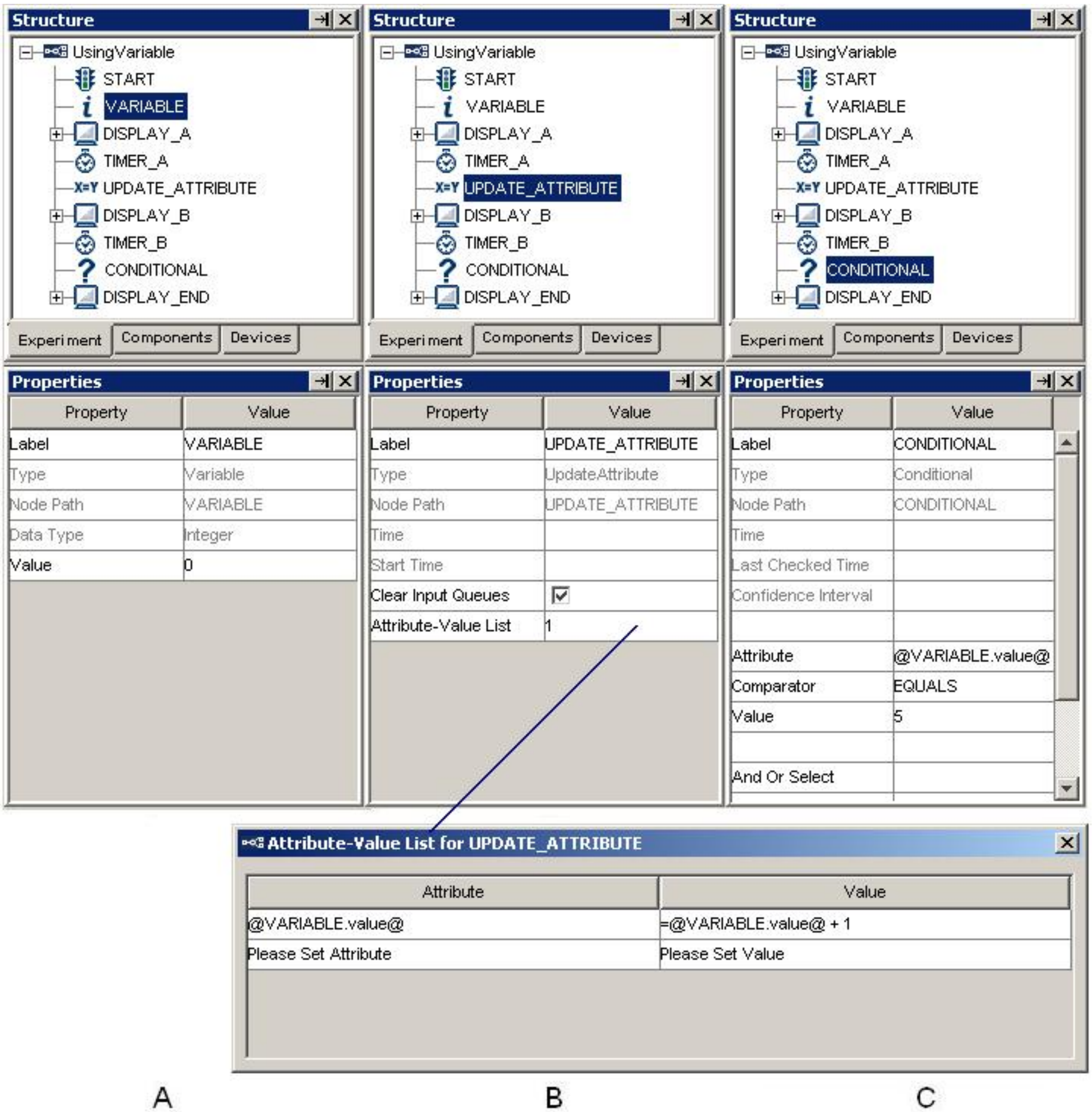


Figure 7-70. Property Settings for Variables.

Variables can be conveniently used as temporary data storage, e.g., to record participants' responses by saving triggered data such as response time and key or button pressed. Simply add a variable from the Component Toolbox into the project workspace, then use an Update Attribute node after the trigger to set the new variable value(s). The default data type for a newly-added variable is "String." To set the type of a variable, simply enter a value in the "Value" field that corresponds to the intended data type. For example (see Figure 7-71), entering "0" in the Value field will set the Type to "Integer," and entering "0.0" will set the Type to "Double." When referring the variable value to an attribute of a node in the graph, make sure the data type of the variable matches the data type of the intended attribute.

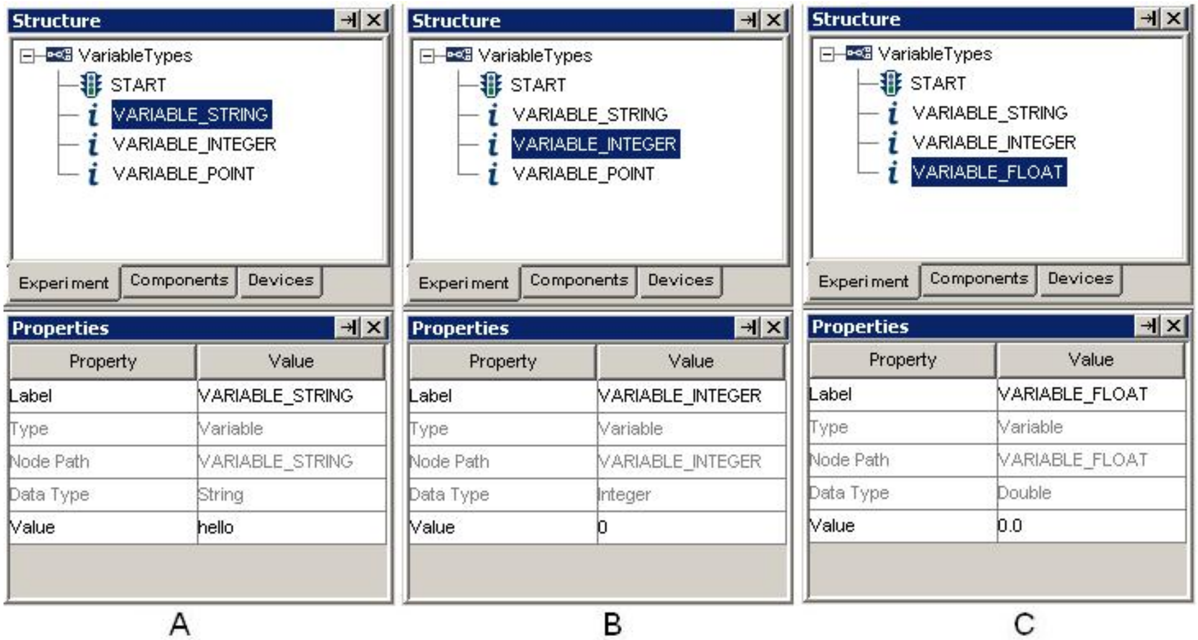


Figure 7-71. Dynamic Data Type Casting.

Make sure to set the initial value of a variable to a plausible value to avoid a build-time error. For example:

- To use a variable to store the temporary value of an image file name, the initial value of the variable should be set to the name of an image resource in the image library, instead of an arbitrary string like “abc”.
- If the variable is used in any equations, the default value needs to be a valid value for equation use. For example, if a variable is used as the divisor in a division operation, make sure that the initial value of the divisor is non-zero.

To clear a non-string value (e.g., a number or point) set in the "Value" attribute of a variable, first set the value to some string (e.g., "hello") and then clear it.

7.11.2 Results File

The Results File ( ) allows users to create a tab-delimited .txt file output separate from the EDF. This is especially useful for non-EyeLink experiments, where no EDF is recorded, but may also be used as a quick summary of trial data. Variables selected to be included in the Results File will be listed as columns. Each time the Add To Results File action is called (typically at the end of the trial), a row is added to the Results File that includes the current value for each variable in the file. Similar to the Variable object, a Results File object does not connect to other objects in the graph.

Field	Attribute Reference	Type	Content

Label *	.label	String	Label of the RESULTS FILE object. The default value is "RESULTS_FILE".
Type #	NR		The Experiment Builder object type for this node (ResultsFile).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Columns	NR		The list of variables to be recorded in the results file.
Use Period for Missing Values † *	.usePeriodForMissingValues	Boolean	If true, a "." will be written out to the results file instead of missing values (i.e., -32768 for numbers and "MISSING_VALUE" for strings).
Field Width *	.fieldWidth	Integer	Specifies the minimum number of characters that are output for the numerical values.
Precision *	.precision	Integer	Specifies the number of digits after the decimal-point character for floating-point values.
Convert Line Break (Return) to New Line Character	.convertLineBreakToNewlineChar	Boolean	Check this option to convert any line breaks (returns) in datasource and variable values into new line characters. (The presence of line breaks in values added to the results file may disrupt the results file formatting.)
Line Break Replacement	.lineBreakReplacement	String	Sets the character(s) to be used to replace the line breaks (returns) in the datasource and variable values.

Results file is useful for recording data in non-EyeLink experiments. The following graph (Figure 7-72) illustrates part of a simple reaction-time experiment:

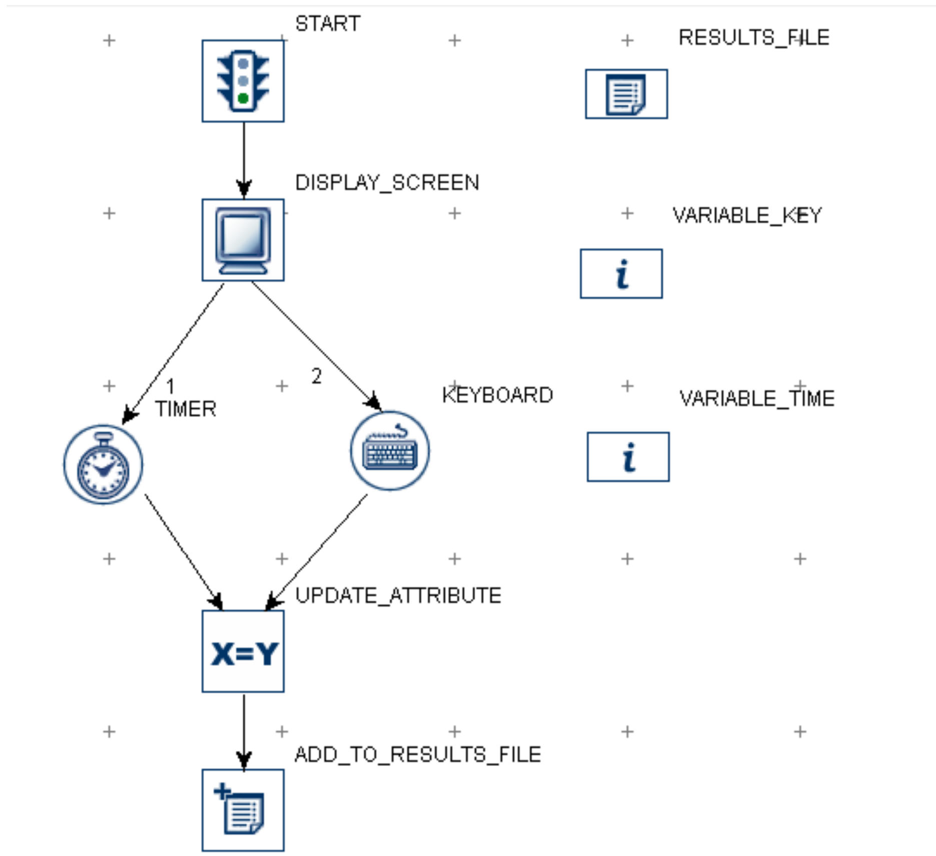


Figure 7-72. Using Results File.

To record the keyboard response and response time to the results file, the user in this example created two new variables: "VARIABLE_KEY," referring to the keyboard response (@KEYBOARD.triggeredData.key@), and "VARIABLE_TIME," referring to the response time from the onset of the screen to the key press event =(@KEYBOARD.triggeredData.time@ - @DISPLAY_SCREEN.time@). The user also added a Results File object to the experiment. and configured the "Columns" property to add ensure all the desired variables are included in the output (note that starting in Experiment Builder 2.0, all variables and data source columns are included in the "Columns" property by default; see Panel A of Figure 7-73). An Add To Results File action is added after the Keyboard trigger to record responses and reaction time for the sequence. The "Results File" property of the Add To Results File action is set to "RESULTS_FILE," the only results file currently in the project. If desired, multiple Results Files may be created and configured with different variables, or made to include different sets of trials.

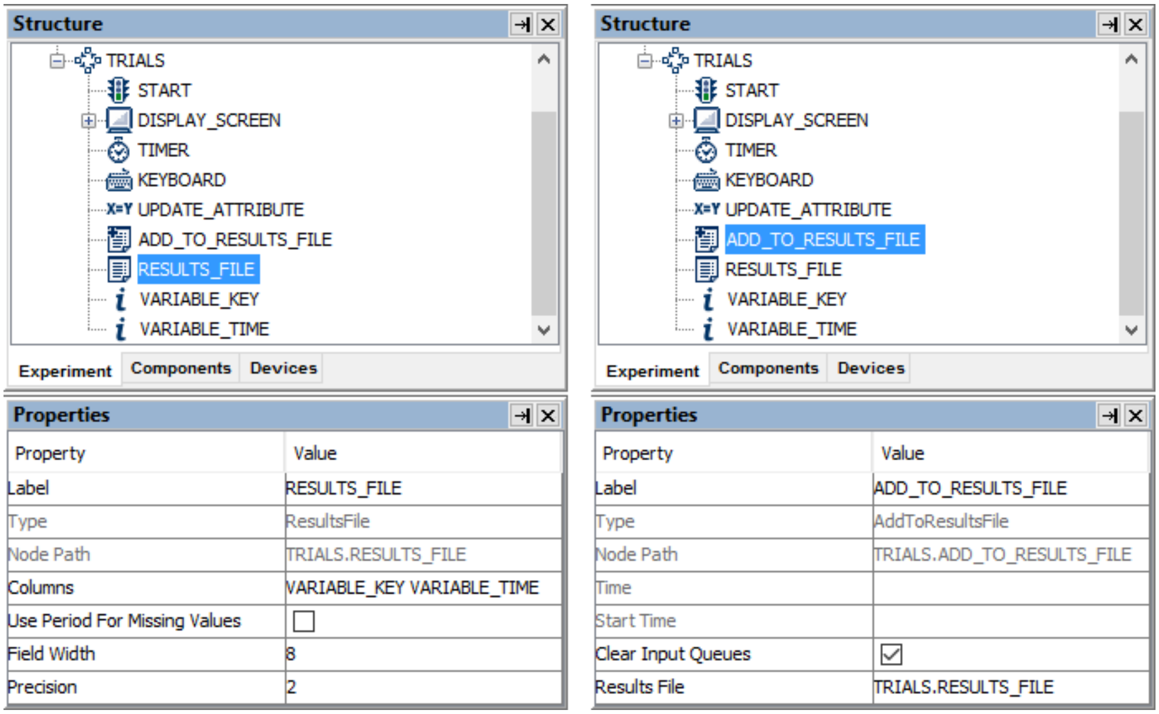


Figure 7-73. Setting Properties of the Results File Node.

When the experiment is executed, a results file is generated in the session folder in the results directory, with one column for each of the output variables. The results file is tab-delimited and can be easily imported into most statistical software.

VARIABLE_TIME	VARIABLE_BUTTON
686.0	b
603.0	n
530.0	n
532.0	b

7.11.3 Accumulator

The accumulator () is used to keep numeric values and provide descriptive statistics of the accumulated data.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the accumulator.
Type #	NR		The Experiment Builder object type for this node (Accumulator).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Maximum Size	.maximumSize	Integer	Maximum number of data points that can be added to the accumulator. If the number added exceeds the limit, the initial data points will be overwritten.

Elements #	.elements	List	A list of the data points added to the accumulator.
Size #	.size	Integer	Actual number of elements in the accumulator.
Sum #	.sum	Number	Sum of all values added to the accumulator.
Maximum #	.maximum	Number	Maximum of all values added to the accumulator.
Minimum #	.minimum	Number	Minimum of all values added to the accumulator.
Mean #	.mean	Number	Mean across all values added to the accumulator.
Median #	.median	Number	Median across all values added to the accumulator.
Standard Deviation #	.stddev	Number	Standard Deviation of all values added to the accumulator.
Standard Error #	.stderr	Number	Standard error value of all values added to the accumulator.

The accumulator can be used as a handy tool for presenting a summary of the participant's performance (e.g., an average RT calculation) at the end of the experiment. For an example, the following figure illustrates an eye-tracking experiment using a saccade trigger with an Accumulator. Whenever the saccade trigger fires, the triggered data is collected and the duration of each saccade can be added to the accumulator. At the end of the trial or at the end of the experiment, we can easily calculate statistics such as the maximum, minimum, mean, etc., of the durations across all saccades. Like the Results File, the Accumulator itself must first be added to the project, and does not connect to other nodes. An Add To Accumulator action is used to send the desired value to the Accumulator.

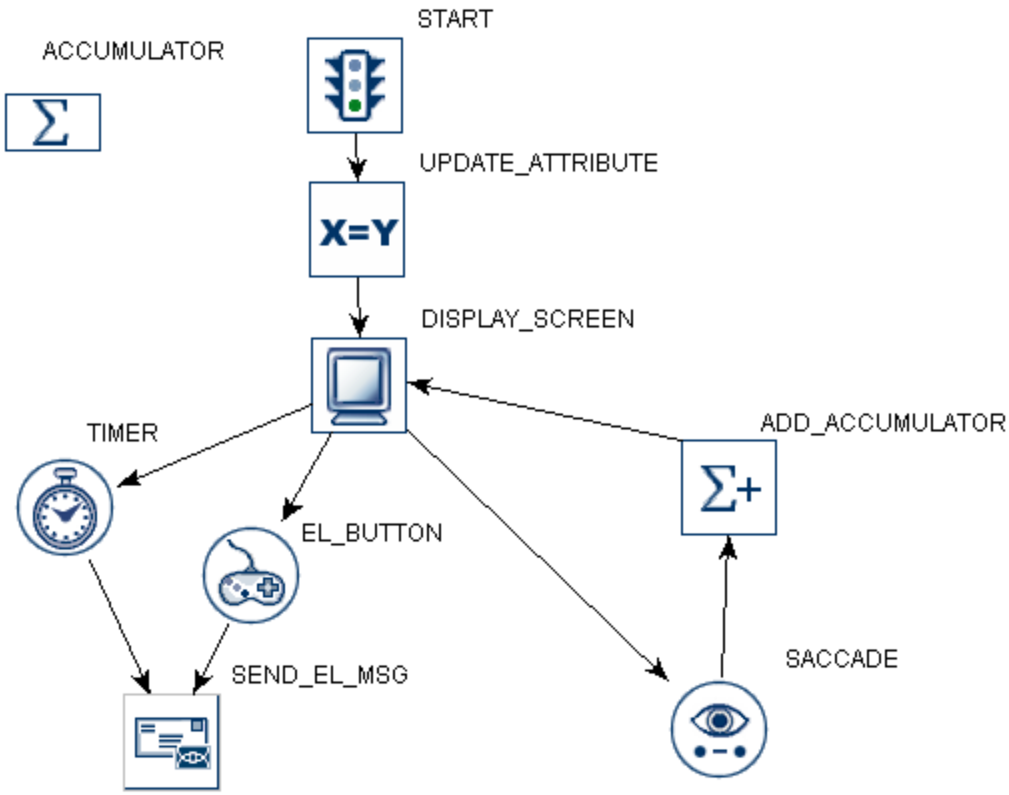
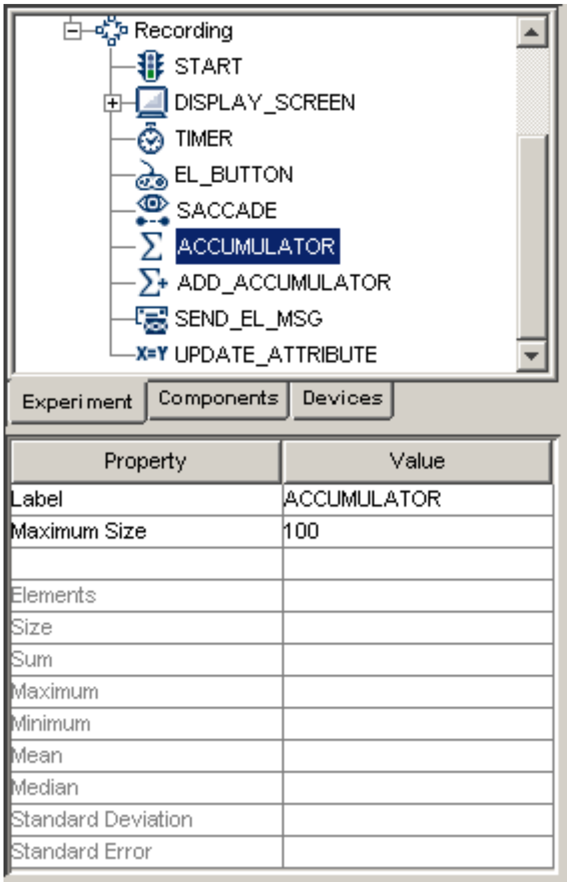


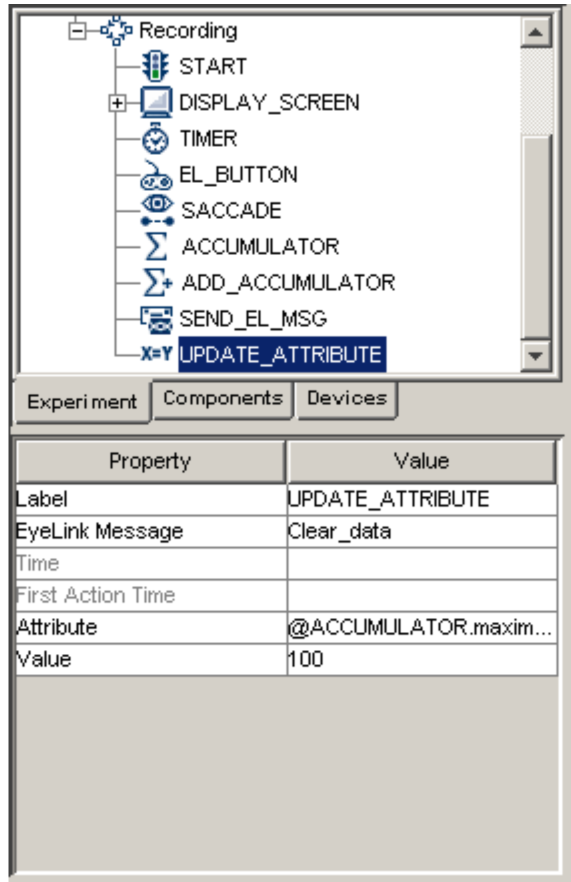
Figure 7-74. Using Accumulator.

When adding a new Accumulator, make sure to first set the Maximum Size attribute (see Panel A of Figure 7-75). Note that if the maximum size is exceeded, the earliest value added to the Accumulator will be flushed to make room for the newly added value. (E.g., if the values 1, 2, 3, 4, and 5 are added in that order to an Accumulator with a Maximum Size of 3, the contents of the Accumulator will be 3, 4, and 5.)

In some applications it may be necessary to clear the data in the accumulator. For instance, in this example, we want to display data from only the saccades in the trial, so it's important to clear the accumulator at the beginning of the trial. The accumulator can be cleared either by adding an "UPDATE_ATTRIBUTE" action and resetting the maximum data size for the accumulator (see Panel B of Figure 7-75), or by using a Reset Node action.



A



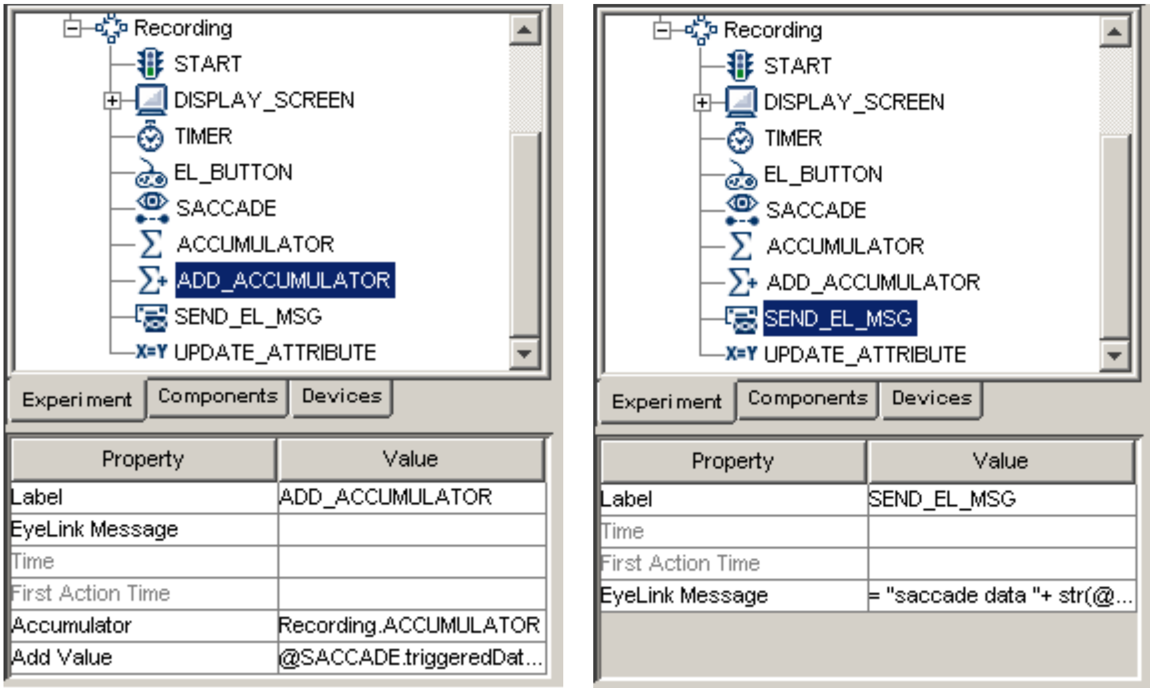
B

Figure 7-75. Setting the Properties of Accumulator.

The Add to Accumulator action is added to the sequence to send the saccade duration data to the Accumulator. After adding the Add to Accumulator action, specify the accumulator in which the data is stored (“Accumulator”) and the value to add (“Add Value”; see Panel A of Figure 7-76). When desired, the data can be retrieved by referring to the properties of the Accumiulator. For example, a Send EyeLink Message action can be used to report the number of saccades in the sequence and some basic statistics of saccade duration:

```
= "saccade data "+ str(@ACCUMULATOR.size@) + "max " + str(@ACCUMULATOR.maximum@)
+ " min " + str(@ACCUMULATOR.minimum@) + " mean " + str(@ACCUMULATOR.mean@)
```

This will record a message similar to “MSG 3153136 saccade data 8 max 60.0 min 48.0 mean 55.0” in the EDF file.



A B

Figure 7-76. Adding Data to and Retrieving Data from the Accumulator.

7.11.4 Custom Class Instance

The Custom Class Instance () creates a new instance of a custom class. Users can select a custom class file from the project library to which the current instance belongs. Simply click the Value field of the "Custom Class" property and select the .py file from the dropdown menu.

Once the class is determined, double-click on the Custom Class Instance in the experiment graph to open a custom class editor for viewing and editing the source code of the custom class. See Chapter 12 "Custom Class" for details.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the custom class instance. By default, the label is "CUSTOM_CLASS_INSTANCE".
Type #	NR		The Experiment Builder object type for this node (CustomClassInstance).
Node Path #	.absPath	String	The absolute path of the node in the experiment graph.
Custom Class *	NR		Select a class (defined in the Experiment Builder library manager) to which the current instance belongs.

Note: The property table of the custom class instance will also list all of the methods and attributes defined in the custom class in an alphabetical order.

8 Screen Builder

Experiment Builder provides a built-in Screen Builder interface as a convenient tool for creating visual displays. After adding a Display Screen action in the workspace, users can open the Screen Builder by double clicking the node.

Screen Builder is a what-you-see-is-what-you-get ("WYSIWYG") type of interface, which allows users to see what the display will actually look like during the runtime of the experiment. The Screen Builder behaves like a drawing board onto which various types of the graphic resources (images, videos, text, or simple line drawings) can be added (see Figure 8-1). Once added, the exact properties of the resources can be further edited from the property panel. For example, for text resources, users can specify the position, font (name, size, and style), color, and alignment style of the text. For a dynamic display with moving objects on the screen, users can specify the movement pattern of the graphic resources. Addition tools such as the drawing grid and interest areas are provided for the ease of screen editing and data analysis.

When users move the mouse cursor around in the Screen Builder, Experiment Builder (version 2.0 or later) prints the current mouse position as well as the color of the pixel (the background of the Screen Builder or resources on the screen) at the current mouse position – see Figure 8-1.

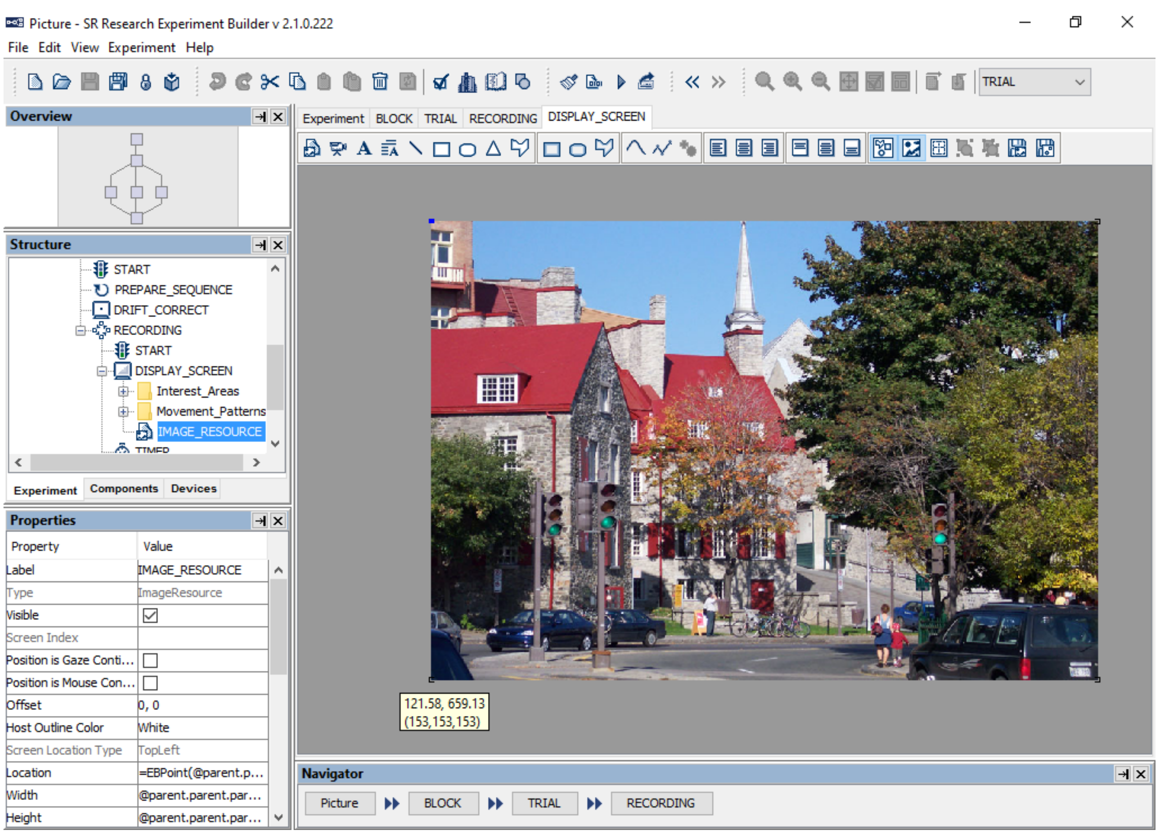


Figure 8-1. Sample View of the Screen Builder Interface.

8.1 Resources

Resources are the individual graphic drawings (e.g., image, video, text, line, etc) to be displayed on the screen. The following types of resources can be added to a display screen: images, videos, text (single line or multiple lines), and simple shapes like rectangles, ellipses, lines, triangles, and polygons (see Figure 8-2).

Figure 8-2. Resources Implemented in Screen Builder.

As for all of the nodes discussed in the previous chapter, the layout and properties of a selected resource can be easily modified in the Property panel. In addition to configuring the physical appearance of the resource (position, size, style, etc.), users may manipulate the following attributes of a graphic resource:

- Visibility: After a resource is added to a screen, it can be either visible or invisible when the display is shown. This property is useful for experiments in which similar displays are used except that one or more items may appear and disappear.
- Position is Gaze or Mouse Contingent: These properties allow a resource to change position according to the current gaze or mouse position (see the GCWINDOW and TRACK examples) during recording. For an image resource, the clipping area can also be made gaze contingent (see the GCWINDOW example).
- Movement Pattern: Users can specify a movement pattern (either sinusoidal or custom) for a resource (see the PURSUIT example). A resource cannot be gaze- or mouse-contingent if it has been assigned a movement pattern.
- Interest Area: For static resources, creating interest areas may simplify data analysis at a later stage. Interest areas can be generated either manually or by using the auto segmentation features of the Screen Builder.
- Location Type: Two location types can be used in the Screen Builder: top-left or center. For the top-left location type, the “Location” attribute of the resource specifies the position of the top-left corner of the resource, while for the center location type, the “Location” attribute specifies the position of the center of the resource. The screen location type can be set from “Preferences → Screen → Location Type”.

The following sections describe the usage and properties of each resource type in detail.

8.1.1 Image Resource

To add an image resource onto a display screen, first make sure images are loaded into the Library Manager by clicking "Edit → Library Manager" from the application menu bar. In the Library Manager, select the "Image" tab and click the "Add" button to load in image files, or select the image files in Windows Explorer (Finder in macOS) and drag them into the Library Manager. The names of the image files to be imported should not contain spaces or non-ASCII characters.

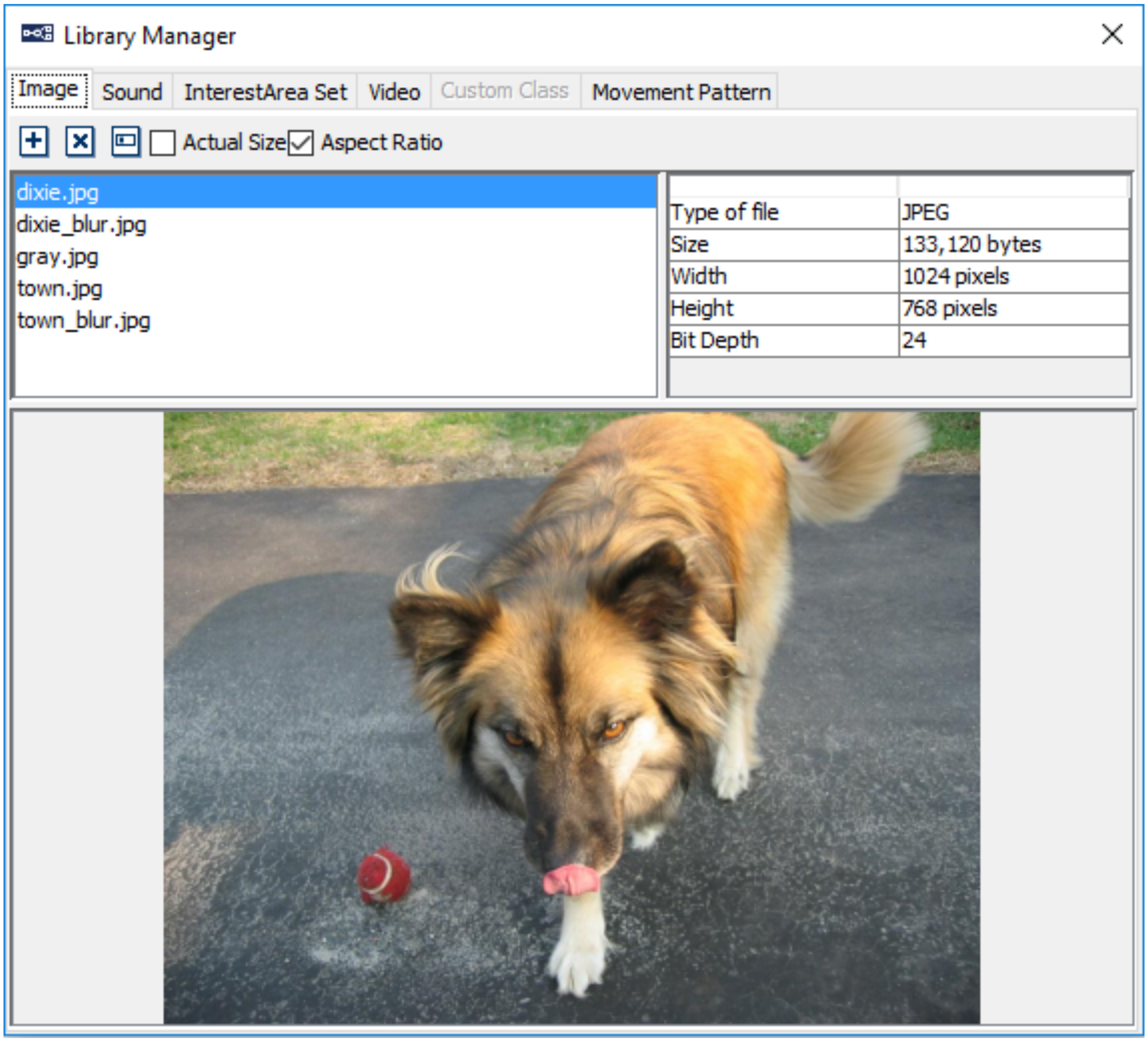


Figure 8-3. Loading Images into Image Library.

The panel on the right side of the Library Manager displays the properties of the images added to the library: type, file size, width and height, and bit depth.

- The following image file formats are supported in Experiment Builder: PNG, TIF, GIF, JPG, and BMP.
- Avoid using images with an excessive width or height value, as the size of the images can be displayed and the display performance depend on the hardware capability of the computer.
- Bit Depth indicates the number of bits used for each color component of a single pixel. Common image files have a color depth of 24-bit - each pixel has three components: red, green blue. Some .BMP and .PNG files come with a color depth of 32 - those images have an additional alpha channel (alpha of 255 is opaque while alpha of 0 is transparent). In the preview area of the Library Manager and Screen Builder, users can place the mouse on top of the image to read the RGBA value of the currently selected pixel. Note - transparency manipulations through the alpha

channel are supported only in version 2 of Experiment Builder when using the OpenGL graphics.

To add an image resource onto a display screen, click the “Insert Image Resource” button () on the Screen Builder toolbar, and then click anywhere in the workspace. Choose the desired image file in the “Select Image” dialog. The image will now be displayed in the Screen Builder.

To adjust the position of the image resource on the screen, click on the image resource and drag it to the intended location, then release the mouse button. The resource position can also be set from the value field of the “Location” property in the Property Panel.

Tip: The x, y coordinates of the current mouse cursor position will be displayed below the cursor if the mouse is left idle for a few seconds in the Screen Builder workspace.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the resource. The default label is “IMAGE_RESOURCE”.
Type #	NR		The type of screen resource (ImageResource)
Visible †	.visible	Boolean	Whether the resource should be visible. The default setting is True (box checked).
Screen Index #	.screenIndex	Integer	Index of the resource in the screen resource list (0 - n).
Position is Gaze Contingent †	.positionAtGazeContingent	Boolean	Whether the position of the resource is contingent on the gaze position. The default setting is False. This setting is only available when the parent display screen is contained inside a recording sequence.
Gaze Contingent Eye	.gazeContingentEye	String	Sets the eye used to provide data for the gaze-contingent drawing. Options are Left, Right, Either, Average, or Cyclopean (default setting). For a left-eye-only recording, data from the left eye is used when the gaze-contingency eye is set to “Left”, “Either”, or “Cyclopean”, and missing data when set to “Right” or “Average”. For a right-eye-only recording, data from the right eye is used when the gaze-contingency eye is set to “Right”, “Either”, or “Cyclopean”, and missing data when set to “Left” or “Average”. For a binocular recording, left eye data is used when the gaze-contingency eye is set to “Left” or “Either”, right eye data is used when set to “Right”, average data from both eyes if this is set to “Average” (with missing data if either either is missing), and average data from both eyes when set to “Cyclopean” (with missing data if both eyes are missing, and data from the remaining tracked eye if a single eye is

			missing).
Contingency Deadband	.contingentDeadband	Tuple of Integers	Sets the minimum amount of eye movement required to update the gaze-contingent moving window. This is designed to make the display drawing less susceptible to jitters in the eye position. Typically the deadband shouldn't be larger than 3.0 pixels—larger deadband values will likely result in a lag in updating the display.
Position is Mouse Contingent †	.positionAtMouseContingent	Boolean	Whether the position of the resource is contingent on the mouse position. The default setting is False.
Offset	.offset	Point	Adjustment of the resource position relative to the intended resource location, whether specified by the Location attribute, the current gaze or mouse position, or a movement pattern. The default value is (0, 0) for a perfect alignment of the resource position with the specified position. Values specified in the Offset will be subtracted from the specified location. For example, if the location field is set to (512, 384), and the offset is (100, 100), the actual resource position will be (412, 284).
Host Outline Color ¶	. hostOutlineColor	Color	The color of the box drawn on the host screen to show the position and dimensions of the current resource. This property is available only if the "Use for Host Display" option of the parent display screen action is enabled and the "Draw to EyeLink Host" property of the prepare sequence action is set to "Primitive".
Screen Location Type #	NR		Whether the location specified below refers to the top-left corner or center of the resource. This setting can be changed in "Screen Preferences".
Location	.location	Point	The coordinates of the top-left corner or center of the resource. If the Offset is non-zero, the actual screen position where the resource is displayed will be the coordinates set in the .location field minus the offset adjustment.
Width	.width	Integer	Intended width of the resource in screen pixels.
Height	.height	Integer	Intended height of the resource in screen pixels.
Movement Pattern ¶ *	NR		Movement pattern (sinusoidal or custom) of the resource.
Prebuild to Image †	.prebuildToImage	Boolean	Whether the resource should be built into an image when the experiment is built (instead of having it created during runtime). Uncheck this option only if you will need to supply the image file name during runtime (e.g., by using a variable or an equation, instead of referring to a data source column or using a static image file name).
Use Software	.useSoftwareSurf	Boolea	If unchecked, memory on the video card is used

Surface †	ace	n	to hold the resource (blitting from the video card memory to the display surface is fast). If checked, the system memory is used to hold the resource (blitting is slow as it is done by copying from RAM to display surface).
Clipping Location	.clippingLocation	Point	The coordinates of the top-left corner of the clipping region. If this is not set to (0,0), only the part of the image within the clipping region will be shown.
Clipping Width	.clippingWidth	Integer	Intended width (in pixels) of the clipping region of the resource. Only the part of the image within the clipping region will be shown.
Clipping Height	.clippingHeight	Integer	Intended height (in pixels) of the clipping region of the resource. Only the part of the image within the clipping region will be shown.
Clipping Area is Position Contingent †	.clippingAreaAtGazeContingent	Boolean	Whether the clipping region should be contingent on the mouse or gaze position. The default setting is False.
Source File Name ¶	.sourceFileName	String	The name of the image file. Make sure that the file name does not contain spaces or non-ASCII characters. The image(s) must be first loaded into the resource library.
Use Original Size †	.useOriginalSize	Boolean	If set to true, this will display the image in its original size; otherwise, the image may be stretched to the dimension set by "Width" and "Height" fields.
Lock Aspect Ratio	.lockAspectRatio	Boolean	This option is used to lock the aspect ratio of the actual image used (instead of the aspect ratio of the template image). If this is unchecked, users have the option of freely modifying the width and height of the image resources. If this is checked, users can freely adjust the "Width" value of the image resource, and the height of the resource will be calculated from the Width value and the aspect ratio of the image.
Use Fixed Pixel Area		Boolean	If this option is checked, the image size will be controlled by the "Total Image Pixel Area" attribute, and the "Width" and "Height" fields will be grayed out. If "Use Fixed Pixel Area" is unchecked, the size of the image will be controlled by the "Width" property based on the aspect ratio of the original image. This option is only available if the "Lock Aspect Ratio" option is enabled.
Total Image Pixel Area	.totalImagePixelArea	Integer	This option is only available if the "Total Image Pixel Area" option is checked. If set to 0 (default value), the image will be displayed in the original size. If set to another integer value, the image will be rescaled to constrain the total pixel area while maintaining the original aspect

			ratio.
Background Color	.backgroundColor	Color	Chromatic multiplier for the pixel values. Each of the RGBA channels of the source image multiplies the intensity of each channel of the background color. For example, color information will be fully preserved when a white background is used, pixels will only be rendered in a gray-scale version when a black background is used, and colors will appear muted when a gray background is used. Default is white so that all of the colors will be rendered. This option is available only in the OpenGL video environment.
Source Factor	.sourceFactor	Integer	In the OpenGL graphics, pixels can be drawn using a function that blends the incoming (source) red, green, blue, and alpha (RGBA) values with the RGBA values that are already in the frame buffer (the destination values). The "Source Factor" specifies how the red, green, blue, and alpha source blending factors are computed. The initial value is GL_SRC_ALPHA. This option is available only in the OpenGL video environment.
Destination Factor	.destinationFactor	Integer	This specifies how the red, green, blue, and alpha destination blending factors are computed. The default value is GL_ONE_MINUS_SRC_ALPHA. This option is available only in the OpenGL video environment.
Use Color Key		Boolean	Whether image transparency should be rendered through the color-keying method. That is, a specific color in the image is designated as the transparent color. Any pixel in the image with the RGB color that matches the transparency color will not be rendered, so the background pixels show through instead. This option, available only in the OpenGL video environment, is equivalent to using the “Transparency Color” in the DISPLAY device in the DirectDraw graphics. This field should be used if the image doesn’t contain the built-in alpha channel; otherwise uncheck this option to perform transparency using the image's alpha channel.
Color Key	.colorKey	Color	This sets an intended color key so the transparency of the image resource can be manipulated. This option is only available when the OpenGL video environment is used and the "Use Color Key" option of the image resource is enabled.

Ignore Alpha	.ignoreAlpha	Boolean	If the "Ignore Alpha" option is unchecked (default setting), the alpha channel of the image resource will be used to render image transparency. When an image is overlaid onto another image, the alpha value of the source (foreground) color is used to determine the resulting color. If the alpha value is transparent, the source color is invisible, allowing the background color to show through. If the "Ignore Alpha" option is checked, the alpha channel data in the image will be ignored. This is option is available only in the OpenGL video environment.

8.1.1.1 Image Displaying Modes

Image Resources in Experiment Builder allow users to display images in their original size, or scaled or stretched to specified dimensions.

1) To display the images in their original size, check the “Use Original Size” property of the image resource. Enabling that field will make the following attributes read-only: “Width”, “Height”, “Clipping Location”, “Clipping Width”, “Clipping Height”, and “Clipping Area is Gaze Contingent”.
2) To stretch all images to a fixed width and height, first make sure that the “Use Original Size” field of the image resource is unchecked, then set the “Width” and “Height” properties to the desired values. If only a portion of the image is to be shown, set the “Clipping Location”, “Clipping Width” and “Clipping Height” attributes. By default, the Clipping Location is (0,0), and the Clipping Width and Height are the same as the image Width and Height. The Clipping Location is relative to the top-left corner of the image.
3) To stretch the images to different dimensions, add two columns in the experiment data source to specify the desired width and height of the image. Refer the “Width”, “Height”, “Clipping Width”, and “Clipping Height” properties of the image resource to the two columns created in the data source. See the “PICTURE” template for an example.

The “Screen Location Type” attribute of the image resource indicates the current location coordinates type. The location type can be set in the Preferences menu in the “Location Type” property of the “Screen” node.

1) “Center” positioning makes it easy to display images in the center of the screen. To center an image resource, select the resource, then click the horizontal center alignment and vertical center alignment ( ) buttons on the Screen Editor toolbar. If the image should be center-aligned to a different position, enter the desired coordinate values in the Location field of the image resource.
2) “TopLeft” positioning can be used if the top-left corner of all images is aligned to a specific (x, y) location. Simply enter the desired (x, y) position in the Location field of the image resource.

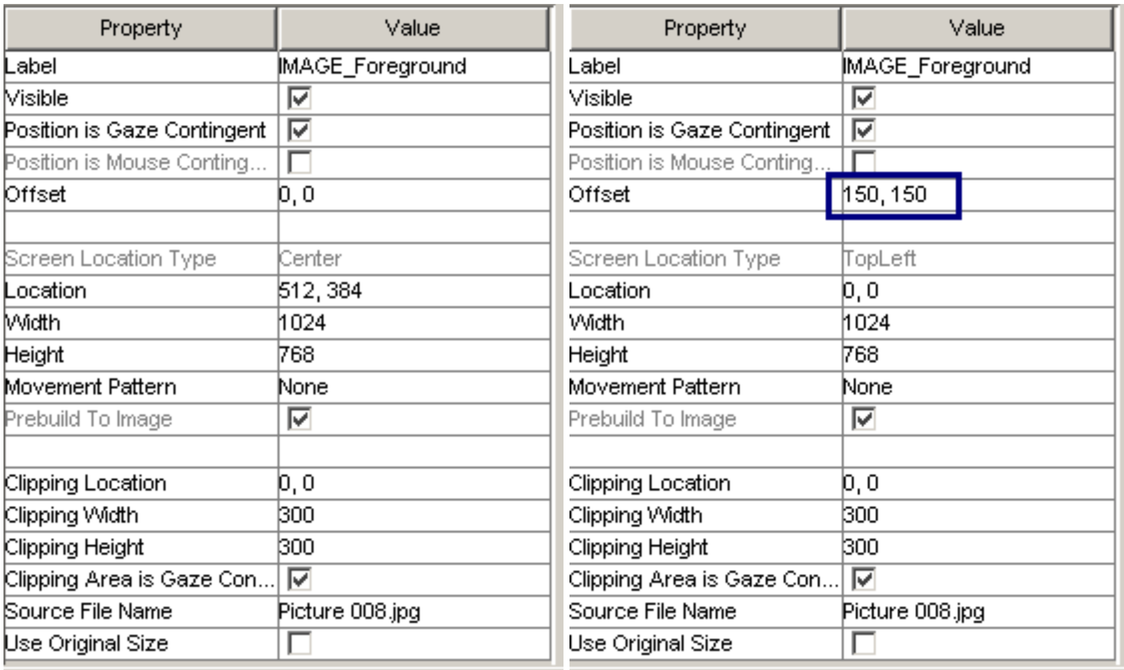
Please note that users should determine the “Location Type” for the project before working on any resources, as changing the location type in the middle of the experiment creation process may cause some undesired behaviors.

8.1.1.2 Gaze-Contingent Window Manipulations

To create a gaze-contingent window manipulation, add two full-screen images to the display screen, one as the “background”—the part of the image to be displayed outside of the gaze-contingent window—and the other one as the “foreground—the part of the image to be displayed in the window. Add the background image resource first, followed by the foreground image resource, so the foreground image is drawn in front of the background. Alternatively, to ensure the foreground image is drawn over the background, right-click the foreground image and select “Order > Bring Forward” (see Section 8.4.6 on setting the order of resources).

Make sure the two image resources are set to the same Location to ensure they overlap properly, either by specifying the same Location for both resources, or by using the horizontal and vertical alignment buttons. For the foreground image, then make sure the “Position is Gaze Contingent” and “Clipping Area is Gaze Contingent” boxes are checked. Note that these two attributes will only be available when the display screen is contained in a Recording sequence; otherwise, they will be grayed out. Set the “Clipping Width” and “Clipping Height” properties (in pixels) of the foreground image to specify the size of the central window. See the “GCWindow” template for an example.

With the Screen Location set to Center, the gaze-contingent clipping area will be centered on the gaze position (see the left panel of Figure 8-4). If the Screen Location is set to TopLeft, the “Offset” attribute of the foreground image should be set to half the clipping area width and height, respectively, to ensure the clipping area is centered on the gaze position (see the right panel of Figure 8-4).



Property	Value
Label	IMAGE_Foreground
Visible	☑
Position is Gaze Contingent	☑
Position is Mouse Conting...	☐
Offset	0, 0
Screen Location Type	Center
Location	512, 384
Width	1024
Height	768
Movement Pattern	None
Prebuild To Image	☑
Clipping Location	0, 0
Clipping Width	300
Clipping Height	300
Clipping Area is Gaze Con...	☑
Source File Name	Picture 008.jpg
Use Original Size	☐

A

Property	Value
Label	IMAGE_Foreground
Visible	☑
Position is Gaze Contingent	☑
Position is Mouse Conting...	☐
Offset	150, 150
Screen Location Type	TopLeft
Location	0, 0
Width	1024
Height	768
Movement Pattern	None
Prebuild To Image	☑
Clipping Location	0, 0
Clipping Width	300
Clipping Height	300
Clipping Area is Gaze Con...	☑
Source File Name	Picture 008.jpg
Use Original Size	☐

B

Figure 8-4. Setting Different Location Types for Images Used in a Gaze-Contingent Window Application.

8.1.1.3 Transparency Manipulation

The Windows version of Experiment Builder uses either the OpenGL or DirectDraw graphics engine whereas the macOS version uses the OpenGL graphics only. When using the DirectDraw graphics, the transparency manipulation is done through color keying. That is, Experiment Builder specifies a particular color to be transparency color (defined in “Transparency Color” of the “Display Device”). When the graphics engine does the drawing on the screen, it checks for what to draw and what not to draw based on the transparency color—when drawing an image on top of a background, the portion of the image matching the transparency color will not be drawn, and as a result, the background will be seen through. With the color keying approach, you usually only have fully transparent or fully opaque colors.

For the OpenGL graphics in Windows or macOS, the color keying approach will still work (ticking the “Use Color Key” option of the image and then specify the appropriate transparent color in the “Color Key” property). Another option is to use the alpha channel, if properly encoded in the images. This works by encoding the transparency information in a separate color channel (i.e., RGBA instead of RGB). When an image is overlaid onto another image, the alpha value of the source (foreground) color is used to determine the resulting color. If the value of the alpha channel is transparent, the source color is invisible, allowing the background color to show through. Alpha values can range from 0-255, allowing 255 different levels of transparency. To render transparency through the alpha channel, make sure both the “Use Color Key” and “Ignore Alpha” options of the image resource are unchecked. Also make sure the image files are properly prepared—the images are usually in .png format, and the "Bit Depth" of the image reported in the image Library Manager should be 32 instead of 24.

8.1.2 Video Resource

The Video Resource ( ) is used to present a video clip in a display screen. Experiment Builder uses a custom-developed video display engine for video clip playback, specifically designed to allow access to the msec time that each frame of the video is displayed (the start of the first retrace that contained the frame data on the display) while the operating system is running in real-time mode. For optimal video playing performance, the display computer (Windows or macOS) should have a fast CPU processor, at least 4 GB of RAM, a video card with at least 1.0 GB of memory and OpenGL 2.0 support. A SSD hard drive is also recommended for fast video data transfer.

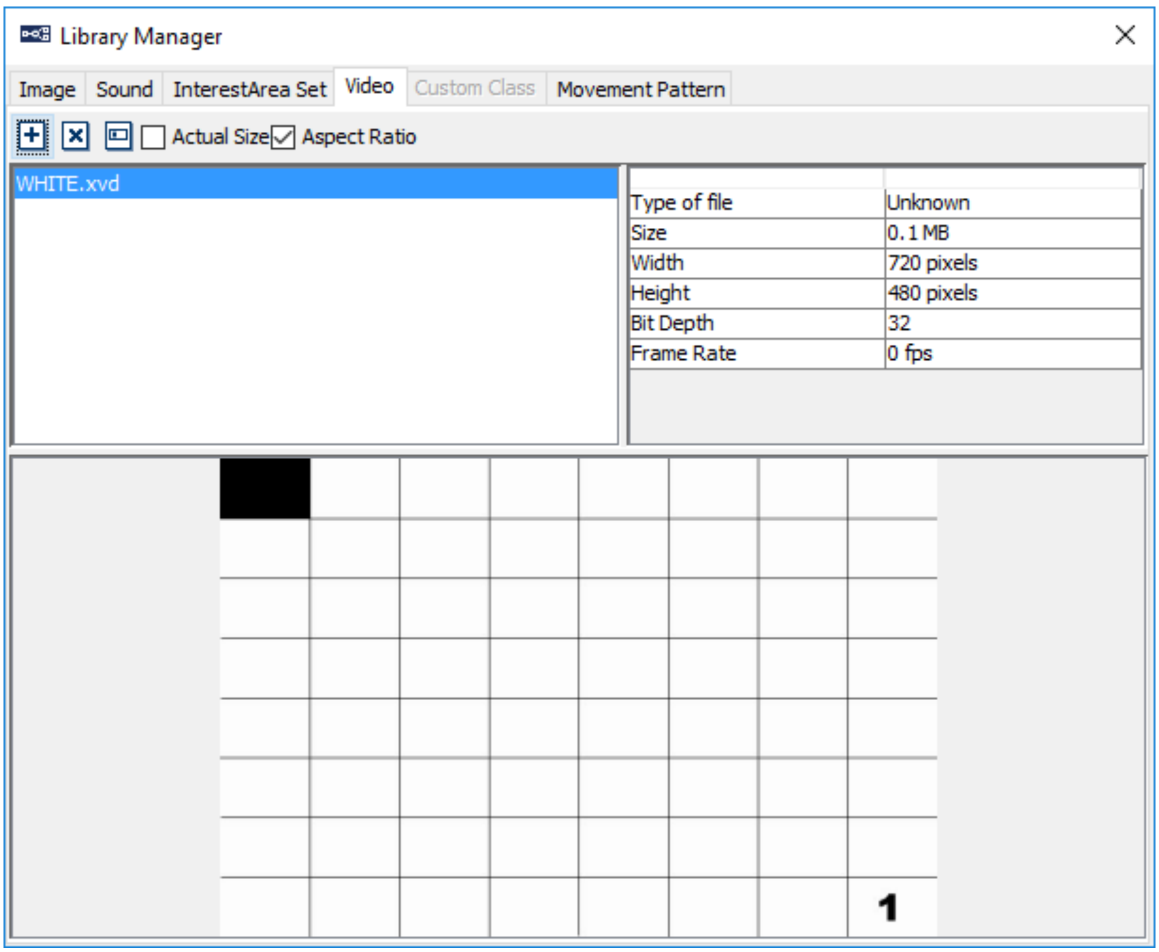


Figure 8-5. Loading Video Clips into Video Library.

Experiment Builder uses ffmpeg library for video presentation. Experiment Builder supports playing of video clips in the .mov, .mp4, and .xvd file formats on both Windows and macOS. Playback of video clips in the .avi file format may depend on the operating system used and the availability of the required codecs; as a result users should first convert those video clips using the Split AVI tool that comes with the Experiment Builder software or another video conversion tool (preferably in "Xvid MPEG codec"; see discussion in section 8.1.2.7 "Video Codec"). Note that if a video clip contains both audio and video streams, the video resource will only play the video part—the audio must be played separately, using a Play Sound action or the "Synchronize Audio" property of the Display Screen (see section 8.1.2.8 "Playing Video Clips with Audio").

Any video clips must be added to the video library before they can be used in the experiment. To add a video resource to a display screen, click the "Insert Video Resource" button ( ) on the Screen Builder toolbar, then click anywhere in the Screen Builder workspace. Choose the desired video file in the "Select Video" dialog. The first frame of the video will now be displayed on the screen.

The following table lists the properties of a video resource.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the video resource. The default label is "VIDEO_RESOURCE".
Type #	NR		The type of screen resource (VideoResource).
Visible †	.visible	Boolean	Whether the resource should be visible. The default setting is True (box checked).
Screen Index #	.screenIndex	Integer	Index of the resource in the screen resource list (0 - n).
Position is Gaze Contingent †	.positionAtGazeContingent	Boolean	Whether the position of the resource is contingent on the gaze position. The default setting is False. This setting is only available when the parent display screen is contained inside a recording sequence.
Gaze Contingent Eye	.gazeContingentEye	String	Sets the eye used to provide data for the gaze-contingent drawing. Options are Left, Right, Either, Average, or Cyclopean (default setting). For a left-eye-only recording, data from the left eye is used when the gaze-contingency eye is set to "Left", "Either", or "Cyclopean", and missing data when set to "Right" or "Average". For a right-eye-only recording, data from the right eye is used when the gaze-contingency eye is set to "Right", "Either", or "Cyclopean", and missing data when set to "Left" or "Average". For a binocular recording, left eye data is used when the gaze-contingency eye is set to "Left" or "Either", right eye data is used when set to "Right", average data from both eyes if this is set to "Average" (with missing data if either is missing), and average data from both eyes when set to "Cyclopean" (with missing data if both eyes are missing, and data from the remaining tracked eye if a single eye is missing).

Contingency Deadband	.contingentDeadband	Tuple of integers	Sets the minimum amount of eye movement required to update the gaze-contingent moving window. This is designed to make the display drawing less susceptible to jitters in the eye position. Typically the deadband shouldn't be larger than 3.0 pixels - larger deadband values will likely result in a lag in updating the display.
Position is Mouse Contingent †	.positionAtMouseContingent	Boolean	Whether the position of the resource is contingent on the mouse position. The default setting is False.
Offset	.offset	Point	Adjustment of the resource position relative to the intended resource location, whether specified by the Location attribute, the current gaze or mouse position, or a movement pattern. The default value is (0, 0) for a perfect alignment of the resource position with the specified position. Values specified in the Offset will be subtracted from the specified location. For example, if the location field is set to (512, 384), and the offset is (100, 100), the actual resource position will be (412, 284).
Host Outline Color ¶	. hostOutlineColor	Color	The color of the box drawn on the host screen to show the position and dimensions of the current resource. This property is available only if the "Use for Host Display" option of the parent display screen action is enabled and the "Draw to EyeLink Host" option of the prepare sequence action is set to "Primitive".
Screen Location Type #	NR		Whether the location specified below refers to the top-left corner or center of the resource. This setting can be changed at "Screen Preferences".
Location	.location	Point	The coordinates of the top-left corner or center of the resource. If the Offset is non-zero, the actual screen position where the resource is displayed will be the coordinates set in the .location field minus the .offset adjustment.
Width #	.width	Integer	Width of the video resource (in pixels).
Height #	.height	Integer	Height of the video resource (in pixels).
Movement Pattern ¶ *	NR		Movement pattern (sinusoidal or custom) of the resource.
Use Software Surface #	.useSoftwareSurface	Boolean	Always true for Video Resources.
Clipping Location	.clippingLocation	Point	The coordinates of the top-left corner of the clipping region. If this is not set to (0,0), only the part of the video within the clipping region will be shown.
Clipping Width	.clippingWidth	Integer	Intended width (in pixels) of the clipping region of the resource. Only the part of the video within the clipping region will be shown.
Clipping Height	.clippingHeight	Integer	Intended height (in pixels) of the clipping region

			of the resource. Only the part of the video within the clipping region will be shown.
Clipping Area is Position Contingent †	.clippingAreaAtGazeContingent	Boolean	Whether the clipping region should be contingent on the mouse or gaze position. The default setting is False.
Play Count	.playCount	Integer	Total number of times the video clip will be played when the display screen is shown. If 0, the clip will be played continuously in a loop.
Frame List	.frameList	List	**XVID video clips:** The intended frames of the video clip to be played. If set to [1--1] (i.e., from the first frame 1 to the last frame -1), the whole clip will be played. Since XVID does not support frame seeking, the first value must be 1, while the end frame can be configured as desired (e.g., to play the first 100 frames, enter "[1-100]"). **ffmpeg encoded clips (e.g., .mov, .mp4) or VFW video clips:** Specifies the frame list (frame number and/or ranges of frames) that should be played for the video. Ranges of frames and frame indexes can be in any order. For example, [1-50,52-100,99-50,50,50] would start to play frames 1 -50, skip frame 51, play frames 52-100, then play frames 99-50 (i.e. backwards), then hold frame 50 for 2 more frames. Note that the performance of presenting non-sequential frames or presenting frames in reverse order will be strongly influenced by the video codec used and the specifications of the display computer. Performance will generally be worse than when playing the video in the standard, first-to-last frame order.
Video Loader	.videoLoader	String	The codec used to the play the video clips. In general, users are recommended to use the "Default" option, as the software will automatically choose the video loader for you based on the file extension. In macOS, the supported video loader options are Default, ffmpegLoader (ideal for most .avi, .mp4, .mov clips), and xvidloader (ideal for most .xvid clips). In Windows, the supported video loader options are Default, ffmpegLoader (ideal for most .mp4, .mov files), vfwloader (ideal for most .avi clips), and xvidloader (ideal for most .xvid clips).
Source File Name ¶	.sourceFileName	String	The name of the video resource file. The video resource must first be loaded into the resource library.
Frame Rate	.frameRate	Float	Intended number of frames (default is 30.0) to

			be displayed each second (typically 30 frames per second for NTSC or 25 frames per second for PAL formatted video). Video playback can be paused by setting the frame rate to 0 and unpaused by setting the frame rate to a value greater than 0. Note that a frame rate higher than the screen refresh rate is not supported by Experiment Builder.
Apply Transparency	.applyTransparency	Boolean	When checked, applies a transparency manipulation to the video - pixels with the same color value as the transparency color will not be drawn. In most cases it is best to leave this in its default setting (unchecked).
Is Playing #	.isPlaying	Boolean	Whether the video clip is playing. Returns “True” if the clip playing is still in progress, and “False” if the playing has stopped or hasn’t started yet.
Current Frame Number #	.currentFrameNumber	Integer	The currently processed frame number. This may not be the currently visible frame on the screen. Increases by one for every frame presented.
Current Frame Index #	.currentFrameIndex	Integer	The currently processed frame index. This should be identical to "Current Frame Number" for a non-looping video. For video played in a loop, this reports the relative frame position in a clip (i.e., a number between 1 and last frame of the video clip).
Next Frame Number #	.nextFrameNumber	Integer	The index number of next frame to be flipped (shown on the screen).
Last Frame Number #	.lastFrameNumber	Integer	The last frame that has been flipped.
Last Frame Time #	.lastFrameTime	Float	The time of the last frame that has been flipped.
Next Frame Desired Time #	.nextFrameDesiredTime	Float	Predicted time when the next frame is flipped.
Displayed Frame Count #	.displayedFrameCount	Integer	Reports the number of frames displayed (not including dropped frames).
Dropped Frame Count #	.droppedFrameCount	Integer	Reports the number of dropped frames.
Frames Per Second #	.FPS	Float	Frames per second calculated as (displayed frames/(duration played in msec/1000))
Duration #	.duration	Float	Duration (in milliseconds) into clip playback. When the playback ends, the duration may be calculated as (@self.displayedFrameCount-1@)/@self.frameRate@. If the video has been paused during playback, the reported duration is calculated from the start to the end of the video, including the pause duration.
Is Completed	.isCompleted	Boolean	Whether the video playback has completed. Reports False before or during video playback,

			and True after playback.
Is Paused	.isPaused	Boolean	Whether the video playback is paused. Reports True if playback is paused, and reports False if playback is ongoing, as well as before and after playback.

8.1.2.1 Reading Frame Time

Experiment Builder can record the time of each frame in the EDF or message file. This can be done by adding the following message to the Message field of the Display Screen:

```
= "Display "  + str(@self.VIDEO_RESOURCE.lastFrameNumber@) + "*CRT*" +
str(@self.VIDEO_RESOURCE.currentFrameNumber@)
```

Output like the following will be written to the EDF:

MSG 8046616 -8 Display 30*CRT*31.

The above sample output shows that at the message time (8046616), the visible frame should be 30 (Last Frame Number), and frame 31 (Current Frame Number) will appear at 8046616 + 8 = 8046624. This flip event also updates frame count and index number, and the associated frame time. After this flip, Experiment Builder processes frame number 32, the next frame to be flipped, with the last flipped frame now set to 31.

8.1.2.2 Video Frame Timing

Experiment Builder decodes each frame of the video in advance and attempts to present the frame at the desired time. The desired display time for a frame is calculated as:

```
desired_frame_time = video_start_time + (frameNumber * 1000.0 / frameRate)
```

where video_start_time is the millisecond time that the first frame of the video was presented, frameNumber is the number of the frame to be presented, and frameRate is the number of frames to display per second. For example, assume the first frame of a video was presented at time T and the frame rate of the video is 30 frames per second. The desired display time for frame 100 would therefore be T + 3333.33 msec.

However, the video frame will likely not be able to be presented at the exact time that is desired, and will instead have an actual display time that is slightly different than the desired frame time. Two main factors can influence the offset between the desired and actual display time for a video frame:

1) Interaction between the display monitor's retrace rate and the video's frame rate. Video frames can only be presented at intervals that are a multiple of the monitor's retrace rate. If the monitor retrace rate and video frame rate are not evenly divisible, then the desired and actual frame display times can be offset by up to one display retrace (e.g., 16.67 msec at 60 Hz).

2) Duration of decoding and displaying the video frame. If the computer hardware used to run the video presentation is not able to decode and display frames fast enough, there may be delays in the frame presentation. If the delay is greater than a frame's duration (e.g., 33.33 msec for a 30 fps video), then a video frame can actually be dropped, increasing the dropped frame count for the video resource.

8.1.2.3 Video Frame Rate and Display Retrace Rate

It is important to know how the nominal frame rate of the video file interacts with the monitor video refresh rate to determine the actual time point at which a frame is displayed. As described above, a video frame's desired display time is equal to:

```
desired_frame_time = video_start_time + (frameNumber*1000.0/frameRate)
```

The video frame's actual display time, assuming the display computer hardware is capable of presenting the video without dropping frames, can be conceptualized as:

```
actual_frame_time = nearestRetraceTo(desired_frame_time)
```

where nearestRetraceTo calculates the display retrace start time that is closest to the desired_frame_time provided to the function.

Take the following Figure 8-6 for an example. If a video clip has a nominal frame rate of 30 fps (one frame every 33.33 ms, blue bars) but the hardware video refresh rate is 85 Hz (one refresh every 11.765 ms, green bars) then the two different update intervals are not multiples of each other. Assuming a video start time of 0, the second frame would have a desired display time of 33.33 ms, but the nearest retrace to the desired time is at time 35.29 msec (retrace rate * 3), which would be the actual time that the frame is displayed.

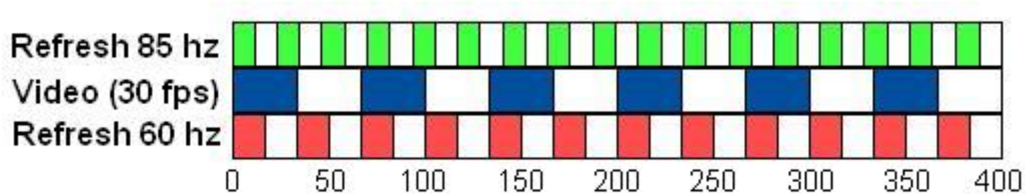


Figure 8-6. Video Frame Rate and Display Retrace Rate.

This suggests that it will be ideal to run a video experiment with the vertical refresh rate being an integer multiple of the frame rate. For practical purposes, that would mean a refresh rate of either 60 Hz (see the red bars), 90 Hz, 120 Hz, or 150 Hz for a video clip playing at 30 frames per second. Refresh rates between integer multiples of the frame rate (75 Hz, for example, with a 30 fps clip) will cause increased variability in the offset between actual and desired video frame display times.

In reality, the refresh rate of a 60 Hz or 120 Hz monitor may be slightly off. For instance, the actual refresh rate of a monitor running at 60 Hz could be 60.01 Hz. This means that even when using a retrace rate that is a multiple of the frame rate, some small drift between actual and desired frame display times can occur during the course of video presentation. If this drift between the actual and desired frame display times approaches one display retrace, the video playing engine corrects for the drift by displaying the current video frame for a duration slightly less than the full frame duration.

8.1.2.4 Pausing, Unpausing, and the Status of Video Playing

Video playback can be paused by setting the frame rate of the video resource to 0 using an UPDATE_ATTRIBUTE action (see Figure 8-7); video clip can be unpaused by setting the frame rate back to the original frame rate. The current status of the video play can be checked by using the ".isPaused" property of the resource; use the ".isCompleted" property to check whether the video play ends. The duration of the video play is reported relative to the onset of the first frame of the video clip.

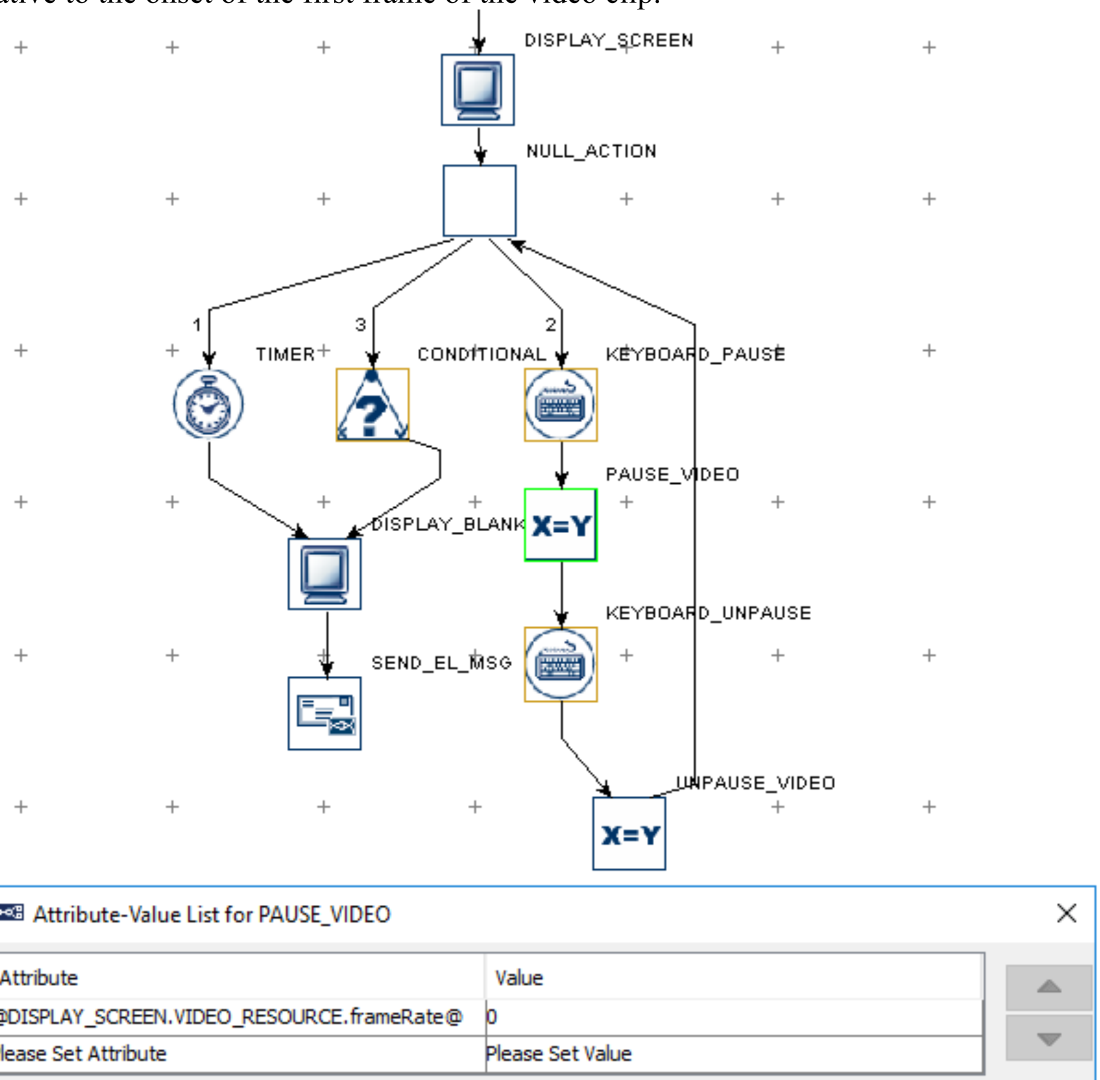


Figure 8-7. Pausing and Unpausing Video Play

8.1.2.5 Dropping Frames

The term "dropping frames" refers to a situation in which a frame or set of frames was not displayed on the screen. Dropped frames indicate that the display computer hardware is not able to keep up with the requested frame rate for the video resource. Experiment Builder will drop a frame if the actual display time for that frame is estimated to be equal to or greater than the desired display time of the upcoming frame. If the video playback performance is very poor, this may result in several frames being dropped in a row.

If a frame is dropped, the "Dropped Frame Count" will be increased in the video resource object. Furthermore, a warning message is printed to the console and to the warnings.log file indicating the occurrence of the frame drop and the index of the dropped frame. You can also detect dropped frames by looking at the display screen messages. If a frame is dropped, no frame display message will be written to the data file, and therefore a discontinuity will be present in the message stream.

To minimize the likelihood of seeing dropped frames when playing video clips, try the following:

- get a high performance display computer with a fast CPU, a large amount of RAM and video card memory, and a fast SSD hard drive
- follow the steps for maximizing the real-time performance of the computer (see section 3.1.2)
- if possible, reduce the resolution of the video clip
- increase the "Video Frame Cache Size" of the Display Device (see section 8.1.2.6)
- re-encode the video clips with another codec

8.1.2.6 Frame Caching

To help ensure smooth video presentation, Experiment Builder caches a certain number of video frames in memory. By decoding frames in advance, the software does not have to wait for the decoding of the next frame before it can be displayed on screen and thus reduces the chances of frame dropping.

The maximum number of frames cached in advance for video resources is specified in the Display Device settings under the "Video Frame Cache Size" property. The cache size can be set to between 5 and 60 frames (5 by default). If playing high-resolution videos on a computer with plenty of video card memory, setting the cache size to an intermediate value (e.g., 25 frames) can improve playback. However, a large frame cache size results in a larger amount of system memory use. This can cause a longer initial preparation time for the video resources, increasing the execution delay of the Prepare Sequence action. A larger frame cache size and increased system memory usage can also cause the overall system performance to degrade if there is not enough physical RAM to hold the frame caches.

8.1.2.7 Video Codec

In Windows, Experiment Builder supports video clips with the .xvd, .mov, and .mp4 file formats, and .avi files compatible with the VFW (video for windows) or ffmpeg specifications. In macOS, Experiment Builder supports files with .xvd, .mov, and .mp4 encoding, and .avi files encoded with the ffmpeg codec.

Users can add .mov, .mp4, or .xvd video clips directly into the Library Manager and then display them through a Video Resource in a Display Screen action. The .avi file format is a container for several types of video clips encoded in different codecs, so video clips in the .avi file format should be re-encoded into the .xvd format using the Split AVI tool packaged with Experiment Builder. When converting the .avi files with Split AVI, set the “Video Codec” in the preferences to “Xvid MPEG-4 Codec” in Windows, or “Xvid Encoder” in macOS (see "Video Experiments" in the html version of this document.) The "Xvid MPEG-4 codec" is not installed by default in Windows, so before using Split AVI, install the codec by running the "Xvid-Install.exe" driver contained in the "Program Files (x86)\SR Research\3rdparty" folder (for 64-bit Windows; for 32-bit Windows it will be under "Program Files\SR Research\3rdparty").

If not properly configured, the Split AVI tool may occasionally drop the last frame during conversion when using the Xvid MPEG-4 codec. Before converting the videos, make sure the “B-VOPs” option, used to control the between-frames compression, is unchecked (see the figure below).

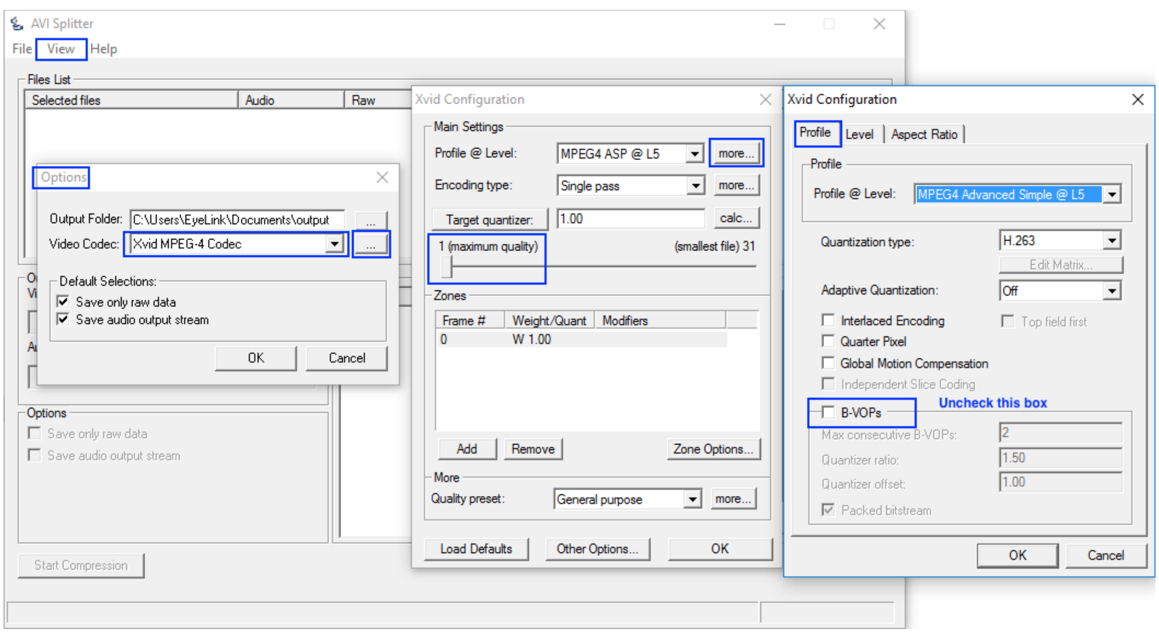


Figure 8-8. Xvid Configuration.

If Split AVI displays an error message "Failed to connect source pin to video. No combination of intermediate filters could be found to make the connection”, this typically indicates the computer does not have the right combination of filters installed to properly decode and re-encode your videos. The issue can often be fixed by installing FFDshow, a DirectShow filter and VFW codec that supports many audio and video formats. The FFDshow installer can be found in the “C:\Program Files (x86)\SR

Research\3rdParty\ffdshow" directory (in 64-bit Windows; "C:\Program Files\SR Research\3rdParty\ffdshow" in 32-bit Windows).

Split AVI may also be used to encode video files into the VFW format by choosing one of the other video codecs from the compressor list, but not all VFW video files can be recognized and loaded into the Library Manager. In addition, the performance of video files converted by different video codecs varies. Users may try installing DivX (http://www.divx.com/divx/play/download/) for VFW codecs with good performance.

Version 3.1 or later of EyeLink Data Viewer supports the .xvd, .mp4, and .mov codecs in the Animation Playback View. Support for the playback of.avi clips in Data Viewer is heavily dependent on the availability of the video codec. In general, users are advised not to use .avi files in the Experiment Builder project if they need to play back the video clips during data analysis.

If users deploy the experiment project and run it on a different deployment computer, please make sure that codec used to test run the video experiment is also installed on the deployment computer as well; otherwise, the deployed experiment will not run.

8.1.2.8 Playing Video Clips with Audio

For a video clip that contains both audio and video streams, the video resource will only play the video part—the audio must be played separately, using a Play Sound action or the "Synchronize Audio" property of the Display Screen. For.avi video clips with audio, the "Split AVI" program can be used to split the video stream from the audio stream in the original video file and save them into two separate files: a video file and a .wav file containing the audio. To split the audio stream without re-encoding the video, check the "Extract Audio Only" option in the configuration dialog box (through "View -> Options"; see the figure below).

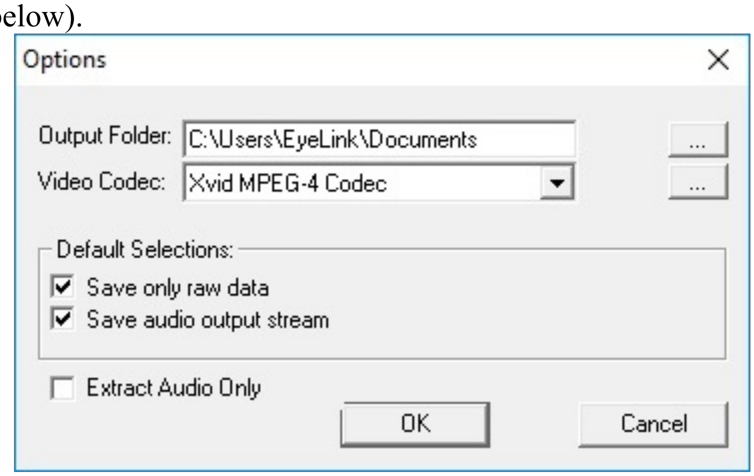


Figure 8-9. Extracting Audio Only from the Video Clip.

To play the video and audio together, use a Display Screen action to show the video stream, and use either a Play Sound action, or the "Synchronize Audio" option of the

Display Screen action to play the audio stream. To synchronize the playback of the video and audio streams, we recommend using the ASIO Audio Driver on Windows or the OS X Audio Driver on Mac to play the audio file. To configure the Audio Driver, click the Devices tab of the Structure panel, and select the "AUDIO" device. On a Windows PC with a supported ASIO-compatible sound card, please make sure the ASIO driver is installed correctly (follow the instructions in the HTML version of this manual under "Installation → Windows PC System Requirements → ASIO Card Installation"). Once the ASIO driver has been selected, double click the Display Screen action used to show the video, and enable the "Synchronize Audio" option. Then select a .wav file from the project library to play with the video. Set the "Sound Offset" to 0 for synchronized audio and video playback. To ensure the audio and video presentation are synchronized, make sure to set the "Frame Rate" property of the Video Resource to the actual framerate(s) of the original video clips. If the framerate is not set properly, the video will play at a different speed than the audio.

If precise audio/video synchronization is not critical to your experiment, or you do not have an ASIO sound card on your display computer, you can alternatively use a separate PLAY_SOUND action right before the DISPLAY_SCREEN action that displays the video, and have the PLAY_SOUND action play the associated .wav file for the video clip. This method will work with any audio card when the AUDIO device is in DirectX driver mode, but will not result in precise synchronization between the audio and video.

8.1.3 Text Resource

The Screen Builder includes two different resources that may be used to add text to a display screen. The Text Resource will present a single line of text, and the Multi-Line Text Resource (discussed in the next section) can present text across multiple lines. To add a Text Resource onto a display screen, click the "Insert Text Resource" button (A) on the Screen Builder toolbar and click at the desired position in the workspace where the text resource will be placed.

To edit the text, double click the resource. A text-editing cursor will appear and users can type text directly in the Screen Builder. The text can also be edited from the value field of the "Text" property in the property panel. Users can either enter the text directly in the text editor or click the right end of the value field to bring up the […] button, then click this button to bring up an attribute editor dialog box. Various aspects of text appearance can be modified, including color, font name, style, and size.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the resource ("TEXT_RESOURCE" by default).
Type #	NR		The type of screen resource (TextResource)
Visible †	.visible	Boolea n	Whether the resource should be visible (True by default).
Screen Index #	.screenIndex	Integer	Index of the resource in the screen resource list (0 - n).
Position is Gaze	.positionAtGazeC	Boolea	Whether the position of the resource is

Contingent †	ontingent	n	contingent on the gaze position. The default setting is False. This setting is only available when the parent display screen is contained inside a recording sequence.
Gaze Contingent Eye	.gazeContingentE ye	String	Sets the eye used to provide data for the gaze-contingent drawing. Options are Left, Right, Either, Average, or Cyclopean (default setting). For a left-eye-only recording, data from the left eye is used when the gaze-contingency eye is set to “Left”, “Either”, or “Cyclopean”, and missing data when set to “Right” or “Average”. For a right-eye-only recording, data from the right eye is used when the gaze-contingency eye is set to “Right”, “Either”, or “Cyclopean”, and missing data when set to “Left” or “Average”. For a binocular recording, left eye data is used when the gaze-contingency eye is set to “Left” or “Either”, right eye data is used when set to “Right”, average data from both eyes if this is set to “Average” (with missing data if either is missing), and average data from both eyes when set to “Cyclopean” (with missing data if both eyes are missing, and data from the remaining tracked eye if a single eye is missing).
Contingency Deadband	.contingentDeadb and	Tuple of Integer s	Sets the minimum amount of eye movement required to update the gaze-contingent moving window. This is designed to make the display drawing less susceptible to jitters in the eye position. Typically the deadband shouldn’t be larger than 3.0 pixels—larger deadband values will likely result in a lag in updating the display.
Position is Mouse Contingent †	.positionAtMouse Contingent	Boolea n	Whether the position of the resource is contingent on the mouse position. The default setting is False.
Offset	.offset	Point	Adjustment of the resource position relative to the intended resource location, whether specified by the Location attribute, the current gaze or mouse position, or a movement pattern. The default value is (0, 0) for a perfect alignment of the resource position with the specified position. Values specified in the Offset will be subtracted from the specified location. For example, if the location field is set to (512, 384), and the offset is (100, 100), the actual resource position will be (412, 284).
Host Outline Color ¶	. hostOutlineColor	Color	The color of the box drawn on the host screen to show the position and dimensions of the current resource. This property is available only if the "Use for Host Display" option of the parent display screen action is enabled and the "Draw

			to EyeLink Host" of the prepare sequence action is set to "Primitive".
Screen Location Type #	NR		Whether the location specified below refers to the top-left corner or center of the resource. This setting can be changed in "Screen Preferences".
Location	.location	Point	The coordinate of the top-left corner or center of the resource.
Width #	.width	Integer	Width of the resource (in pixels).
Height #	.height	Integer	Height of the resource (in pixels).
Movement Pattern ¶ *	NR		Movement pattern (sinusoidal or custom) of the resource
Prebuild to Image †	.prebuildToImage	Boolean	Whether the resource should be built into an image when the experiment is built (instead of having it created during the actual execution of the trial). **IMPORTANT:** If the "Prebuild to Image" option is turned off, the run-time resource rendering may not look exactly as it does in the screen editor. In addition, images will not be saved to support Data Viewer overlay.
Use Software Surface †	.useSoftwareSurface	Boolean	If unchecked, memory on the video card is used to hold the resource (blitting from the video card memory to the display surface is fast). If checked, the system memory is used to hold the resource (blitting is slow as it is done by copying from RAM to display surface).
Font Color	.fontColor	Color	Color in which the text is drawn. The default color is Black (0, 0, 0).
Font Name ¶	.fontName	String	Specifies the typeface name of the font. Font Name can be selected from a dropdown list by clicking the Value cell of this property. The default font is "Times New Roman". When transferring project from one computer to another, please ensure the target computer has this font installed.
Font Style ¶	.fontStyle	String	Sets whether the text is to be rendered using a normal, italic, or bold face.
Font Size	.fontSize	Integer	Sets the desired font size (20 by default). Please note that text of the same font size will look smaller (by a factor of about 1.33) on macOS than on Windows due to different default DPI values used across the two operating systems.
Underline †	.underline	Boolean	Underlines the text if checked.
Text	.text	String	Text to display onscreen.
Use Runtime Word Segment Interest Area * †	.useRuntimeIAS	Boolean	If enabled, an Interest Area set file will be created during runtime to provide segmentation for individual words. The segmentation parameters can be configured in the "Screen ->

			Built-in Interest Area Preferences" settings.

8.1.3.1 Non-ASCII Characters

If intending to use any characters that do not fit in the ASCII encoding range (1-127), please make sure UTF-8 encoding is enabled. Go to Edit → Preferences and make sure the "Encode Files as UTF-8" box of the Build/Deploy node is checked (see Figure 8-10; this node is checked by default in later versions of Experiment Builder). This includes non-English characters (eg. à, è, ù, ç), special curved quotes, and any non-European language characters (e.g., Chinese characters). In addition, please make sure that the right font for the text is chosen before entering any text.

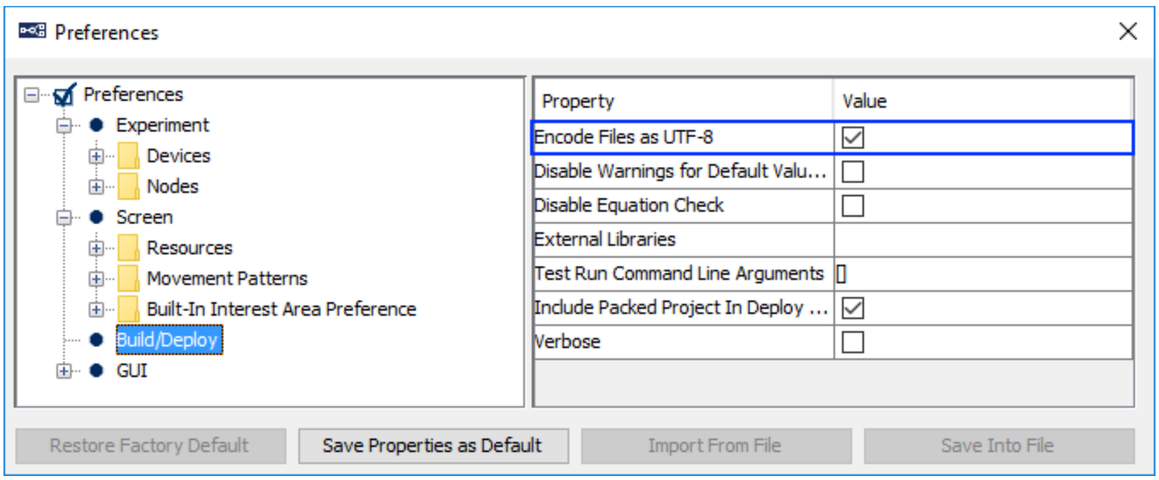


Figure 8-10. Setting UTF-8 Encoding.

8.1.3.2 Anti-aliasing and Transparency

Anti-aliasing is one of the most important techniques in making graphics and text easy to read and pleasing to the eye on-screen. Take the text in Figure 8-11 for example. Panel A shows an aliased character, in which all of the curves and line drawing appear coarse, while Panel C shows the same character anti-aliased, which looks smooth. Anti-aliasing is done by substituting shades of grey (Panel D) around the lines which would otherwise be broken across a pixel (Panel B).

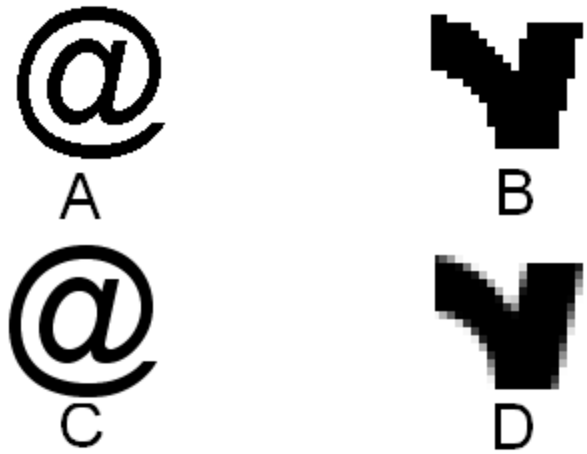


Figure 8-11. Aliased and Anti-aliased Texts.

To apply anti-aliasing, first check the Experiment Builder preference settings under Edit → Preferences (ExperimentBuilder → Preferences in macOS). Click the "Screen" node and make sure that the "Antialias Drawing" box is checked (see Figure 8-12).

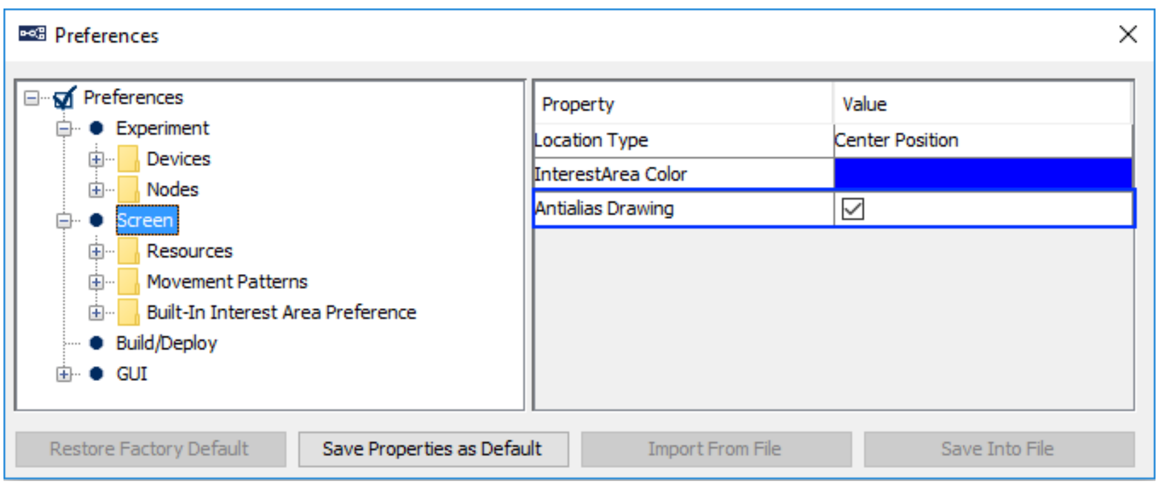


Figure 8-12. Antialiasing Drawing Preference Setting.

When using the DirectDraw Video Environment, anti-aliasing works well with a uniform background. If using DirectDraw, set the Transparency color of the Experiment close to, but not identical to, the background color in the display. For example (see Figure 8-13), to show black (0, 0, 0) text over white (255, 255, 255) background, users may set the transparency color to something close to white, for example, (251, 250, 251). Never set the transparency color the same as the display background color—this will cause the display to be drawn improperly. If using macOS, make sure the resolution (Preferences -> Experiment -> Devices -> Display -> "Width" and "Height") is set to the native resolution of the built-in screen or external monitor to achieve the best anti-aliasing results.

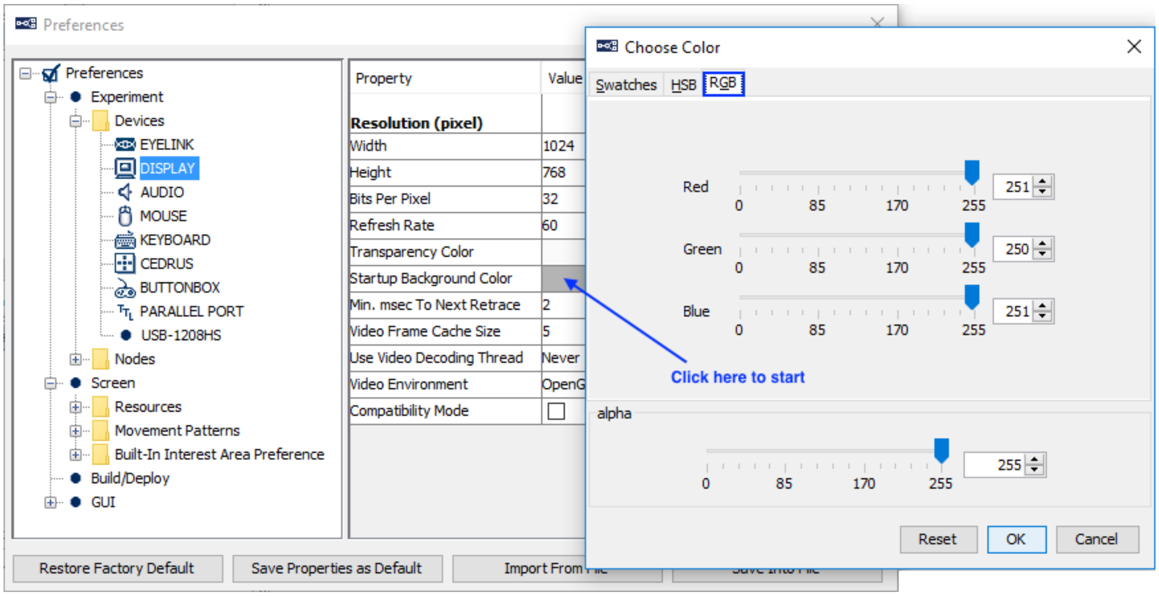


Figure 8-13. Setting the Transparency Color for the Experiment.

Generally speaking, anti-aliasing should be applied when using text, multi-line text resources, line, ellipse, and freeform screen resources. The following sample experiments use anti-aliasing in resource drawing: Simple, Stroop, TextPage, TextLine, Saccade, and Pursuit.

8.1.4 Multiline Text Resource

The Multiline Text Resources allows users to present up to a full page of text, as opposed to the single-line text resource mentioned above. To add a multiline text resource, click on the "Insert Multiline Text Resource" button ( ) on the Screen Builder toolbar and then click anywhere in the workspace.

To edit a multiline text resource that has been added to the screen, double-click within the boundaries of the resource (make sure to click an area with no other overlapping screen resources). If the "Full Screen" property of the multiline text resource is checked, double-click anywhere in the Screen Builder workspace with no other resources. This will bring up the Multiline Text Resource Editor. Users can type text directly in the editor, or paste text copied to the clipboard by pressing Ctrl + V on Windows or Command ⌘ + V on macOS. The toolbar of the text editor allows users to specify the text formatting, including the font, size, text style (bold, italic, underline, subscript, superscript, strikethrough), text color, background color, line spacing, horizontal alignment style (left-aligned, right-aligned, justified, or centered), and vertical alignment style (top-aligned, centered, or bottom-aligned). To select all the text in the editor, click the button in the toolbar , or press Ctrl + A in Windows or Command ⌘ + A in macOS. To change the font size of the selected text, type the new value into the font size field and press the Enter key to register the change. Text of the same font size will look smaller (by a factor of about 1.33) on macOS than on Windows due to different default DPI values used across the two operating systems.

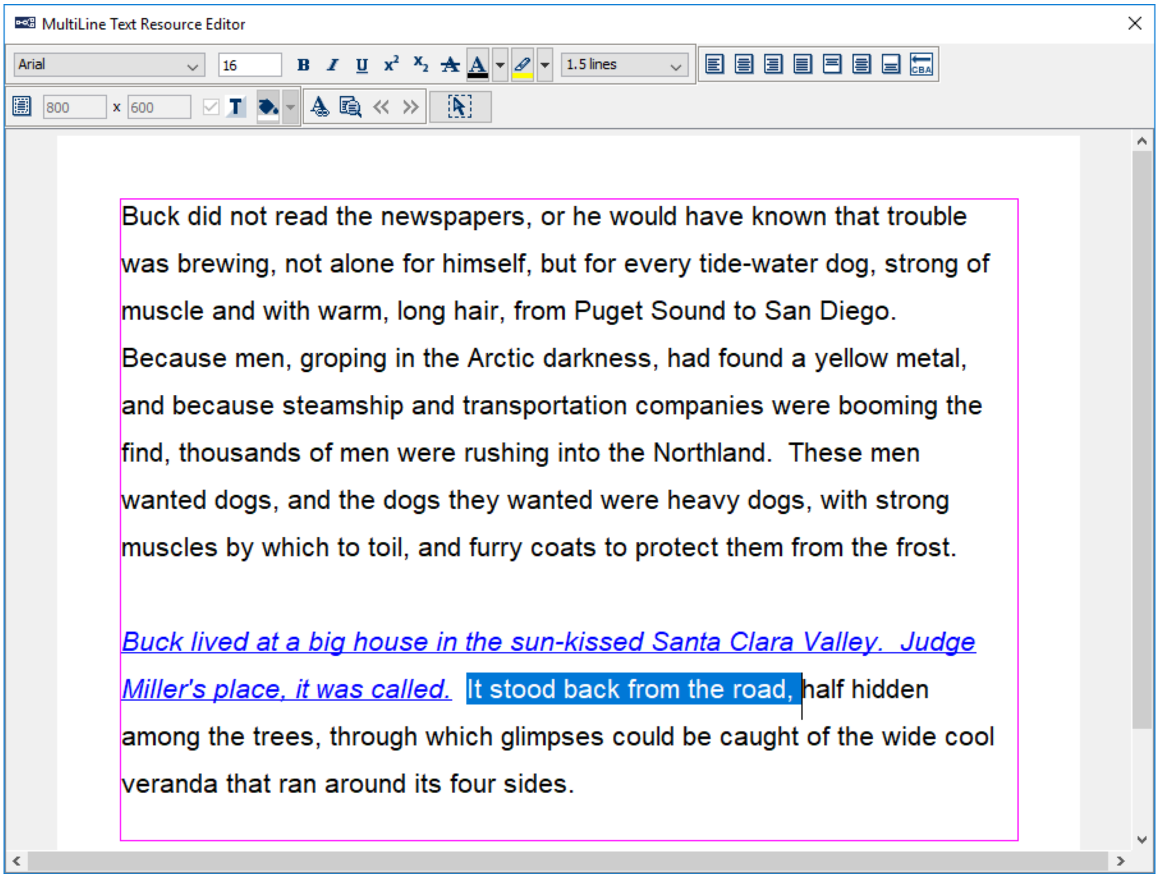


Figure 8-14. Multiline Text Resource Editor.

As with other screen resources, users can present different materials across trials by referring the multiline text resource to a data source column. To add a reference in the Multiline Text Resource Editor, click the button in the toolbar. This will open an Attribute Editor—in the "Node Attribute" column of the Attribute Editor, choose the data source column that contains the intended text to be used for each trial. The referenced text will be placed at the current cursor position and displayed as a "[@]" in the editor. Version 2.0 of the software adds a preview option for multiline text resources when the text is specified by a reference to the data source. Click the "Preview" button () on the right-end of the toolbar to preview the text from the first trial in the data source, then use the « and » buttons to navigate to different trials in the data source. The multiline text resource supports only references that link to data source columns, and not text created by equations. (The single-line text resource mentioned in the previous section may be used to present text created by equations during runtime.)

To configure the margins of the text, click the "margins" button () on the editor toolbar.

In versions 2.0 and later of Experiment Builder, users may customize the dimensions of the multiline text resource. To set the resource dimensions, first uncheck the “Full Screen” option in the properties panel. Then open the Multiline Text Resource Editor and set the intended width and height of the resource in the boxes on the left side of the toolbar. If “Full Screen” is disabled, the Background Transparency property (or the  icon in the editor toolbar) can be toggled to set the resource transparency. If Transparency is disabled, the desired “Background Color” can be set by clicking the value cell in the Properties panel or by clicking the  button in the editor toolbar.

The following table lists the properties of a multiline text resource.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the resource (“MULTILINE_TEXT_RESOURCE” by default).
Type #	NR		The type of screen resource (MultiLineTextResource)
Visible †	.visible	Boolean	Whether the resource should be visible (True by default).
Screen Index #	.screenIndex	Integer	Index of the resource in the screen resource list (0 - n).
Position is Gaze Contingent †	.positionAtGazeContingent	Boolean	Whether the position of the resource is contingent on the gaze position. The default setting is False. This setting is only available when the Full Screen property of the multiline text resource is disabled, no movement pattern is applied, and the parent display screen is contained inside a recording sequence.
Gaze Contingent Eye	.gazeContingentEye	String	Sets the eye used to provide data for the gaze-contingent drawing. Options are Left, Right, Either, Average, or Cyclopean (default setting). For a left-eye-only recording, data from the left eye is used when the gaze-contingency eye is set to “Left”, “Either”, or “Cyclopean”, and missing data when set to “Right” or “Average”. For a right-eye-only recording, data from the right eye is used when the gaze-contingency eye is set to “Right”, “Either”, or “Cyclopean”, and missing data when set to “Left” or “Average”. For a binocular recording, left eye data is used when the gaze-contingency eye is set to “Left” or “Either”, right eye data is used when set to “Right”, average data from both eyes if this is set to “Average” (with missing data if either is missing), and average data from both eyes when set to “Cyclopean” (with missing data if both eyes are missing, and data from the remaining tracked eye if a single eye is missing).

Contingency Deadband	.contingentDeadband	Tuple of Integers	Sets the minimum amount of eye movement required to update the gaze-contingent moving window. This is designed to make the display drawing less susceptible to jitters in the eye position. Typically the deadband shouldn't be larger than 3.0 pixels—larger deadband values will likely result in a lag in updating the display.
Position is Mouse Contingent †	.positionAtMouseContingent	Boolean	Whether the position of the resource is contingent on the mouse position. The default setting is False. This setting is only available when the Full Screen property of the multiline text resource is disabled, and no movement pattern is applied.
Offset #	.offset	Point	Adjustment of the resource position relative to the intended resource location, whether specified by the Location attribute, the current gaze or mouse position, or a movement pattern. The default value is (0, 0) for a perfect alignment of the resource position with the specified position. Values specified in the Offset will be subtracted from the specified location. For example, if the location field is set to (512, 384), and the offset is (100, 100), the actual resource position will be (412, 284).
Host Outline Color ¶	. hostOutlineColor	Color	The color of the box drawn on the host screen to show the position and dimensions of the current resource. This property is available only if the "Use for Host Display" option of the parent display screen action is enabled and the "Draw to EyeLink Host" of the prepare sequence action is set to "Primitive".
Screen Location Type #	NR		Whether the location specified below refers to the top-left corner or center of the resource. This setting can be changed in "Screen Preferences".
Location	.location	Point	The coordinates of the top-left corner or center of the resource, depending on the Screen Preferences. If the Offset is non-zero, the actual screen position where the resource is displayed will be the coordinates set in the .location field minus the offset adjustment. For a full-screen multiline text resource, the default location is (0, 0) for top-left screen coordinate and center of screen in the center-position coordinate type.
Width #	.width	Integer	Width of the resource. This can be configured in the Multiline Text Resource editor if the Full Screen property below is unchecked.
Height #	.height	Integer	Height of the resource. This can be configured in the Multiline Text Resource editor if the Full Screen property below is unchecked.
Movement	NR		Movement pattern (sinusoidal or custom) of the

Pattern			resource.
Prebuild to Image # †	.prebuildToImage	Boolean	Whether the resource should be built into an image when the experiment is built (instead of having it created during the actual execution of the trial). This field is always true for the multiline text resource.
Use Software Surface †	.useSoftwareSurface	Boolean	If unchecked, memory on the video card is used to hold the resource (blitting from the video card memory to the display surface is fast). If checked, the system memory is used to hold the resource (blitting is slow as it is done by copying from RAM to display surface).
Use Runtime Word Segment InterestArea * †	.useRuntimeIAS	Boolean	If enabled, an Interest Area set file will be created during runtime to provide segmentation for individual words. The segmentation parameters can be configured in the "Screen -> Built-in Interest Area Preferences" settings.
Full Screen	NR		Whether the multiline text resource should be a full-screen resource or not. If unchecked, users can configure the dimensions in the Multiline Text Resource editor.
Text Orientation	NR		This option is applicable to the treatment of the punctuation position in bidirectional languages (e.g., Arabic, Hebrew). If the "Left-to-Right" option is selected (default), the punctuation mark is placed at the right side of the text; if the "Right-to-Left" option is selected the punctuation mark is placed at the left side of the text.
Background Transparent	.backgroundTransparency	Boolean	Whether the multiline text resource should appear transparent. This option is only available if the "Full Screen" option is unchecked.
Background Color	.backgroundColor	Color	Sets the background color of the resource if the "Background Transparent" is unchecked. This option is only available if the "Full Screen" option is unchecked.
HTML Style	.HTMLStyle	String	Whether to use Basic or CSS formatting when using HTML text. With the "Basic" option, basic HTML tags (e.g., color, font, size) can be used to format the text. The "CSS" option allows additional formatting options using CSS tags, including line spacing and alignment. The default "Auto-detect" option will have the software determine the formatting method based on the HTML code supplied.

8.1.4.1 Non-ASCII Text

If using any characters outside of the ASCII encoding range (1-127), please make sure UTF-8 encoding is enabled (UTF-8 encoding is enabled by default in recent versions of

Experiment Builder). Go to Edit → Preferences and make sure the "Encode Files as UTF-8" box of the Build/Deploy node is checked (see Figure 8-10). Non-ASCII characters include non-English characters (eg. à, è, ù, ç), curved quotes, and any non-European language characters (e.g., Chinese characters).

When presenting text that use right-to-left script (e.g., Hebrew, Arabic, Persian/Farsi), make sure the "Text Orientation" is set to "Right to Left" so that punctuation marks are properly placed at the left side of the text. For proper interest area segmentation with right-to-left text, enable the "Pixel Based" option in the WORD_SEGMENT preferences and set the Segmentation Direction as "Right to Left, Top to Bottom" (see Figure 8-15).

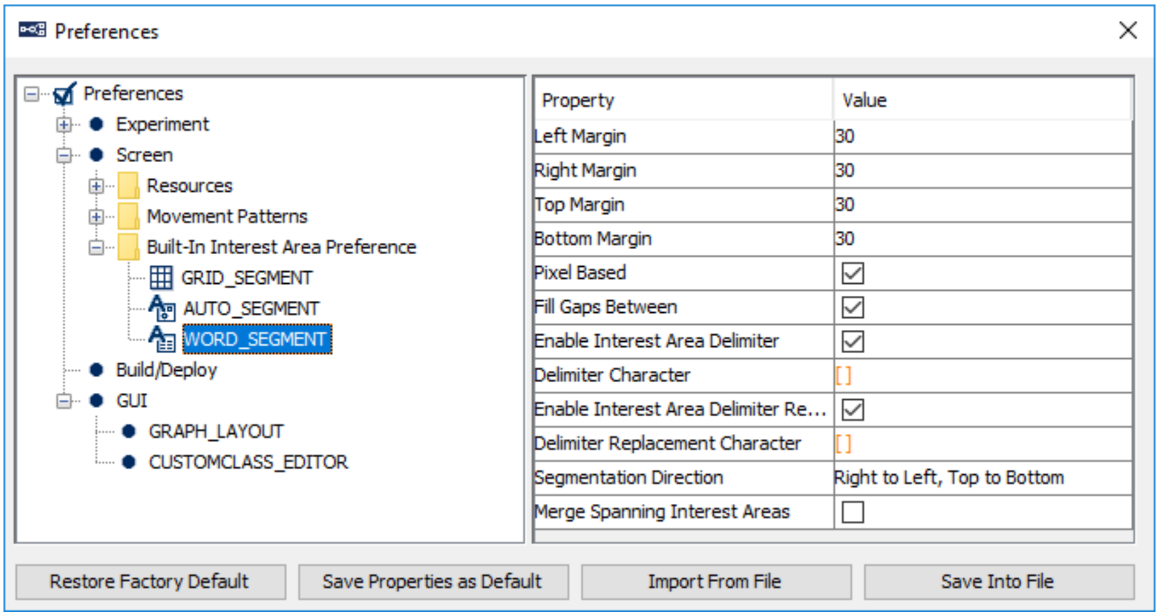


Figure 8-15. Word Segmentation Preferences for Right-to-Left Text

For some languages that do not have spaces between words (e.g., Chinese, Japanese and Thai), it is often useful to create an interest area for each character of the text. To enable character-based segmentation, check the box for the "Enable Character Segment" option in the WORD_SEGMENT preferences (see Figure 8-16). (If more control is desired over the segmentation, use the delimiter options discussed in Section 8.3.2 "Automatic Segmentation" and embed delimiter characters in the text).

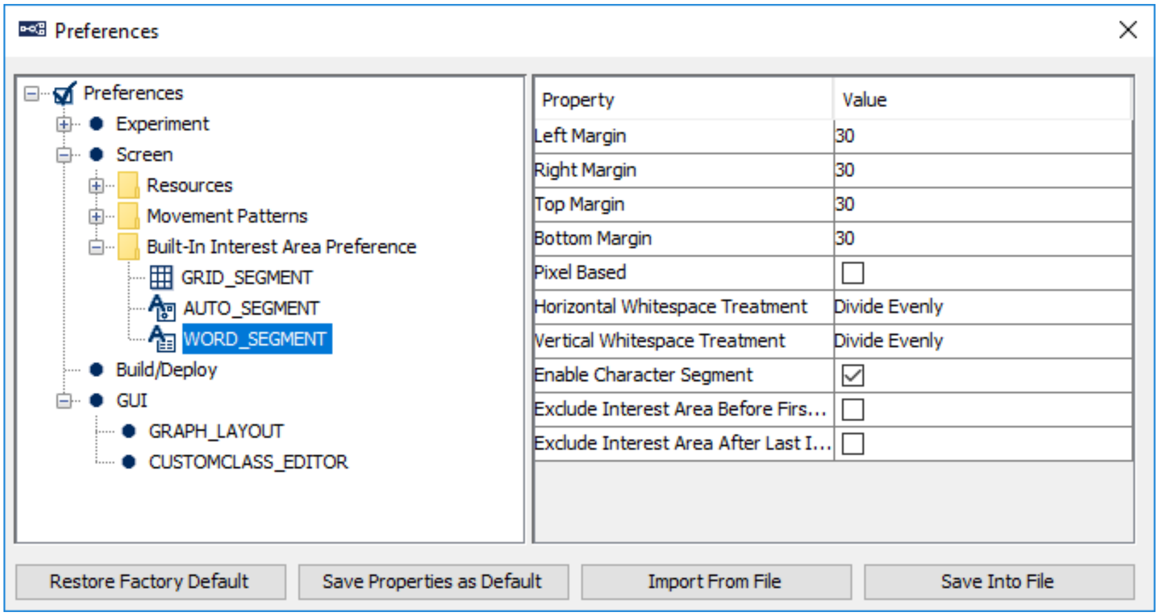


Figure 8-16. Word Segmentation Preferences for Texts without Space between Words

8.1.4.2 HTML Text

Version 2.0 of Experiment Builder supports formatting multiline text resources with HTML code. To use HTML formatting, wrap the text within a pair of <html> and </html> tags. When using HTML tags in the multiline text resource, the settings of the style buttons in the Multiline Text Resource Editor (e.g., font name, font size, color, line space, alignment) will not have an effect on the text formatting. Plain text formatting (e.g., using "\n" for a new line, "\t" for a tab) will also be ignored.

Instead, text can be formatted by using the basic HTML formatting styles within the text. See http://www.w3schools.com/html/html_formatting.asp and http://www.w3schools.com/html/html_styles.asp for a list of supported formatting styles. This page (http://www.jonstorm.com/html/font.htm) gives a fairly comprehensive example of text formatting. See the CHM version of this document (section "Screen Builder -> Resources -> Multiline Text Resource - > Related") for a project that replicates the text presentation in Experiment Builder.

For example, the following text can be entered into a datasource column, and the multiline text resource can refer to the datasource column:

<html> <p>Buck did not read the <i>newspapers</i>, or he would have known that trouble was brewing.</p></html>

Experiment Builder will then render the above text as the following during runtime:

Buck did not **read** the *newspapers*, or he would have known that trouble was brewing.

Version 2.1.512 of Experiment Builder provides support for using Cascading Style Sheets (CSS) to control the look and layout of the text. CSS gives the user additional flexibility and control over the formatting, including line spacing and the positioning of the text on screen. When using the CSS style support, all of the settings (including margins) in the Multiline Text Editor will be ignored, so CSS tags must be used to specify the settings (e.g., the “font-size” tag specifies the size of the text, and the “line-height” tag controls the spacing). To make the font size consistent with other text resources that do not use HTML formatting, use the “font-size” tag with “px” units (instead of “pt”) in the HTML code. Please note that the current version of Experiment Builder doesn’t yet support vertically centering HTML text—the “top” tag may be used instead to set the resource height. The following example illustrates using the HTML text with CSS to control the height and position of text.

```
<html><style>body{background: LightGray} section {line-height: 60px;  text-
align: left; text-indent: 50px; position: absolute; left: 50px; top: 50px; width:
800px;border: 3px dotted blue; }</style><section><p style = "font-
size:30px;font-family: tahoma"> Buck did not <b>read </b> the
<i>newspapers</i>, or <FONT COLOR="red"> he would</FONT> have known
that trouble was brewing. Because men, groping in the Arctic darkness, had found
a yellow metal, and because steamship and transportation companies were
booming the find, thousands of men were rushing into the Northland. <br>Buck
lived at a big house in the sun-kissed Santa Clara Valley.  Judge Miller's place, it
was called.  It stood back from the road, half hidden among the trees, through
which glimpses could be caught of the wide cool veranda that ran around its four
sides. </p></section></html>
```

Experiment Builder will then render the above text during runtime as the following (Figure 8-17):

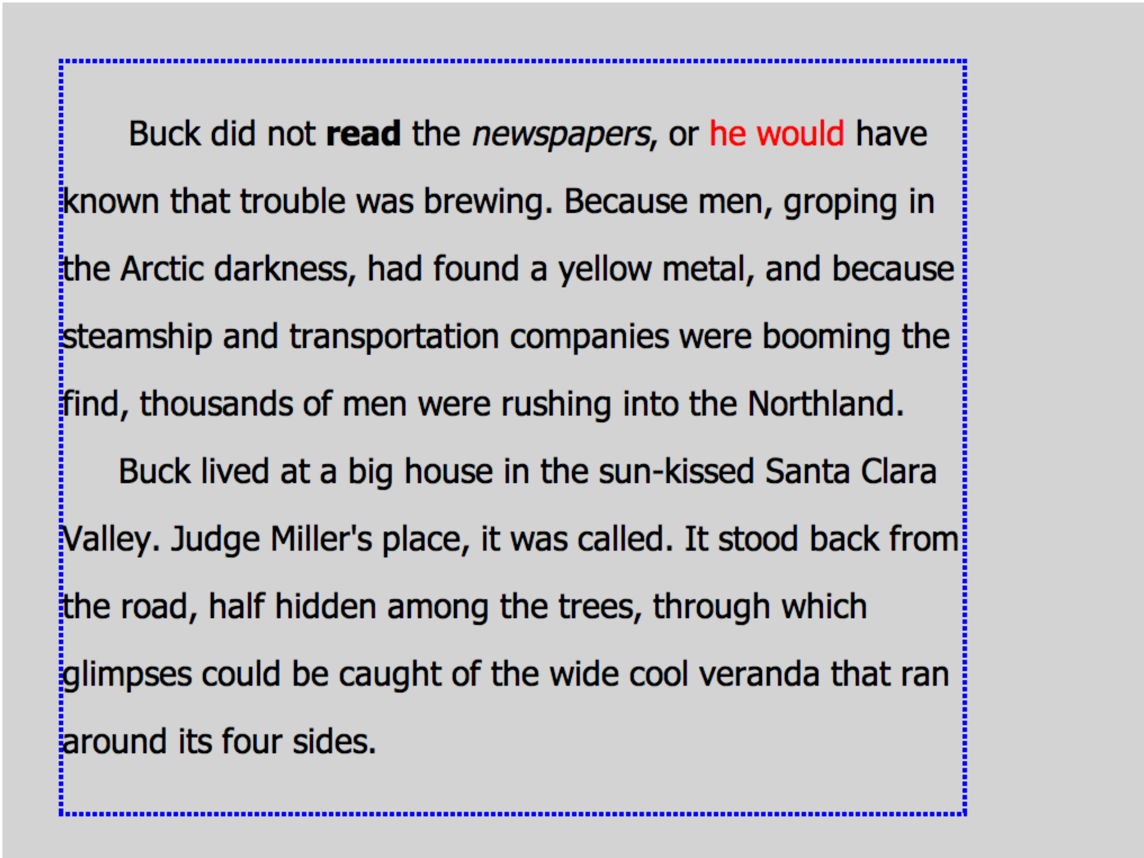


Figure 8-17. Example Text Display Created by HTML Text with CSS Suport

The "HTML Style" property of the resource can typically be left to the default "Auto-detect", so the software will determine the formatting method based on the HTML code supplied.

8.1.5 Line Resource

A line resource creates a line drawing on the screen. Click the "Draw Line Resource" button ( ) on the toolbar to select the line resource type. Place the mouse cursor at the desired line start location in the work space, click down the left mouse button, keep dragging the mouse cursor until it reaches the desired end location, and then release the mouse button. The precise location of the line resource can be edited in the properties panel. Select the "Start Point" and "End Point" attributes and enter the desired positions in the (x, y) format. The color and width of the line resource can also be modified.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the resource ("LINE_RESOURCE" by default).
Type #	NR		The type of screen resource (LineResource)
Visible †	.visible	Boolean	Whether the resource should be visible. The default setting is True.

Screen Index #	.screenIndex	Integer	Index of the resource in the screen resource list (0 - n).
Position is Gaze Contingent †	.positionAtGazeContingent	Boolean	Whether the position of the resource is contingent on the gaze position. The default setting is False. This setting is only available when the parent display screen is contained inside a recording sequence.
Gaze Contingent Eye	.gazeContingentEye	String	Sets the eye used to provide data for the gaze-contingent drawing. Options are Left, Right, Either, Average, or Cyclopean (default setting). For a left-eye-only recording, data from the left eye is used when the gaze-contingency eye is set to “Left”, “Either”, or “Cyclopean”, and missing data when set to “Right” or “Average”. For a right-eye-only recording, data from the right eye is used when the gaze-contingency eye is set to “Right”, “Either”, or “Cyclopean”, and missing data when set to “Left” or “Average”. For a binocular recording, left eye data is used when the gaze-contingency eye is set to “Left” or “Either”, right eye data is used when set to “Right”, average data from both eyes if this is set to “Average” (with missing data if either is missing), and average data from both eyes when set to “Cyclopean” (with missing data if both eyes are missing, and data from the remaining tracked eye if a single eye is missing).
Contingency Deadband	.contingentDeadband	Tuple of integers	Sets the minimum amount of eye movement required to update the gaze-contingent moving window. This is designed to make the display drawing less susceptible to jitters in the eye position. Typically the deadband shouldn’t be larger than 3.0 pixels—larger deadband values will likely result in a lag in updating the display.
Position is Mouse Contingent †	.positionAtMouseContingent	Boolean	Whether the position of the resource is contingent on the mouse position. The default setting is False.
Offset	.offset	Point	Adjustment of the resource position relative to the intended resource location, whether specified by the Location attribute, the current gaze or mouse position, or a movement pattern. The default value is (0, 0) for a perfect alignment of the resource position with the specified position. Values specified in the Offset will be subtracted from the specified location. For example, if the location field is set to (512, 384), and the offset is (100, 100), the actual resource position will be (412, 284).
Host Outline Color ¶	. hostOutlineCol	Color	The color of the box drawn on the host screen to show the position and dimensions of the current

	or		resource. This property is available only if the "Use for Host Display" option of the parent display screen action is enabled and the "Draw to EyeLink Host" of the prepare sequence action is set to "Primitive".
Screen Location Type	NR		Whether the location specified below refers to the top-left corner or center of the resource. This setting can be changed in “Screen Preferences”.
Location	.location	Point	The coordinates of the top-left corner or center of the resource.
Width #	.width	Integer	Width of the resource (in pixels).
Height #	.height	Integer	Height of the resource (in pixels).
Movement Pattern ¶ *	NR		Movement pattern (sinusoidal or custom) of the resource.
Prebuild to Image †	.prebuildToImage	Boolean	Whether the resource should be built into an image when the experiment is built (instead of having it created during the actual execution of the trial). **IMPORTANT:** If the "Prebuild to Image" option is turned off, the run-time resource rendering may not look exactly as it does in the screen editor. In addition, images will not be saved to support Data Viewer overlay.
Use Software Surface †	.useSoftwareSurface	Boolean	If unchecked, memory on the video card is used to hold the resource (blitting from the video card memory to the display surface is fast). If checked, the system memory is used to hold the resource (blitting is slow as it is done by copying from RAM to display surface).
Color	.color	Color	Color in which the line is drawn. The default color is medium gray (128, 128, 128).
Stroke Width	.strokeWidth	Integer	Specifies the width (1 pixel by default) of the pen.
Start Point	.startPoint	Point	(x, y) coordinates of the starting point of the line.
End Point	.endPoint	Point	(x, y) coordinates of the ending point of the line.

8.1.6 Rectangle Resource

The rectangle resource creates a filled or framed rectangle on the screen. Click the “Draw Rectangle Resource” button ( ) on the toolbar to select the resource type. Then simply click and drag the mouse within the Screen Builder to draw the rectangle. The precise size and location of the resource can be set in the properties panel with the “Location”, “Width”, and “Height” attributes. The appearance of the rectangle’s border can be set with the “Color” and “Stroke Width” attributes. If the “Filled” property is set to true, the interior of the rectangle will be filled with the color specified as the “Fill Color”; otherwise, only the border of the rectangle will be drawn, and the fill color will be ignored.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the resource. The default value is "RECTANGLE_RESOURCE".
Type #	NR		The type of screen resource (RectangleResource)
Visible †	.visible	Boolean	Whether the resource should be visible. The default setting is True (box checked).
Screen Index #	.screenIndex	Integer	Index of the resource in the screen resource list (0 - n).
Position is Gaze Contingent †	.positionAtGazeContingent	Boolean	Whether the position of the resource is contingent on the gaze position. The default setting is False. This setting is only available when the parent display screen is contained inside a recording sequence.
Gaze Contingent Eye	.gazeContingentEye	String	Sets the eye used to provide data for the gaze-contingent drawing. Options are Left, Right, Either, Average, or Cyclopean (default setting). For a left-eye-only recording, data from the left eye is used when the gaze-contingency eye is set to "Left", "Either", or "Cyclopean", and missing data when set to "Right" or "Average". For a right-eye-only recording, data from the right eye is used when the gaze-contingency eye is set to "Right", "Either", or "Cyclopean", and missing data when set to "Left" or "Average". For a binocular recording, left eye data is used when the gaze-contingency eye is set to "Left" or "Either", right eye data is used when set to "Right", average data from both eyes if this is set to "Average" (with missing data if either is missing), and average data from both eyes when set to "Cyclopean" (with missing data if both eyes are missing, and data from the remaining tracked eye if a single eye is missing).
Contingency Deadband	.contingentDeadband	Tuple of integers	Sets the minimum amount of eye movement required to update the gaze-contingent moving window. This is designed to make the display drawing less susceptible to jitters in the eye position. Typically the deadband shouldn't be larger than 3.0 pixels—larger deadband values will likely result in a lag in updating the display.
Position is Mouse Contingent †	.positionAtMouseContingent	Boolean	Whether the position of the resource is contingent on the mouse position. The default setting is False.
Offset	.offset	Point	Adjustment of the resource position relative to the intended resource location, whether specified by the Location attribute, the current gaze or mouse position, or a movement pattern. The default value is (0, 0) for a perfect

			alignment of the resource position with the specified position. Values specified in the Offset will be subtracted from the specified location. For example, if the location field is set to (512, 384), and the offset is (100, 100), the actual resource position will be (412, 284).
Host Outline Color ¶	.hostOutlineColor	Color	The color of the box drawn on the host screen to show the position and dimensions of the current resource. This property is available only if the "Use for Host Display" option of the parent display screen action is enabled and the "Draw to EyeLink Host" of the prepare sequence action is set to "Primitive".
Screen Location Type #	NR		Whether the location specified below refers to the top-left corner or center of the resource. This setting can be changed in Screen Preferences.
Location	.location	Point	The coordinates of the top-left corner or center of the resource.
Width	.width	Integer	Width of the resource (in pixels).
Height	.height	Integer	Height of the resource (in pixels).
Movement Pattern ¶ *	NR		Movement pattern (sinusoidal or custom) of the resource.
Prebuild to Image †	.prebuildToImage	Boolean	Whether the resource should be built into an image when the experiment is built (instead of having it created during the actual execution of the trial). **IMPORTANT:** If the "Prebuild to Image" option is turned off, the run-time resource rendering may not look exactly as it does in the screen editor. In addition, images will not be saved to support Data Viewer overlay.
Use Software Surface †	.useSoftwareSurface	Boolean	If unchecked, memory on the video card is used to hold the resource (blitting from the video card memory to the display surface is fast). If checked, the system memory is used to hold the resource (blitting is slow as it is done by copying from RAM to display surface).
Color	.color	Color	Color of the resource outline. The default color is medium gray (128, 128, 128).
Filled †	.filled	Boolean	Whether the interior of the resource should be filled. If False, this draws a framed rectangle. True by default.
Fill Color	.fillColor	Color	Color filling the resource interior. The default color is light gray (192, 192, 192).
Stroke Width	.strokeWidth	Integer	Specifies the width (1 by default) of the pen in pixels.

8.1.7 Ellipse Resource

Similar to the rectangle resource, clicking on the 'Draw Ellipse Resource' tool button ( ) creates a filled or framed ellipse bounded by a box defined by the "Location", "Width", and "Height" properties of the resource. Follow the same steps as in the previous section to create an ellipse resource and to modify its appearance.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the resource. The default value is "ELLIPSE_RESOURCE".
Type #	NR		The type of screen resource (EllipseResource).
Visible †	.visible	Boolean	Whether the resource should be visible. The default setting is True (box checked).
Screen Index #	.ScreenIndex	Integer	Index of the resource in the screen resource list (0 - n).
Position is Gaze Contingent †	.positionAtGazeContingent	Boolean	Whether the position of the resource is contingent on the gaze position. The default setting is False. This setting is only available when the parent display screen is contained inside a recording sequence.
Gaze Contingent Eye	.gazeContingentEye	String	Sets the eye used to provide data for the gaze-contingent drawing. Options are Left, Right, Either, Average, or Cyclopean (default setting). For a left-eye-only recording, data from the left eye is used when the gaze-contingency eye is set to "Left", "Either", or "Cyclopean", and missing data when set to "Right" or "Average". For a right-eye-only recording, data from the right eye is used when the gaze-contingency eye is set to "Right", "Either", or "Cyclopean", and missing data when set to "Left" or "Average". For a binocular recording, left eye data is used when the gaze-contingency eye is set to "Left" or "Either", right eye data is used when set to "Right", average data from both eyes if this is set to "Average" (with missing data if either is missing), and average data from both eyes when set to "Cyclopean" (with missing data if both eyes are missing, and data from the remaining tracked eye if a single eye is missing).
Contingency Deadband	.contingentDeadband	Tuple of integers	Sets the minimum amount of eye movement required to update the gaze-contingent moving window. This is designed to make the display drawing less susceptible to jitters in the eye position. Typically the deadband shouldn't be larger than 3.0 pixels—larger deadband values will likely result in a lag in updating the display.
Position is Mouse	.positionAtMouseContingent	Boolean	Whether the position of the resource is contingent on the mouse position. The default

Contingent †			setting is False.
Offset	.offset	Point	Adjustment of the resource position relative to the intended resource location, whether specified by the Location attribute, the current gaze or mouse position, or a movement pattern. The default value is (0, 0) for a perfect alignment of the resource position with the specified position. Values specified in the Offset will be subtracted from the specified location. For example, if the location field is set to (512, 384), and the offset is (100, 100), the actual resource position will be (412, 284).
Host Outline Color ¶	. hostOutlineColor	Color	The color of the box drawn on the host screen to show the position and dimensions of the current resource. This property is available only if the "Use for Host Display" option of the parent display screen action is enabled and the "Draw to EyeLink Host" of the prepare sequence action is set to "Primitive".
Screen Location Type #	NR		Whether the location specified below refers to the top-left corner or center of the resource. This setting can be changed in “Screen Preferences”.
Location	.location	Point	The coordinates of the top-left corner or center of the resource.
Width	.width	Integer	Width of the resource (in pixels).
Height	.height	Integer	Height of the resource (in pixels).
Movement Pattern ¶ *	NR		Movement pattern (sinusoidal or custom) of the resource.
Prebuild to Image †	.prebuildToImage	Boolea n	Whether the resource should be built into an image when the experiment is built (instead of having it created during the actual execution of the trial). **IMPORTANT:** If the "Prebuild to Image" option is turned off, the run-time resource rendering may not look exactly as it does in the screen editor. In addition, images will not be saved to support Data Viewer overlay.
Use Software Surface †	.useSoftwareSurf ace	Boolea n	If unchecked, memory on the video card is used to hold the resource (blitting from the video card memory to the display surface is fast). If checked, the system memory is used to hold the resource (blitting is slow as it is done by copying from RAM to display surface).
Color	.color	Color	Color of the resource outline. The default color is medium gray (128, 128, 128).
Filled †	.filled	Boolea n	Whether the interior of the resource should be filled. If False, just draws a framed ellipse. True by default.
Fill Color	.fillColor	Color	Color filling the resource interior. The default

			color is light gray (192, 192, 192).
Stroke Width	.strokeWidth	Integer	Specifies the width (1 by default) of the pen in pixels.

8.1.8 Triangle Resource

The triangle resource can be used to create an isosceles triangle. (To create other types of triangle, use the freeform resource instead.) To create a triangle resource on the screen, click the “Draw Triangle Resource” button (△) on the toolbar. Then simply click and drag the mouse within the Screen Builder to draw the rectangle.

To adjust the location of the triangle resource, select the resource, then click and drag it to the intended location. The precise location of the resource can also be set in the value field of the “Location” property. To adjust the height and width of the triangle, select the resource and hover the cursor over one of the three vertices—the cursor will change to a resizing cursor (e.g., ⤢). Then simply click and drag the vertex to its intended location.

The appearance of the triangle resource can be configured in the “Color”, “Fill Color”, and “Stroke Width” properties. If the “Filled” property is set to true, the interior of the rectangle will be filled with the color specified as the “Fill Color”; otherwise, only the border of the rectangle will be drawn, and the fill color will be ignored.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the resource. The default label is “TRIANGLE_RESOURCE”.
Type #	NR		The type of screen resource (TriangleResource).
Visible †	.visible	Boolean	Whether the resource should be visible. This is True by default (box checked).
Screen Index #	.screenIndex	Integer	Index of the resource in the screen resource list (0 - n).
Position is Gaze Contingent †	.positionAtGazeContingent	Boolean	Whether the position of the resource is contingent on the gaze position. The default setting is False. This setting is only available when the parent display screen is contained inside a recording sequence.
Gaze Contingent Eye	.gazeContingentEye	String	Sets the eye used to provide data for the gaze-contingent drawing. Options are Left, Right, Either, Average, or Cyclopean (default setting). For a left-eye-only recording, data from the left eye is used when the gaze-contingency eye is set to “Left”, “Either”, or “Cyclopean”, and missing data when set to “Right” or “Average”. For a right-eye-only recording, data from the right eye is used when the gaze-contingency eye is set to “Right”, “Either”, or “Cyclopean”, and missing data when set to “Left” or “Average”. For a binocular recording, left eye data is used

			when the gaze-contingency eye is set to “Left” or “Either”, right eye data is used when set to “Right”, average data from both eyes if this is set to “Average” (with missing data if either is missing), and average data from both eyes when set to “Cyclopean” (with missing data if both eyes are missing, and data from the remaining tracked eye if a single eye is missing).
Contingency Deadband	.contingentDeadband	Tuple of integers	Sets the minimum amount of eye movement required to update the gaze-contingent moving window. This is designed to make the display drawing less susceptible to jitters in the eye position. Typically the deadband shouldn’t be larger than 3.0 pixels—larger deadband values will likely result in a lag in updating the display.
Position is Mouse Contingent †	.positionAtMouseContingent	Boolean	Whether the position of the resource is contingent on the mouse position. The default setting is False.
Offset	.offset	Point	Adjustment of the resource position relative to the intended resource location, whether specified by the Location attribute, the current gaze or mouse position, or a movement pattern. The default value is (0, 0) for a perfect alignment of the resource position with the specified position. Values specified in the Offset will be subtracted from the specified location. For example, if the location field is set to (512, 384), and the offset is (100, 100), the actual resource position will be (412, 284).
Host Outline Color ¶	.hostOutlineColor	Color	The color of the box drawn on the host screen to show the position and dimensions of the current resource. This property is available only if the "Use for Host Display" option of the parent display screen action is enabled and the "Draw to EyeLink Host" of the prepare sequence action is set to "Primitive".
Screen Location Type #	NR		Whether the location specified below refers to the top-left corner or center of the resource. This setting can be changed in “Screen Preferences”.
Location	.location	Point	The coordinates of the top-left corner or center of the resource.
Width #	.width	Integer	Width of the resource (in pixels).
Height #	.height	Integer	Height of the resource (in pixels).
Movement Pattern ¶ *	NR		Movement pattern (sinusoidal or custom) of the resource.
Prebuild to Image †	.prebuildToImage	Boolean	Whether the resource should be built into an image when the experiment is built (instead of having it created during the actual execution of the trial).

			IMPORTANT: If the "Prebuild to Image" option is turned off, the run-time resource rendering may not look exactly as it does in the screen editor. In addition, images will not be saved to support Data Viewer overlay.
Use Software Surface †	.useSoftwareSurface	Boolean	If unchecked, memory on the video card is used to hold the resource (blitting from the video card memory to the display surface is fast). If checked, the system memory is used to hold the resource (blitting is slow as it is done by copying from RAM to display surface).
Color	.color	Color	Color of the resource outline. The default color is medium gray (128, 128, 128).
Filled †	.filled	Boolean	Whether the interior of the resource should be filled. The default setting is True.
Fill Color	.fillColor	Color	Color filling the resource interior. The default color is light gray (192, 192, 192).
Stroke Width	.strokeWidth	Integer	Specifies the width (1 by default) of the pen in pixels.
Point One #	.pointOne	Point	(x, y) coordinates of the first point of the triangle.
Point Two #	.pointTwo	Point	(x, y) coordinates of the second point of the triangle.
Point Three #	.pointThree	Point	(x, y) coordinates of the third point of the triangle.

8.1.9 Freeform Resource

The freeform resource can be used to draw a polygon consisting of two or more vertices connected by straight lines. To create a freeform resource on the screen, it may be helpful to first determine the list of x, y coordinates for all of the intended vertices in order. Click the “Draw Freeform Resource” button ( ) on the toolbar, then click the mouse in the Screen Builder workspace at the intended position for the first vertex. Next, click the position for the second vertex, and continue for the remaining points. To end drawing, simply press the “Enter” key, and the last vertex will be connected back to the first. To create a curved object, simply click and drag the mouse cursor along the intended shape until the shape is closed.

To move a freeform resource on the screen, simply select the object and drag it to a desired location. To adjust the position of individual vertices, select the resource and hover the cursor over one of the vertices—the cursor will change to a resizing cursor (e.g.,). Then simply click and drag the vertex to its intended location.

The appearance of the triangle resource can be configured in the “Color”, “Fill Color”, and “Stroke Width” properties. If the “Filled” property is set to true, the interior of the rectangle will be filled with the color specified as the “Fill Color”; otherwise, only the border of the rectangle will be drawn, and the fill color will be ignored.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the resource. The default label is "FREEFORM_RESOURCE".
Type #	NR		The type of screen resource (FreehandResource).
Visible †	.visible	Boolean	Whether the resource should be visible. True by default.
Screen Index #	.screenIndex	Integer	Index of the resource in the screen resource list (0 - n).
Position is Gaze Contingent †	.positionAtGazeContingent	Boolean	Whether the position of the resource is contingent on the gaze position. The default setting is False. This setting is only available when the parent display screen is contained inside a recording sequence.
Gaze Contingent Eye	.gazeContingentEye	String	Sets the eye used to provide data for the gaze-contingent drawing. Options are Left, Right, Either, Average, or Cyclopean (default setting). For a left-eye-only recording, data from the left eye is used when the gaze-contingency eye is set to "Left", "Either", or "Cyclopean", and missing data when set to "Right" or "Average". For a right-eye-only recording, data from the right eye is used when the gaze-contingency eye is set to "Right", "Either", or "Cyclopean", and missing data when set to "Left" or "Average". For a binocular recording, left eye data is used when the gaze-contingency eye is set to "Left" or "Either", right eye data is used when set to "Right", average data from both eyes if this is set to "Average" (with missing data if either is missing), and average data from both eyes when set to "Cyclopean" (with missing data if both eyes are missing, and data from the remaining tracked eye if a single eye is missing).
Contingency Deadband	.contingentDeadband	Tuple of integers	Sets the minimum amount of eye movement required to update the gaze-contingent moving window. This is designed to make the display drawing less susceptible to jitters in the eye position. Typically the deadband shouldn't be larger than 3.0 pixels—larger deadband values will likely result in a lag in updating the display.

Position is Mouse Contingent †	.positionAtMouseContingent	Boolean	Whether the position of the resource is contingent on the mouse position. The default setting is False.
Offset	.offset	Point	Adjustment of the resource position relative to the intended resource location, whether specified by the Location attribute, the current gaze or mouse position, or a movement pattern. The default value is (0, 0) for a perfect alignment of the resource position with the specified position. Values specified in the Offset will be subtracted from the specified location. For example, if the location field is set to (512, 384), and the offset is (100, 100), the actual resource position will be (412, 284).
Host Outline Color ¶	.hostOutlineColor	Color	The color of the box drawn on the host screen to show the position and dimensions of the current resource. This property is available only if the "Use for Host Display" option of the parent display screen action is enabled and the "Draw to EyeLink Host" of the prepare sequence action is set to "Primitive".
Screen Location Type #	NR		Whether the location specified below refers to the top-left corner or center of the resource. This setting can be changed in “Screen Preferences”.
Location	.location	Point	The coordinates of the top-left corner or center of the resource.
Width #	.width	Integer	Width of the resource (in pixels).
Height #	.height	Integer	Height of the resource (in pixels).
Movement Pattern ¶ *	NR		Movement pattern (sinusoidal or custom) of the resource.
Prebuild to Image †	.prebuildToImage	Boolean	Whether the resource should be built into an image when the experiment is built (instead of having it created during the actual execution of the trial). **IMPORTANT:** If the "Prebuild to Image" option is turned off, the run-time resource rendering may not look exactly as it does in the screen editor. In addition, images will not be saved to support Data Viewer overlay.
Use Software Surface †	.useSoftwareSurface	Boolean	If unchecked, memory on the video card is used to hold the resource (blitting from the video card memory to the display surface is fast). If checked, the system memory is used to hold the resource (blitting is slow as it is done by copying from RAM to display surface).
Color	.color	Color	Color of the resource outline. The default color is medium gray (128, 128, 128).
Filled †	.filled	Boolean	Whether the interior of the freeform should be filled. The default setting is True.

Fill Color	.fillColor	Color	Color filling the resource interior. The default color is light gray (192, 192, 192).
Stroke Width #	.strokeWidth	Integer	Specifies the width (1 by default) of the pen in pixels.
Points #	.points	List of Points	List of (x, y) coordinates of the vertex points of the freeform shape.

8.2 Movement Patterns

Experiment Builder allows users to define Movement Patterns, so that screen resources such as images, shapes, text and videos may move on-screen. Various movement patterns can be created, allowing resources to move at a constant speed, oscillate sinusoidally, or jump discontinuously. This is convenient for experiments showing moving targets on the screen, such as smooth pursuit paradigms.

Two types of movement patterns can be created: Sinusoidal and Custom. To create a movement pattern, click the "Insert Sine MovementPattern" button ( ) or "Insert Custom MovementPattern" button ( ) on the Screen Builder toolbar (see Figure 8-18). After creating the movement pattern, users can assign the pattern to a resource by setting the "Movement Pattern" attribute of the resource.

Figure 8-18. Creating a Movement Pattern.

In order for Data Viewer to integrate the target position information, write out a "!V TARGET_POS" message from the Display Screen action used to present the moving screen resource. (See the EyeLink Data Viewer User Manual, section "Protocol for EyeLink Data to Viewer Integration → Target Position Commands", or the "Pursuit" example, for illustrations of using this message). Target position can be derived from the TARGET_X and TARGET_Y variables of a Sample Report.

8.2.1 Sinusoidal Movement Pattern

Smooth sinusoidal movement patterns are widely used in diagnostic testing due to their wide range of velocities and lack of abrupt changes in speed and direction. To review the properties of a movement pattern, click the movement pattern node in the Structure Panel of the Project Explorer Window. The defining parameters of a sinusoidal movement are the frequency (cycles per second), amplitude of the movement, start phase, and the center X and Y coordinates (see the following table for details). In one full cycle, the target will move from (X_{center} - $X_{amplitude}$, Y_{center} - $Y_{amplitude}$) to (X_{center} + $X_{amplitude}$, Y_{center} + $Y_{amplitude}$), and the movement will be centered at (X_{center}, Y_{center}).

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the sinusoidal movement pattern ("SINE_PATTERN" by default).
Type #	NR		The type of Experiment Builder object

			(SinePattern).
Screen Location Type #	NR		Whether the locations specified refer to the top-left corner or center of the resource. This setting can be changed at "Screen Preferences".
Start Time	.startTime	Float	Start Time of the movement. Typically set to 0 so that the start time of the movement pattern is aligned to the display screen action.
Amplitude X	.amplitudeX	Float	The amplitude of horizontal movement in pixels (341.0 by default).
Amplitude Y	.amplitudeY	Float	The amplitude of vertical movement in pixels (256.0 by default).
Center X	.plotX	Float	The horizontal center of the movement in pixels. Typically the center of the screen.
Center Y	.plotY	Float	The vertical center of the movement in pixels.
Frequency X	.frequencyX	Float	The speed of horizontal movement (in number of cycles per second; Hz).
Frequency Y	.frequencyY	Float	The speed of vertical movement (in number of cycles per second; Hz).
Start Phase X	.startPhaseX	Float	The start phase position of horizontal movement. This number should be between 0 and 360.
Start Phase Y	.startPhaseY	Float	The start phase position of vertical movement. This number should be between 0 and 360.

Note: Amplitude X should be set to 0 for a vertical sine movement and Amplitude Y should be 0 for a horizontal movement. X and Y amplitudes must be the same for a circular movement; unequal values will result in an elliptic movement.

The start point of the movement is specified by the Start Phase X and Start Phase Y. The following table lists the most important landmark positions in a sinusoidal movement.

Dimension	**Phase**	**Position**	**Direction**
Horizontal (x)	0°	Center	Moving right
Horizontal (x)	90°	Right	Stationary
Horizontal (x)	180°	Center	Moving left
Horizontal (x)	270°	Left	Stationary
Vertical (y)	0°	Center	Moving down
Vertical (y)	90°	Bottom	Stationary
Vertical (y)	180°	Center	Moving up
Vertical (y)	270°	Top	Stationary

For a horizontal-only movement, Start Phase Y should be set to 0°. A Start Phase X of 0° defines a movement that starts at the center of the movement range and moves right; a Start Phase X of 90° defines a movement that starts at the right end of the range and moves left; a Start Phase X of 180° defines a movement that starts at the center of the range and moves left; and a Start Phase X of 270° defines a movement that starts at the left end of the movement and moves right.

For a vertical-only movement, Start Phase X should be set to 0°. A Start Phase Y of 0° creates a movement that starts at the center of the movement range and moves down; a Start Phase Y of 90° creates a movement that starts at the low end of the range and moves up; a Start Phase Y of 180° creates a movement tat starts at the center of the range and moves up; and a Start Phase Y of 270° creates a movement that starts at the top end of the range and moves down.

The sinusoidal movement can be two-dimensional if both Start Phase X and Start Phase Y are non-zero. To create a clockwise circular or elliptic movement pattern, make sure Start Phase X - Start Phase Y = 90°, and for a counterclockwise movement, make sure Start Phase Y - Start Phase X = 90°. The circular or elliptic movement will be reduced to a movement along an oblique axis if Start Phase Y = Start Phase X. All other phase value combinations will result in a complex Lissajous figure.

8.2.2 Custom Movement Pattern

Experiment Builder also allows users to create Custom Movement Patterns consisting of a linear movement at a constant velocity or a set of such linear smooth movements. The custom movement pattern uses a list of resource positions specifying the destination movement position and the time in milliseconds (since the start of the current screen) when the resource reaches the position. A message can be sent when each target position is reached.

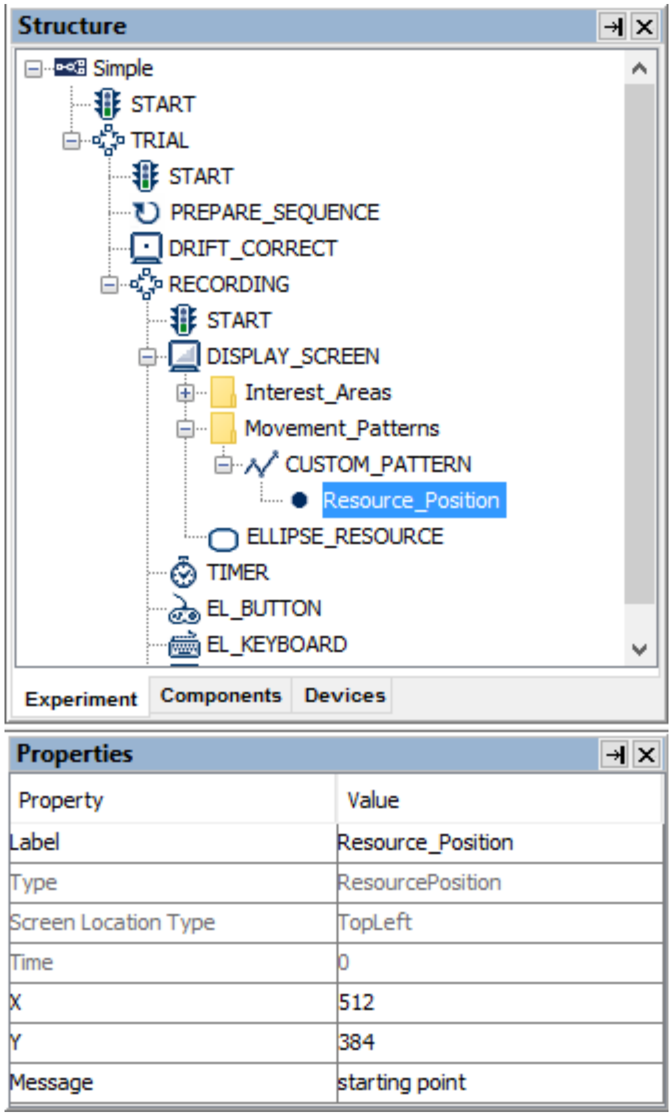


Figure 8-19. Adding Resource Positions to a Custom Movement Pattern.

To create a custom movement pattern, users can either add resource positions and define their x, y coordinates and time values in the Screen Builder, or specify a movement pattern file that contains the coordinates and time for each position:

8.2.2.1 Option 1: Adding Resource Postions

To specify the movement pattern in the Screen Builder, first click the "Insert Custom MovementPattern" button () on the Screen Builder toolbar. Then select the movement pattern in the Structure panel and make sure that the "Use Points From File" box is unchecked.

When a custom movement pattern is created with this option, a default Resource_Position node is automatically created in the Structure panel within the movement pattern to serve as the start point of the movement pattern—its Time property is set to 0 and cannot be changed. The x and y coordinates are initially set to the center of the screen. This node cannot be deleted unless the entire movement pattern is removed.

To add additional positions to the movement pattern, click the "Insert Resource Position in the selected Custom MovementPattern" (). Each additional resource position node can be updated with the intended coordinate and time values.

Consider the following custom movement pattern: the first (default) resource position has a time field of 0 and a screen position of (512, 384); the second point has a time of 1000 and a position of (100, 384); and the third point has a time of 6000 and a position of (800, 384). This translates into two segments of movement. The first segment moves from (512, 384) to (100, 384) when the sequence starts; the movement ends in 1000 milliseconds. The second movement starts from time 1000 (since the sequence starts) and ends on time 6000, moving smoothly from position (100, 384) to (800, 384).

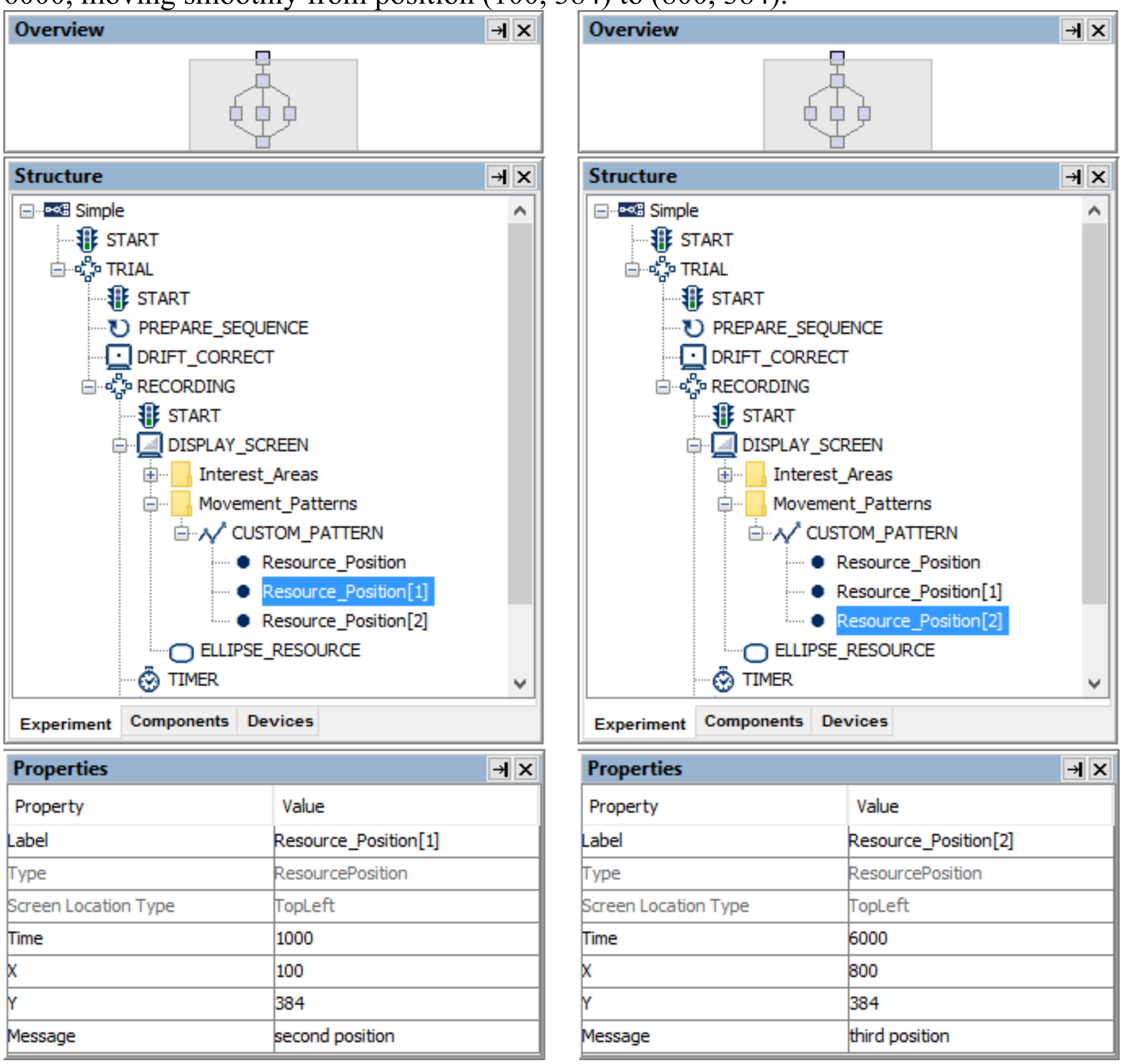


Figure 8-20. Creating a Custom Movement Pattern.

8.2.2.2 Option 2: Movement Pattern File

Alternatively, users can create a tab-delimited text file to specify the landmark positions in a movement pattern; this is particularly useful when a large number of movement segments must be specified. The movement pattern file should contain time (integer), x (integer), and y (integer) fields, followed by an optional message field (string). Neighboring fields should be separated by a tab:

0	512	384	"Start of Movement"
1000	100	384	"Left End"
6000	800	384	"Right End"

Save this .txt file and add it to the "Movement Pattern" tab of the Library Manager.

In the Screen Builder, click the “Insert Custom MovementPattern” button ( ) on the Screen Builder toolbar. Then select the movement pattern in the Structure panel and check the "Use Points From File" box. Select the movement pattern file from the dropdown list or specify the file in the attribute editor.

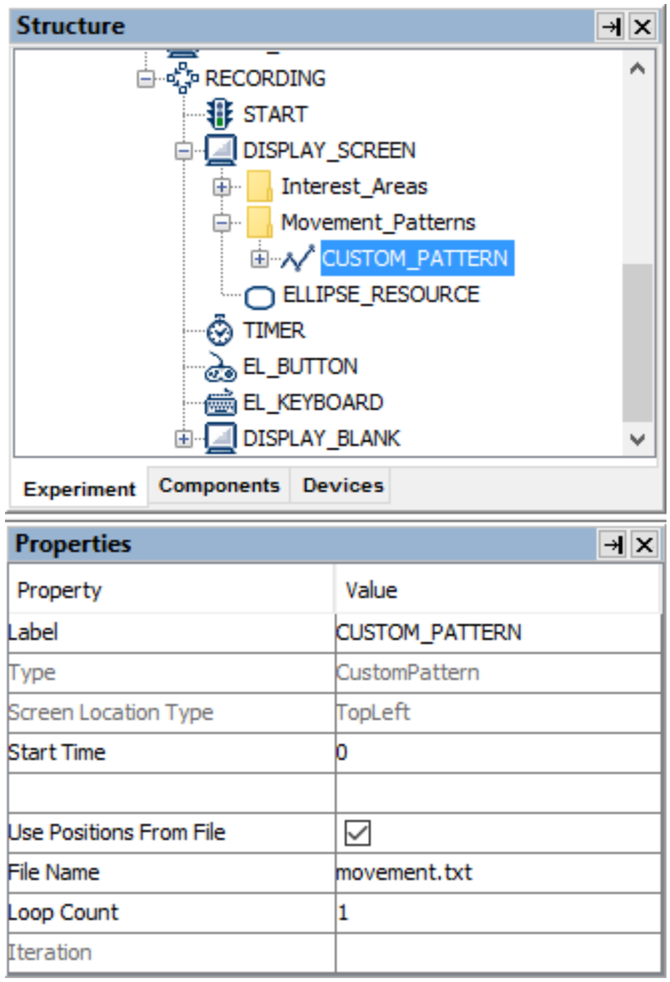


Figure 8-21. Creating a File-based Custom Movement Pattern.

The following is a list of properties for a custom movement pattern.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the custom movement pattern. The default label is "CUSTOM_PATTERN".
Type #	NR		The type of Experiment Builder object (CustomPattern).
Screen Location Type #	NR		Whether the location specified refers to the top-left corner or center of the resource. This setting can be changed in "Screen Preferences".
Start Time	.startTime	Float	Start Time of the movement. Typically set to 0 so that the movement pattern is aligned to the display screen action.
Use Positions From File †	.usePositionsFromFile	Boolean	If unchecked (default), the user can define the movement pattern by adding a list of resource positions to the movement pattern. If enabled, the movement pattern point list should instead

			be specified in a text file. Make sure the text file is added into the "Movement Pattern" tab of the Library Manager, then either select the pattern from dropdown list by double-clicking in the Value cell, or define it attribute editor.
File Name	.fileName	String	Name of a text file that is used to specify the custom movement pattern.
Loop Count	.loop	Integer	This sets the number of times the custom movement pattern should repeat.
Iteration	.iteration	Integer	This reports the current iteration number (starting from 0) of the repeated movement pattern.

Each of the individual resource positions in the custom movement pattern has the following properties.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the resource position in the custom movement pattern. The default label is "Resource_Position".
Type #	NR		The type of Experiment Builder object (ResourcePosition).
Screen Location Type #	NR		Whether the locations specified refer to the top-left corner or center of the resource. This setting can be changed in "Screen Preferences".
Time #	.time	Integer	Time (since the start of the movement pattern) when the resource reaches the destination position.
X	.x	Integer	X coordinate of the resource when this segment of movement finishes.
Y	.y	Integer	Y coordinate of the resource when this segment of movement finishes.
Message	.message	String	Message text to be sent when the resource reaches the specified position.

8.3 Interest Areas

Interest areas can be drawn on the Screen Builder workspace and their details recorded in the EDF file to simplify subsequent analysis with EyeLink Data Viewer. The interest areas created in the Screen Builder will not be visible to the participants during data collection. To show interest areas on the workspace, the "Toggle Interest Area Visibility" button should be clicked on the Screen Builder toolbar (see Figure 8-22). In the Structure panel, interest areas are listed under the "Interest_Areas" folder of the Display Screen node.

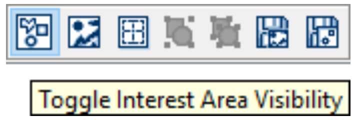


Figure 8-22. Toggling Interest Area Visibility.

8.3.1 Manually Creating an Interest Area

SR Research Experiment Builder supports three types of interest areas (rectangular, elliptic, or freeform). The following sections illustrate the use of each type of interest area.

Figure 8-23. Creating an Interest Area.

To create a rectangular interest area, click the "Insert Rectangle Interest Area Region" button (). Then simply click and drag the mouse within the Screen Builder to draw the rectangle. The precise location of the rectangular interest area can be edited in the property panel. An elliptic interest area () can be created in a similar fashion. A freeform interest area () can be created in the same way as a freeform resource (see Section 8.1.9).

8.3.1.1 Rectangular/Elliptic Interest Area

The following table lists the properties of a rectangular or elliptic interest area. Please note that the precise location of an interest area can be edited with the "Location", "Width", and "Height" attributes in property table.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the Rectangle or Ellipse interest area. The default label is "RECTANGLE_INTERESTAREA" or "ELLIPSE_INTERESTAREA".
Type #	NR		The type of Experiment Builder object (RectangleInterestArea or EllipseInterestArea).
ID *	.ID	String	Ordinal ID of the interest area.
Data Viewer Name	.DVName	String	Text associated with the interest area in Data Viewer.
Color *	NR	Color	Color used to draw the interest area in the Screen Builder.
Screen Location Type	NR		Whether the locations specified refer to the top-left corner or center of the interest area. This global setting can be changed in "Screen Preferences".
Location	.location	Point	The top-left or center of the interest area, depending on the preference setting of screen location type.

Width	.width	Integer	The width of the interest area in pixels.
Height	.height	Integer	The height of the interest area in pixels.

8.3.1.2 Freeform Interest Area

The shape of a freeform interest area can be adjusted by moving the vertices individually. To adjust the position of individual vertices, select the interest and hover the cursor over one of the vertices—the cursor will change to a resizing cursor (e.g., ⤢). Then simply click and drag the vertex to its intended location. The properties of a freeform interest area are listed in the following table.

Field	**Attribute Reference**	**Type**	**Content**
Label *	.label	String	Label of the Freeform interest area. The default label is “FREEFORM_INTERESTAREA”.
Type #	NR		The type of Experiment Builder object (FreehandInterestArea).
ID *	.ID	String	Ordinal ID of the interest area.
Data Viewer Name	.DVName	String	Text associated with the interest area when viewing in Data Viewer.
Color *	NR	Color	Color used to draw the interest area in the Screen Builder.
Screen Location Type #	NR		Whether the locations specified refer to the top-left corner or center of the interest area. This global setting can be changed in “Screen Preferences”.
Location	.location	Point	The top-left or center of the interest area, depending on the preference setting of screen location type.
Points #	.points	List of Points	List of points (x, y coordinates) for the vertices of the interest area.

8.3.2 Automatic Segmentation

Interest areas can be automatically created for some screen resources. To automatically create rectangular or elliptic interest areas to contain resources on the screen, select the desired resource(s), then right-click and select "Create Interest Area Set → Auto Segment" (see Figure 8-24). The margins and shape of the interest areas can be set in the "AUTO_SEGMENT" preference settings (from the Edit → Preferences menu or ExperimentBuilder → Preferences in macOS, select Preferences → Screen → Built-in Interest Area Preference → AUTO_SEGMENT). An interest area created with the "Auto Segment" option will be associated with the screen resource and its location. Its width and height cannot be modified directly, but will vary along with the shape and size of the resource.

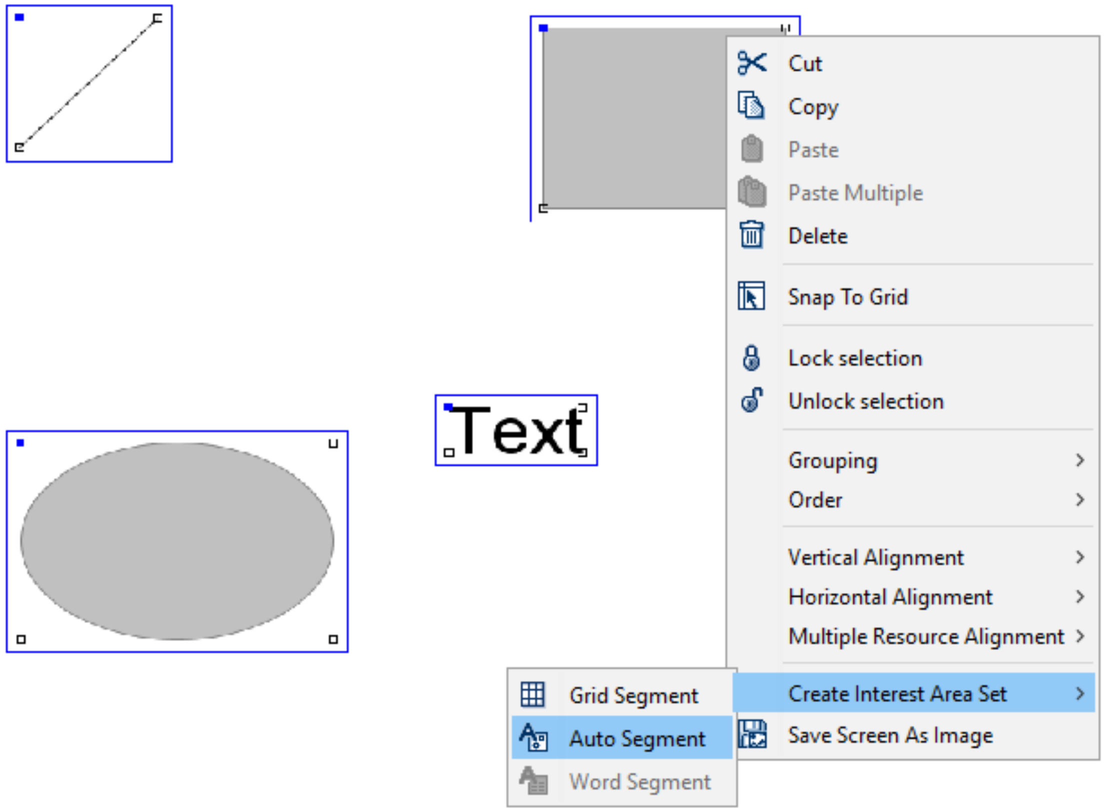


Figure 8-24. Creating Interest Area with Auto Segmentation.

There are two ways to automatically segment text resources into interest areas for each individual word. For static text (i.e., text that remains constant each trial), this can be done by selecting the text resource, right-clicking, and selecting "Create Interest Area Set → Word Segment" from the popup menu. These interest area sets will remain from trial to trial, even if the text in the resource has changed.

For text that changes from trial to trial, select the text resource or multi-line text resource and check the "Use Runtime Word Segment InterestArea" option in the resource's Properties table. **Note:** Interest areas created with runtime word segmentation will not be listed under the "Interest_Areas" folder of the Display Screen action and will not be displayed in the Screen Editor. The ID values of the automatically created interest areas start at 1 and continue within the trial across multiple display screens.

By default, the automatic word segmentation is based on the space character between words, though users may choose other delimiter options. For example, to see whether the participant detects semantic anomaly in the sentence "The authorities were trying to decide where to bury the survivors", a user may group "bury the survivors" into one interest area instead of creating three separate interest areas. To determine their own interest area boundaries, the user can decide to use a custom delimiter. Users can set a custom delimiter in the WORD_SEGMENT preference settings (from the Edit →

Preferences menu or ExperimentBuilder → Preferences in macOS, select Preferences → Screen → Built-in Interest Area Preference → WORD_SEGMENT). Check the "Enable Interest Area Delimiter" option, and set the "Delimiter Character" to the desired character—in this case, the user is defining the asterisk as the delimiter, so they would set Delimiter Character to “[*]”. Check the "Enable Interest Area Delimiter Replacement" option and set the "Delimiter Replacement Character" as a single space. **Note:** the default value for Delimiter Character is “[ ]”, which may appear empty but actually contains a space character. Make sure when defining custom delimiter characters to remove the space and include only your intended character.

After setting the custom delimiter character, the user may replace each space in the original sentence with an ‘*’:

"*The*authorities*were*trying*to*decide*where*to*bury the survivors.*"

Users may also generate a set of rectangular interest areas partitioning the entire work space into grids. Click the right mouse button in the workspace to bring up a popup menu. Select "Create Interest Area Set → Grid Segment". The number of columns and rows created is set in the "Rows" and "Columns" options of the "GRID_SEGMENT" preference settings (from the Edit → Preferences menu or ExperimentBuilder → Preferences in macOS, select Preferences → Screen → Built-in Interest Area Preference → GRID_SEGMENT).

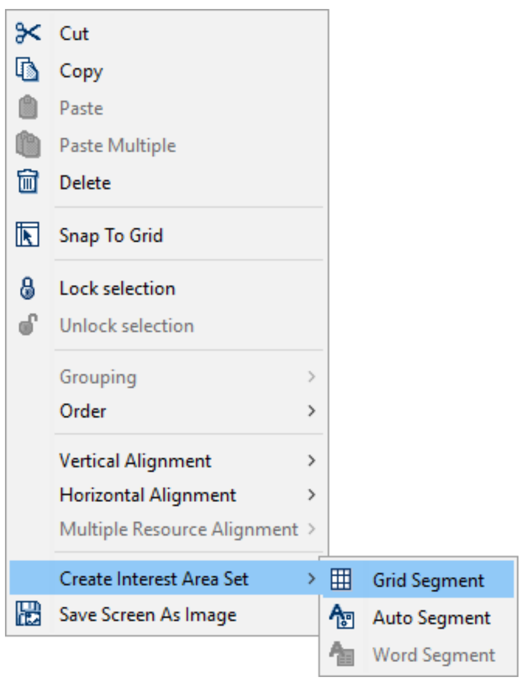


Figure 8-25. Creating Interest Area with Grid Segmentation.

8.3.3 Using Interest Area Set Files

For some experiments, it may be difficult to define interest areas within Experiment Builder. For example, if the experiment presents different images across trials, it may be difficult to manually create built-in interest areas or to create runtime interest areas automatically. It is generally simplest to create the interest areas manually in Data Viewer, then save the created interest areas as Interest Area Set files. With this approach, the user can run through their project once (either with a pilot participant or using Mouse Simulation mode), then open the .edf in Data Viewer. They can then easily scroll through trials, creating and saving one interest area set file for each of the images to be displayed. The Interest Area Sets can then be added to the "InterestArea Set" tab of the Library Manager. Select the Display Screen to which the interest areas are associated and set "InterestArea Set Name" field to a desired interest area set file, or link to a column in the data source that lists the interest area set name to use for that trial. Please make sure the name of the interest area file does not contain space or non-ASCII characters.

In an interest area set file, each line represents one interest area. The interest areas are coded in the following formats:

*** Rectangular Interest Area:**

```
RECTANGLE	id	left	top	right	bottom	[label]
```

The "id", "left", "top", "right", and "bottom" fields must be integer numbers. For example,

```
RECTANGLE	1	118	63	332	208
	RECTANGLE_INTERESTAREA
```

*** Elliptic Interest Area:**

```
ELLIPSE	id	left	top	right	bottom	[label]
```

The "id", "left", "top", "right", and "bottom" fields must be integer numbers. For example,

```
ELLIPSE	2	191	168	438	350	ELLIPSE_INTERESTAREA
```

*** Freehand Interest Area:**

```
FREEHAND	id	x1,y1	x2,y2	...	xn,yn	[label]
```

The "id" field and each item in the pairs of "xi,yi" must be integer numbers. The x and y coordinates in each pair are delimited by a comma (,). For example,

```
FREEHAND	3	481,54 484,57 678,190 602,358 483,330 483,327 493,187
468,127	FREEFORM_INTERESTAREA
```

Versions 2.1 and higher of EyeLink Data Viewer support dynamic interest areas. The format of the dynamic interest areas is the same as discussed above except for two additional parameters at the beginning of the line.

start_offset end_offset RECTANGLE id left top right bottom [label]
e.g., -500 -1500 RECTANGLE 1 0 0 512 384 images\hearts.jpg

The "start_offset" and "end_offset" values are usually negative, indicating a future time relative to the start of the currently selected interest period in Data Viewer (the default Full Trial Period will be used if no interest periods have been created for the viewing session). If the interest areas are read from a file specified by a message in the EDF file (e.g., the "!V IAREA FILE" message in the EDF file), the "start_offset" and "end_offset" are relative to the time stamp of that message in the EDF file. For example, if the interest area file message was written at 800 ms following the trial start, the particular interest area of the above example would start at 1300 ms and end at 2300 ms following the trial start.

For all three types of interest areas, please make sure the individual fields are tab-delimited.

Note: Interest areas contained in an interest area file will not be listed under the "Interest_Areas" folder of the Display Screen action nor will be displayed in the Screen Builder editor.

8.4 Resource Operations

The current section lists miscellaneous operations for adjusting the appearance of display screens and the layout of resource components.

8.4.1 Resource Editing

The following operations can be applied to screen resources, interest areas and movement patterns: Cut ( ), Copy ( ), Paste ( ) and Delete ( ) using the application menubar, the toolbar, or the popup menu.

8.4.2 Resource Alignment

The position of screen resources and interest areas can be adjusted with alignment buttons on the Screen Builder toolbar (see Figure 8-26). To adjust an item's alignment, select the item and then click one of the alignment tool buttons. The horizontal alignment buttons determine the position of a resource on the horizontal dimension: left aligned, right aligned, or centered. The vertical alignment buttons determine the position on the vertical dimension: top-aligned, bottom-aligned, or centered. Alternatively, select the resource, then right-click and choose one of the alignment buttons from the popup menu.

Figure 8-26. Resource Alignment (Left) and Toggling Grid Visibility.

Version 2.0 of Experiment Builder added options to support the relative alignment of multiple resources on the screen. In the Screen Builder, select two or more resources, click the right mouse button, and choose the "Multiple Resource Alignment Options" menu option. When an alignment operation is selected, the positions of the selected resources will be set to the position of the last resource in the selection (i.e., the last resource selected will not move). When a resizing operation is selected, the horizontal and/or vertical dimensions of the selected resources will be rescaled to be the width or height of the last resource in the selection (i.e., the last resource selected will not be resized). The following table describes the supported alignment/resizing options.

Align Lefts	This aligns the left edges of the resources, without changing the vertical positions of the resources.
Align Centers	This aligns the center of the resources, without changing the vertical positions of the resources.
Align Rights	This aligns the right edges of the resources, without changing the vertical positions of the resources.
Align Tops	This aligns the top edges of the resources, without changing the horizontal positions of the resources.
Align Middles	This aligns the centers of the resources, without changing the horizontal positions of the resources.
Align Bottoms	This aligns the bottom edges of the resources, without changing the horizontal positions of the resources.
Make Same Width	This makes the width of the selected resources to be the same as the last resource in the selection, without changing the height of the resources.
Make Same Height	This makes the height of the selected resources to be the same as the last resource in the selection, without changing the width of the resources.
Make Same Size	This makes the size (bounding box) of the selected resources to be the same as the last resource in the selection.
Make Horizontal Spacing Equal	This makes the horizontal spacing equal among the selected resources without adjusting the vertical spacing.
Make Vertical Spacing Equal	This makes the vertical spacing equal among the selected resources without adjusting the horizontal spacing.

When arranging many resources onscreen it may be helpful to use the "Snap to Grid" option. First, click the "Toggle Grid Visibility" button (see Figure 8-27). This will create a grid, partitioning the whole workspace into small areas. The number of gridlines can be configured in the "Grid Columns" and "Grid Rows" attributes of the Display Screen. Once the grid is properly configured, select the resource to be aligned, then right-click and select "Snap to Grid" in the popup menu. This will align the center of the resource to the center of the grid if the location type is set as "Center Position", and align the top-left corner of the resource with the top-left edge of the grid if the location type is set as "TopLeft Position" (see the preference settings for Screen).

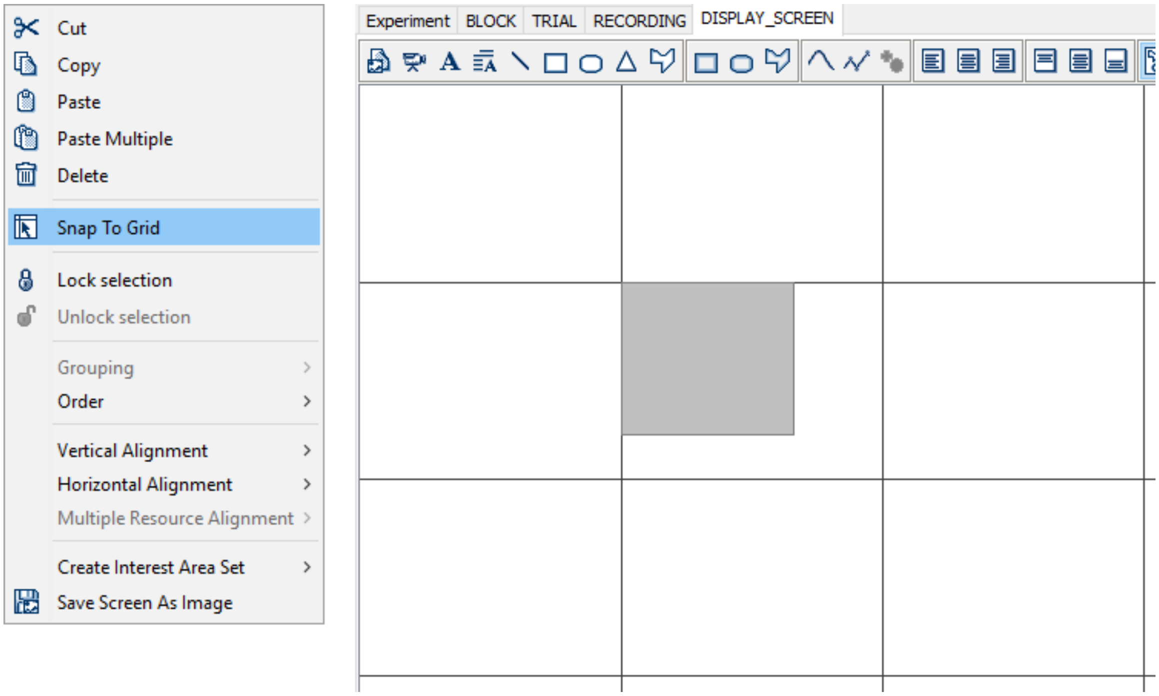


Figure 8-27. Snap to Grid.

Position alignments should be re-applied if the properties of the resource have been changed. For example, in a top-left screen coordinate system, changing the font size of the text resource after applying the center alignment will result in the text not being displayed in the center of the screen.

8.4.3 Resource Locking

When building the screen, users may want to lock a resource to prevent it from being moved or resized by accident. To lock a resource, right-click on the resource and choose "Lock Selection" option from the popup menu. To unlock the resource, select the "Unlock Selection" option from the popup menu.

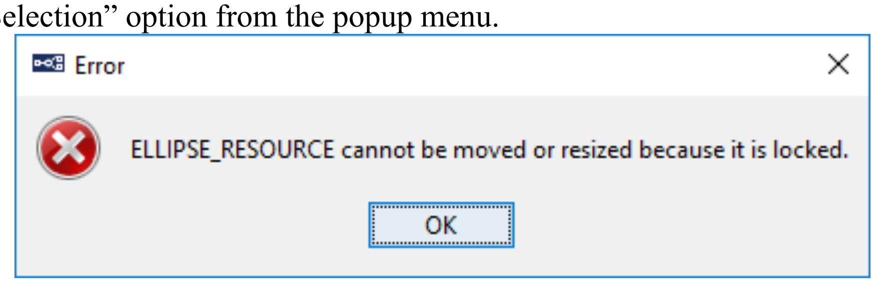


Figure 8-28. Error When Trying to Modify a Locked Resource.

When a resource is locked, any attempts to change the location of the resource from the workspace will prompt an error (see Figure 8-28, though users can still make modifications from the properties panel of the resource. Alternatively, first unlock the resource, make the adjustments, and then re-lock the resource.

8.4.4 Resource Grouping

Resource grouping offers a handy tool so several individual component resources can be treated as a single resource for the purposes of moving and aligning. For example, after a schematic face is created on the screen with several components resources, a user may want to adjust the position of the whole drawing. It will be much easier if all of the components resources are grouped and moved together than the individual resource components are moved individually. To group several resources together, select the resources, right-click and select “Grouping → Group” in the popup menu. To ungroup resources, select “Grouping → Ungroup”. Alternatively, click the “Group” or “Ungroup” tool buttons on the Screen Builder toolbar (see Figure 8-29).

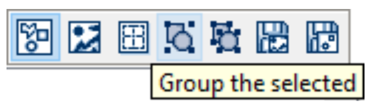


Figure 8-29. Resource Grouping.

Please note that after several resources are grouped together, a “COMPOSITE_RESOURCE” object is created, and the individual component resources are removed from the Structure Panel (see Figure 8-30). The content of the Property Panel is also updated to reflect this change.

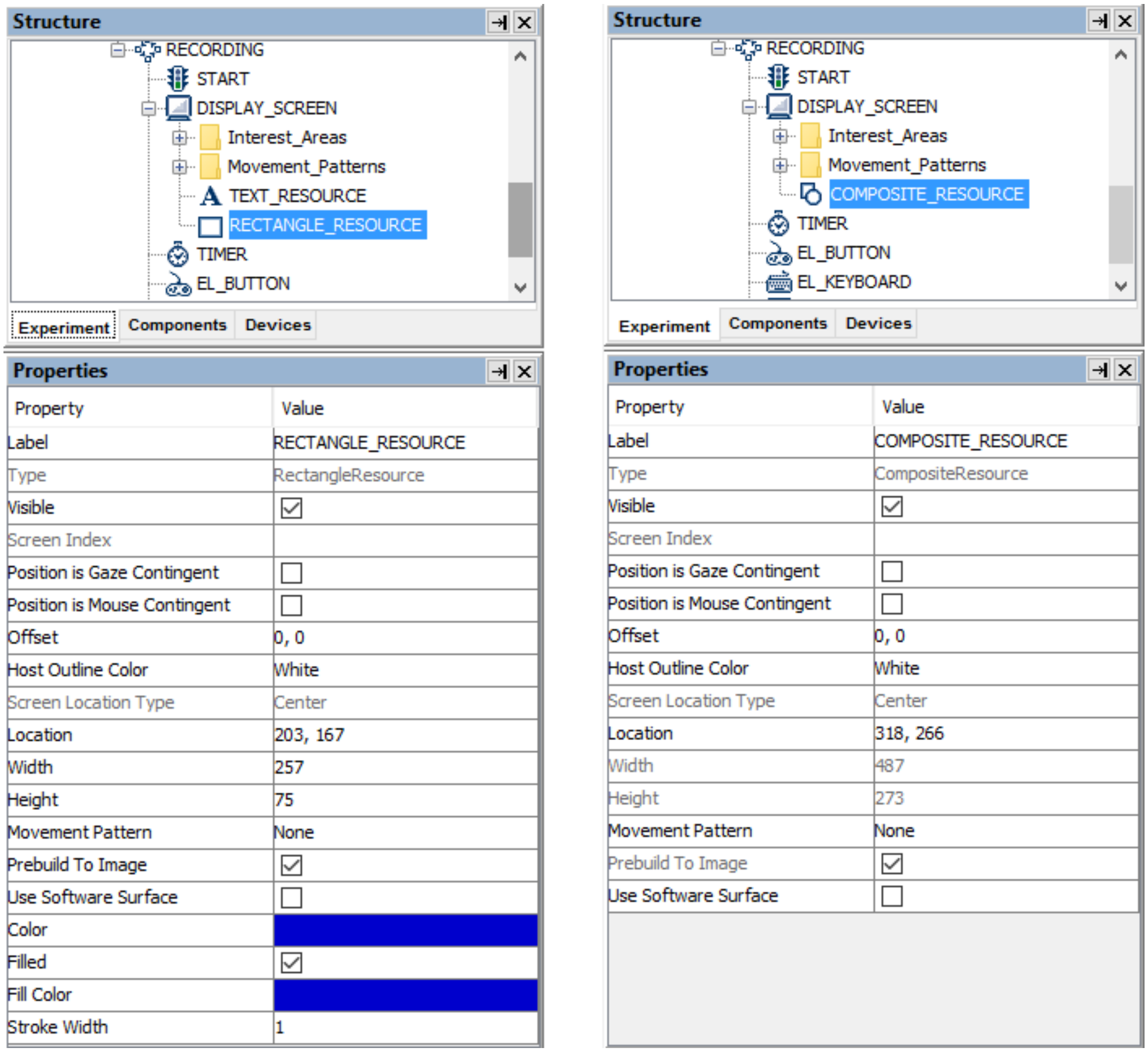


Figure 8-30. Creating a Composite Resource.

8.4.5 Composite Resource

A "COMPOSITE_RESOURCE" object can be created by grouping several individual resources together. The individual component resources are removed from the structure panel when a composite resource is created.

Field	Attribute Reference	Type	Content
Label *	.label	String	Label of the resource ("COMPOSITE_RESOURCE" by default).
Type #	NR		The type of screen resource (CompositeResource).
Visible †	.visible	Boolean	Whether the resource should be visible. The default setting is True (checked).
Screen Index #	.screenIndex	Integer	Index of the resource in the screen resource list

			(0 - n).
Position is Gaze Contingent †	.positionAtGazeContingent	Boolean	Whether the position of the resource is contingent on the gaze position. The default setting is False. This setting is only available when the parent display screen is contained inside a recording sequence.
Gaze Contingent Eye	.gazeContingentEye	String	Sets the eye used to provide data for the gaze-contingent drawing. Options are Left, Right, Either, Average, or Cyclopean (default setting). For a left-eye-only recording, data from the left eye is used when the gaze-contingency eye is set to “Left”, “Either”, or “Cyclopean”, and missing data when set to “Right” or “Average”. For a right-eye-only recording, data from the right eye is used when the gaze-contingency eye is set to “Right”, “Either”, or “Cyclopean”, and missing data when set to “Left” or “Average”. For a binocular recording, left eye data is used when the gaze-contingency eye is set to “Left” or “Either”, right eye data is used when set to “Right”, average data from both eyes if this is set to “Average” (with missing data if either is missing), and average data from both eyes when set to “Cyclopean” (with missing data if both eyes are missing, and data from the remaining tracked eye if a single eye is missing).
Contingency Deadband	.contingentDeadband	Tuple of integer	Sets the minimum amount of eye movement required to update the gaze-contingent moving window. This is designed to make the display drawing less susceptible to jitters in the eye position. Typically the deadband shouldn’t be larger than 3.0 pixels—larger deadband values will likely result in a lag in updating the display.
Position is Mouse Contingent †	.positionAtMouseContingent	Boolean	Whether the position of the resource is contingent on the mouse position. The default setting is False.
Offset	.offset	Point	Adjustment of the resource position relative to the intended resource location, whether specified by the Location attribute, the current gaze or mouse position, or a movement pattern. The default value is (0, 0) for a perfect alignment of the resource position with the specified position. Values specified in the Offset will be subtracted from the specified location. For example, if the location field is set to (512, 384), and the offset is (100, 100), the actual resource position will be (412, 284).
Host Outline Color ¶	.hostOutlineColor	Color	The color of the box drawn on the host screen to show the position and dimensions of the current resource. This property is available only if the

			"Use for Host Display" option of the parent display screen action is enabled and the "Draw to EyeLink Host" of the prepare sequence action is set to "Primitive".
Screen Location Type #	NR		Whether the location specified below refers to the top-left corner or center of the resource. This setting can be changed in “Screen Preferences”.
Location	.location	Point	The coordinates of the top-left corner or center of the resource.
Width #	.width	Integer	Width of the resource (in pixels).
Height #	.height	Integer	Height of the resource (in pixels).
Movement Pattern ¶ *	NR		Movement pattern (sinusoidal or custom) of the resource.
Prebuild to Image † #	.prebuildToImage	Boolean	Whether the resource should be built into an image when the experiment is built (instead of having it created during the actual execution of the trial). **IMPORTANT:** If the "Prebuild to Image" option is turned off, the run-time resource rendering may not look exactly as it does in the screen editor. In addition, images will not be saved to support Data Viewer overlay.
Use Software Surface †	.useSoftwareSurface	Boolean	If unchecked, memory on the video card is used to hold the resource (blitting from the video card memory to the display surface is fast). If checked, the system memory is used to hold the resource (blitting is slow as it is done by copying from RAM to display surface).

8.4.6 Resource Order

As resources are added to the screen, new resources are added in front of existing resources, which can result in some resources being occluded (see Figure 8-31). Therefore, the surface layout of individual resources may be rearranged.

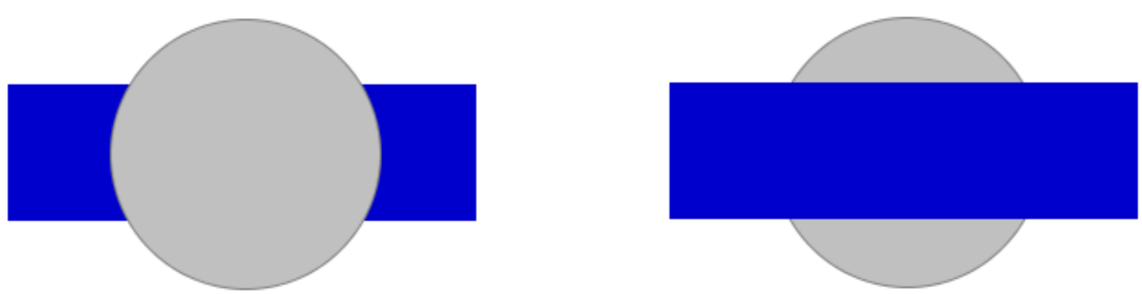


Figure 8-31. Two Resources with Different Resource Order.

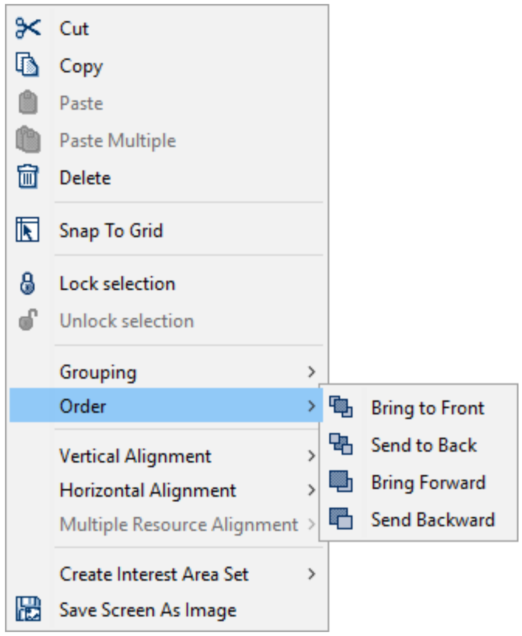


Figure 8-32. Changing the Order of Resources.

To change the order of a resource, select the resource, right-click, and choose one of the options under the "Order" menu from the popup menu (see Figure 8-32). "Bring to Front" makes the selected resource to appear on the topmost layer, so no other resources can occlude it; "Send to Back" moves the selected resource to the bottommost layer; "Bring Forward" moves the resource one layer closer to the surface; and "Send Backward" moves the resource one layer away from the surface. Changing the resource order on the workspace also modifies the order of the resource listed in the structure panel.

8.4.7 Others

The Screen Builder allows users to adjust the canvas size of the workspace. If the "Fit to Screen" option is enabled (see Figure 8-33), the workspace area is scaled to the size of the screen to be displayed; otherwise, the workspace area is set to its actual size (i.e., one pixel of workspace area corresponds to one pixel of computer desktop).

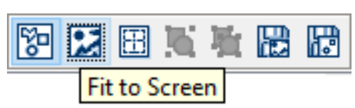


Figure 8-33. Choosing "Fit to Screen" Option.

Finally, users can save the current graphics in the work space to a file with the "Save Screen as Image" option (see Figure 8-34).

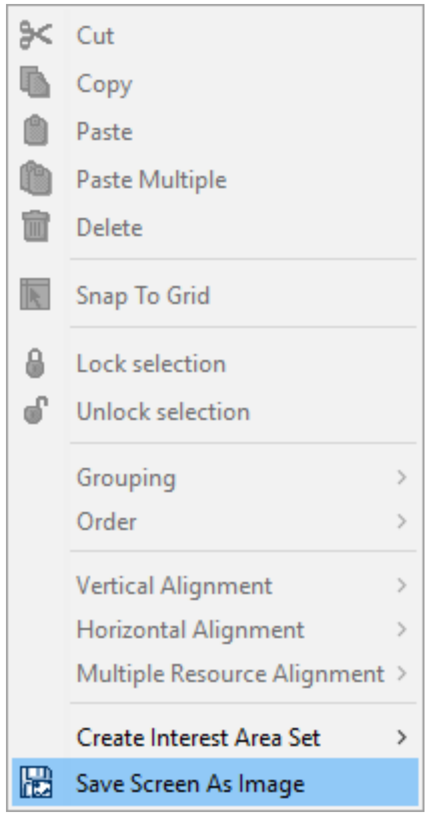


Figure 8-34. Save Screen as Image.

9 Data Source

An important issue for most experiments is to specify the actual parameters of the individual trials. For example, which experiment condition should each trial be in? Which image should be presented? One approach would be to hard code the content of each trial in the experiment. Obviously, this will be extremely time-consuming and error-prone if there are several hundreds of trials involved, as is often the case for a perception or cognition experiment.

Experiment Builder handles this issue by allowing users to create prototypical trials for the experiment and to supply the actual parameters for individual trials from a Data Source (see Figure 9-1). A data source can be created within Experiment Builder or by loading a text file. During the execution of an experiment, lines in the data source are read one at a time, supplying the actual parameters for each trial. Resources in the trial can load parameters from the data source by setting attribute references, which are discussed further in chapter 10.

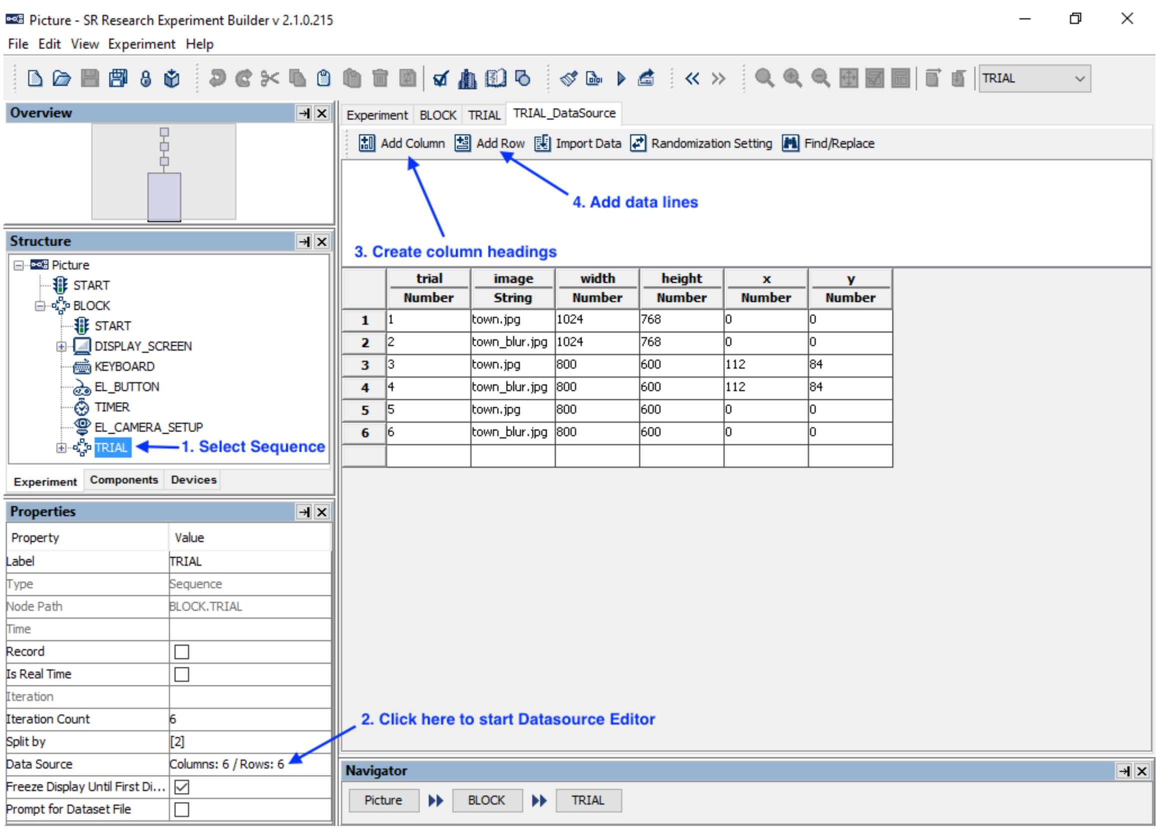


Figure 9-1. Using Data Source in Experiment Builder.

9.1 Creating Data Source

A data source is attached to a sequence, with each iteration of a sequence corresponding to a row of the data source. To create a data source, select the intended sequence node and click the value field of the "Data Source" property (by default, it shows "Columns: 0 / Rows: 0"). This will bring up the Data Source Editor. Any existing data sources will be listed in the dropdown menu on the rightmost end of the application toolbar ("None" if no data source has been created). Select a data source from this menu will bring up its data source editor.

9.2 Editing Data Source

To create a new data source, click the "Add Column" button () at the top of the Data Source Editor window.

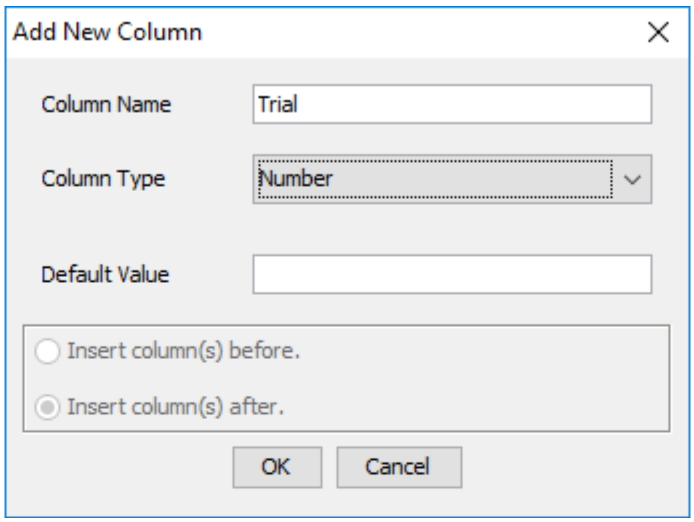


Figure 9-2. Change the Type of Variables.

In the Add New Column dialog (see Figure 9-2), fill in the "Column Name" field. The column name must be a string starting with a letter between 'a' and 'z' or 'A' and 'Z', and must consist only of alphanumerical characters ('A' - 'Z', 'a' - 'z', '0' - '9', or '_'); any space entered is converted to an underscore. The new data source column name shouldn't duplicate the name of any existing data source columns, variable labels, or any of these reserved words: "EYELINK", "DISPLAY", "AUDIO", "TTL", and "CEDRUS". In the "Column Type" dropdown list, choose the appropriate data type. If desired, set the Default Value for the new. Select the location where the column should be created (at the end of the data source editor, to the left of the currently selected column, or to the right of the currently selected column) and then click "OK" to create the new. Subsequent data source columns can also be added by selecting an existing data source column, clicking the right mouse button, and choosing the "Insert Column" option.

After adding the first column, an empty anchor row will be created. Click the empty cell, type a value into the cell, and press the ENTER key to register the change. This will now be the fist data source row, and a new blank anchor row will be created. Click the "Add Row" button () to create more rows of empty cells for data input. By default, the new data source rows will be created at the end of the table, or users can choose to insert the new row(s) above or below the currently selected data source row(s).

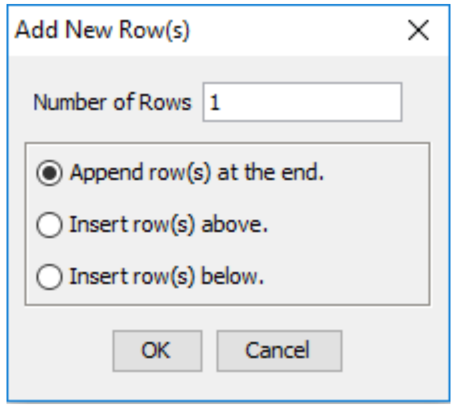


Figure 9-3. Adding New Rows to the Data Source.

Currently, Experiment Builder supports six data types: Number, String, Point, Color, List, and Boolean.

- The Number data type consists of one integer (1, 2, 3, ...) or float number (0.1, 2.0, 3.14159, ...) in each cell.
- The String data type can consist of any text. Note that the entered string does not need to be in quotes—if the text contains or is flanked by a pair of quotes, the quotes will be shown.
- The Point data type consists of two numbers separated by a comma representing the x and y coordinates—a pair of brackets will be added automatically.
- The Color data type consists of three integer numbers between 0 and 255, separated by commas, representing the red, green, and blue values. The program will automatically fill in a fourth alpha value of 255 when the entered color data is accepted.
- The List data type consists of a list of numbers, strings, colors, points, or lists, with each in the list separated by a comma. A pair of square brackets will be added automatically.
- The Boolean data type consists of either "true" or "false" in the data cell.

Figure 9-4 illustrates the use of these data types.

	Trial	Text	Location	List	Color
	Number	String	Point	List	Color
1	1	One	(512.0,384.0)	[1, 2]	(255,0,0,255)
2	2	Two	(512.0,384.0)	[1, 2]	(0,255,0,255)
3	3	Three	(200.0,100.0)	[6, 7]	(0,0,255,255)
4	4	Four	(100.0,200.0)	[6, 7]	(0,0,0,255)

Figure 9-4. Data Types Used in Experiment Builder.

To delete a data column, click the column heading of the intended column, then right-click and select "Cut" or "Delete" from the popup menu. To copy a column of data, click the column heading, then right-click and select "Copy". Then press "Paste" to append the new column to the end of the data source. To select a row, click on the row label. The same Copy, Paste, Cut and Delete operations may be performed on rows.

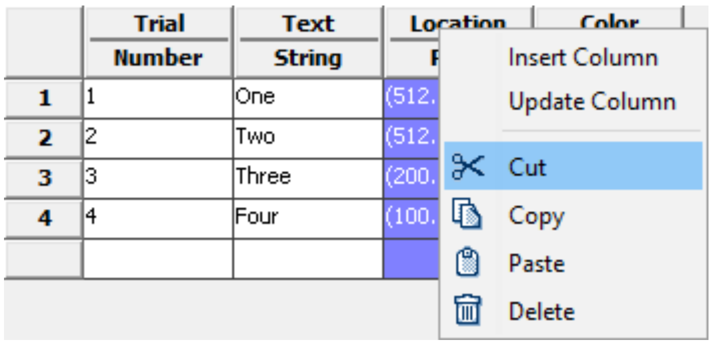


Figure 9-5. Editing Operations for Data Source Columns and Rows.

The Copy, Paste, Cut and Delete operations may also be used on a single selected cell or a range of selected cells. Users may copy cells from the Data Source Editor and paste them into a spreadsheet program like Microsoft Excel, or copy data from a spreadsheet program into the Data Source Editor. Selections can also be copied and pasted between two ongoing Experiment Builder sessions. **Note:** when copying and pasting between projects, or from an external spreadsheet program, make sure the data types of the copied cells match the types specified in the columns (e.g., do not paste a column of string data to a column specified as the color type).

Please make sure that there are no empty cells in the data source editor before performing a Test Run or Deploying the project.

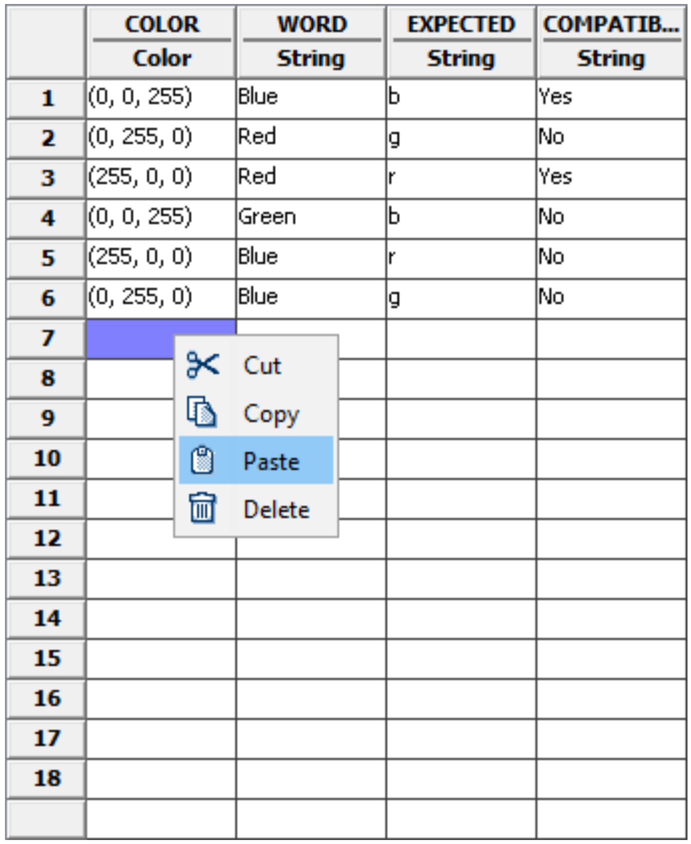


Figure 9-6. Editing Data Source Cells.

Version 2.0 of Experiment Builder allows users to find or replace text strings in the data source editor using the Find/Replace tool ( ). With the "Wrap searches" option (enabled by default), if the searched value is not found between the current position and the end of the Data Source, the tool will begin searching again from the beginning.

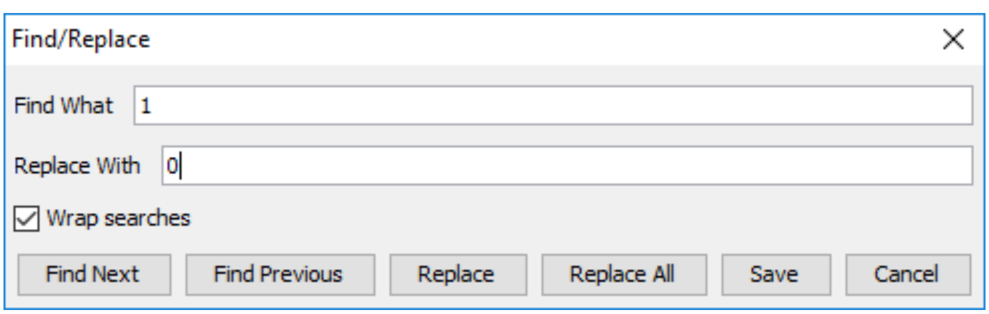


Figure 9-7. Importing an Existing File as Data Source.

The new version of Experiment Builder also supplies a workspace above the data source where the content of the currently selected data cell will be displayed. This expanded workspace can be useful for data source editing, especially if the cell contains lots of data (e.g., paragraphs of text). The changes to the data cell through this expanded workspace will be saved when you click anywhere in the data source editor.

9.3 Importing Existing Files as Data Source

For greater flexibility, users can also generate a data source with an external text editor software like Wordpad, Notepad, etc., and then load the plain-text file into Experiment Builder. In that file, use the first row for column variable labels. Experiment Builder 2.0 supports using various column delimiter characters, although earlier versions of Experiment Builder require Tab as the delimiter, so using Tab as the delimiter will improve compatibility. To import a data source from a text file, click the "Import Data" Button ( ) on the data source editor screen. In the "Import Data" dialog, choose the target file and the delimiter used. If the external data source file is encoded in the ASCII format, leave the "Encoding" field as "default". If the file is encoded in the UTF-8 format, choose UTF-8 from the dropdown menu. Then click the "Import" button.

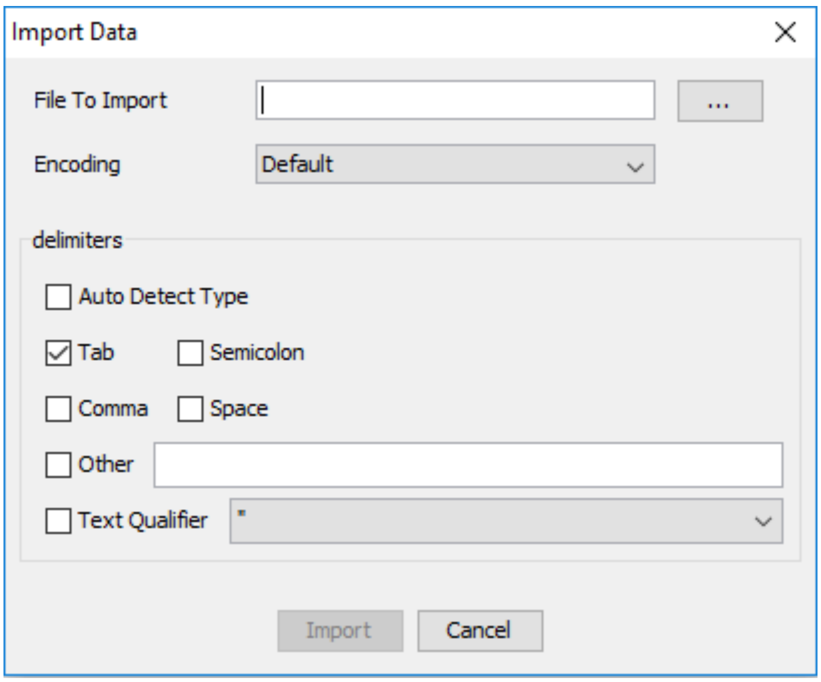


Figure 9-8. Importing an Existing File as Data Source.

If the current data source editor has existing data before the external data file is imported, choose whether to append the new data after the existing data lines, or to overwrite the old data lines (see Figure 9-9).

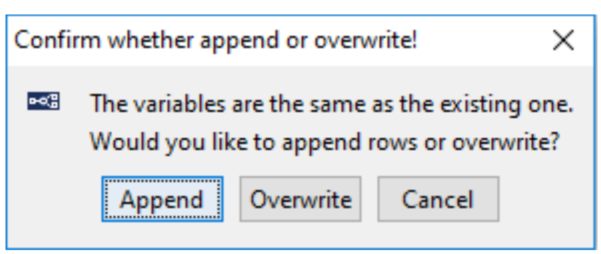


Figure 9-9. Append or Overwrite Confirmation.

Experiment Builder will automatically detect the type of data source columns upon importing the external file. To change data type for a column, click the column heading, then right-click and select “Update Column” from the popup menu. Then choose the desired data type.

9.4 Using Data Source File

Experiment Builder allows users to specify an external Data Source file to be loaded each time they run the experiment. To enable this option, select the sequence that the data source is attached to, and check the box for "Prompt for Dataset file" (unchecked by default). If checked, when running the experiment, the user will be prompted for a data source file for the session. Then either select the intended external data source file, or click the "datasets" folder and choose the default .dat file prepared by the program. If the "Prompt for Dataset file" option is unchecked, the file chooser will not be displayed during experiment runtime and the default data source file will be chosen.

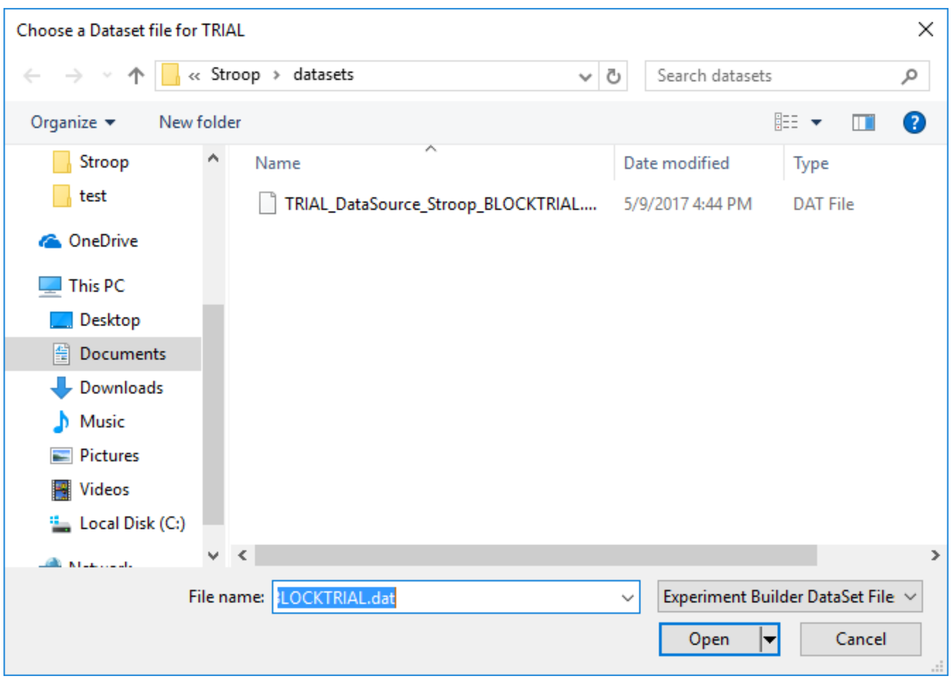


Figure 9-10. Choosing a Data Set File during Run-Time.

It's possible to prepare your own version of the data source file. When preparing data source files, please:

- Make sure all of the variable labels on the first row of the file are in lower case, regardless of the case used in the data source editor.
- Add a $ before the label of a string column (e.g., $word)—a $ sign should not be used for the labels of any other data types.
- Use a tab to separate between neighboring fields.

- Wrap the position and color values within (), string values with a pair of "", and list values with [].
- Make sure all of the values in each column of the data file appear in the original column of the data source editor.

9.5 Data Source Splitby

The "Split by" property specifies the actual number of iterations of a sequence to be executed each time the sequence is encountered. This can be used to divide the trials specified in the data source into different blocks. To divide the trials between the blocks, select the block the data source is attached to, and set the "Split by" attribute. For instance, if a user has 80 trials in their data source, but wants to split these trials evenly across two different blocks, they can set the Split by value to [40].

This feature can also be used to for experiments in which unequal number of trials are tested in different blocks. For example, the user may now want to run 32 trials in the first block, followed by 48 trials in the second block. In this case, they can enter [32, 48] in the "Split by" attribute.

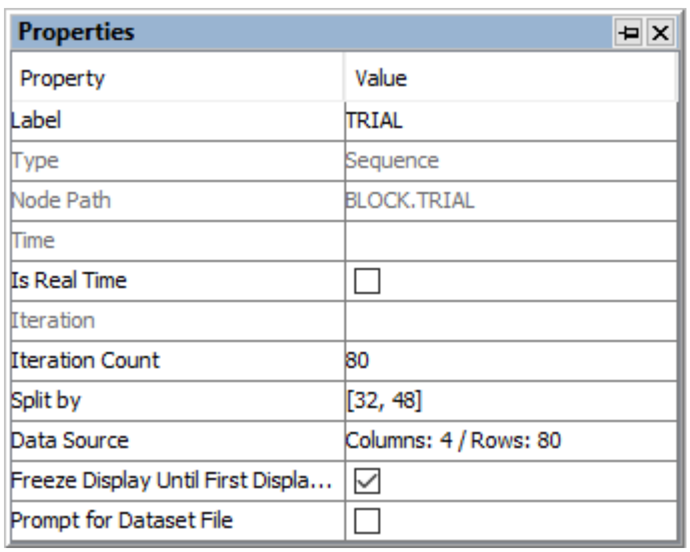


Figure 9-11. Using "Split by" Option to Customize the Number of Iterations to Run in a Sequence.

9.6 Data Source Randomization

In most experiments, the trial order is randomized so the experiment materials are not presented in the same sequence across participants. Users can perform data source randomization either internally (during runtime of the experiment) or externally (before running the experiment). These two randomization methods are almost identical except that the external randomizer allows for further counterbalancing manipulations across participants. You may experiment with both methods to see which one fits your needs better.

9.6.1 Internal Randomization

To configure the internal randomization, click the "Randomization Setting" ( ) button in the data source editor and make sure "Disable Run-Time Randomization" is unchecked (this option can be checked to disable the randomization for debugging purposes if necessary).

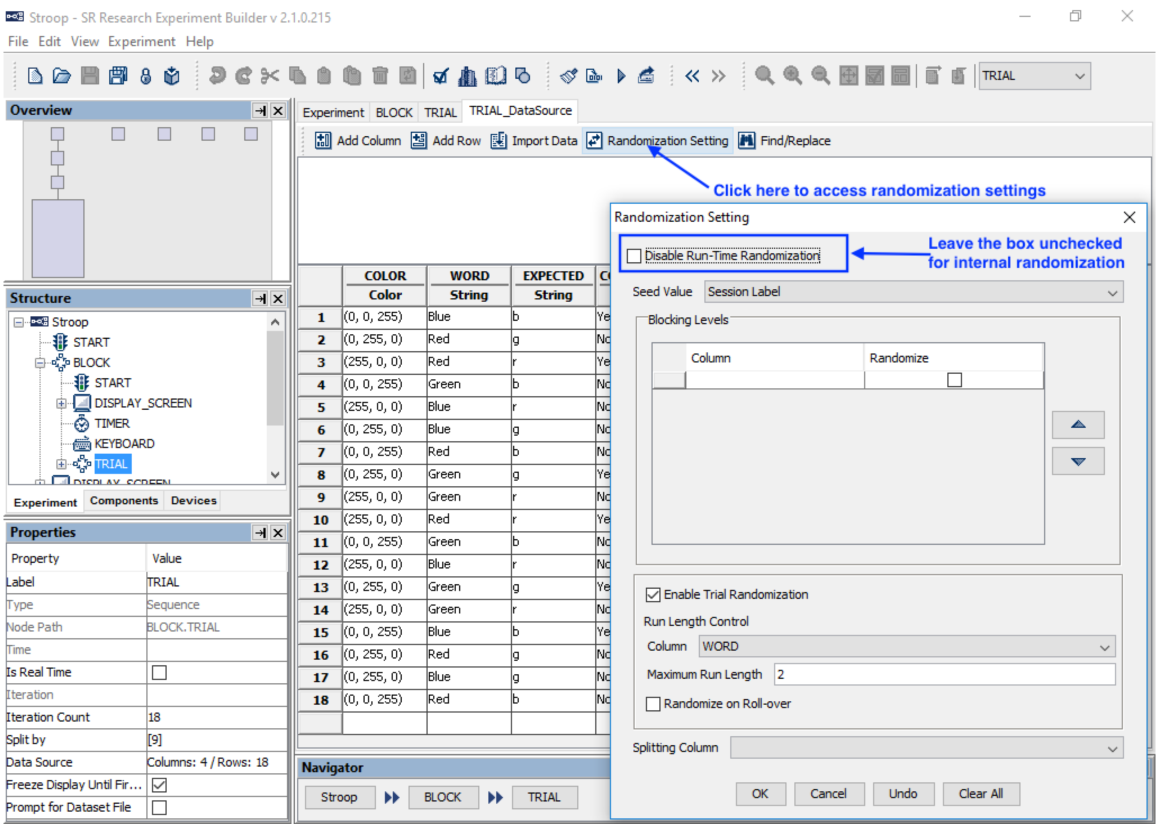


Figure 9-12. Using Internal Randomization.

9.6.1.1 Randomization Seed

If the Seed Value is set to "Current Time", the current Display PC system time is used as the randomization seed. If set to "Session Label", the string you input in the "Session Name" dialog box when running the experiment is used as the randomization seed. Any two runs of randomization with the same seed will generate identical randomization outputs.

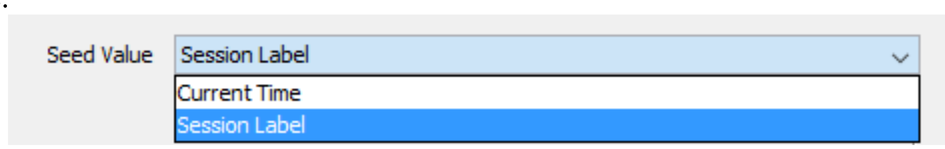


Figure 9-13. Setting Randomization Seed.

9.6.1.2 Blocking

In some cases, when randomizing trials, it may be necessary to keep certain trials grouped together. The internal randomizer allows users to define blocking variables to group trials—all trials with the same value of the blocking variable will appear in a group. To add a blocking level in the Randomization Setting window, click the first cell under the “Column” heading, and then choose the blocking variable from the dropdown list. If a second blocking level is needed, simply click the second “Column” cell, and so on. To change the order of the blocking variables, click the numeric heading to the left of the variable column so the row is highlighted, then click the up or down button on the right side of the window. To remove an existing blocking level, simple click the “Column” cell and then choose the first value (blank) in the dropdown list. If a blocking manipulation is not required in your experiment design, simply leave the “Blocking Levels” field empty.

If blocking is applied, the order of the trial groups (i.e., different values of the blocking variable) to appear in the randomization output can be controlled by whether the “Randomize” box is checked or not.

- If the “Randomize” box is not checked: The order of the blocking groups will be the same as the order they appear in the original data file. For example, the four levels of the $var_abcd variable appear in the order of ABCD in the original file. The $var_abcd variable in the randomization output also appear in the order of ABCD.

- If the “Randomize” box is checked: Levels of the blocking variable will appear in a random order. For example, blocking by variable "$var_abcd" with randomization type set to "Random" will create one of the 24 possible orders (ABCD, ABDC, ACBD, ACDB, ADCB, ADBC, BACD, BADC, BCAD, BCDA, BDAC, BDCA, CABD, CADB, CBAD, CBDA, CDAB, CDBA, DABC, DACB, DBAC, DBCA, DCAB, or DCBA).

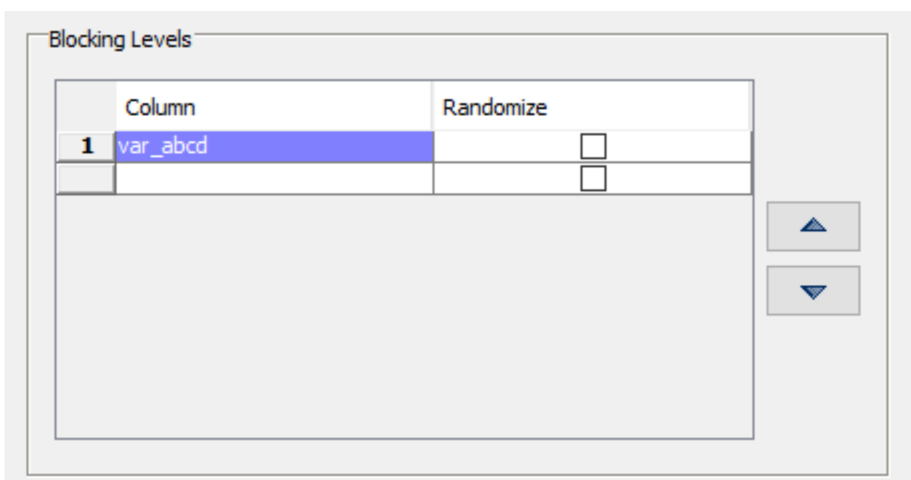


Figure 9-14. Configuring Randomization Blocking.

9.6.1.3 Trial randomization and Run Length Control

If the "Enable Trial Randomization" box is checked, the trial order will be randomized. To limit how many trials with the same condition can be run consecutively, choose a variable to serve as the 'Run Length Control' from the dropdown list (currently, only one run length control variable is supported). Enter the “Maximum Run Length”, the maximum number of consecutive trials to run with the same condition, and press Enter to register the change. Version 2.0 of the software allows the maximum run length to be set to 1 or higher. **Note:** controlling run length may not be possible for some data sets. While the software applies run-length control across trials within each blocking group, this control is not enforced for consecutive trials spanning two blocking groups.

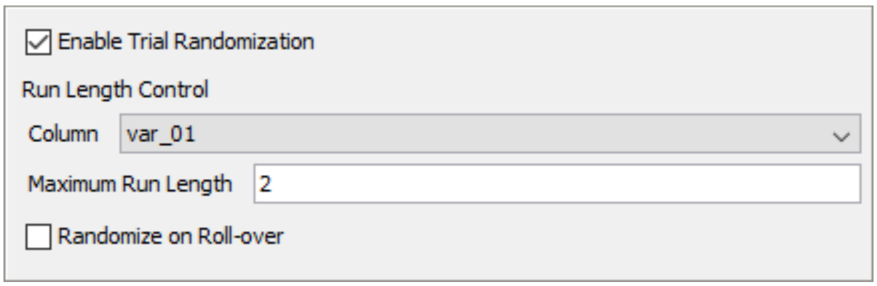


Figure 9-15. Enabling Trial Randomization and Configuring Run-Length Control.

9.6.1.4 Randomize on Roll-Over

If checked, a different randomization sequence will be created for the data source when it is re-used. Otherwise, the same randomization output will be reused.

9.6.1.5 Splitting Column

For some users, it may be convenient to create a large data source containing multiple sets of trials, and run only a set of trials per session. For instance, this makes it easy to implement between-participant manipulations without having to create multiple separate Experiment Builder scripts, or to choose from different fixed pseudorandom trial orders. Users can define a Splitting Column in the Randomization Setting window (see Figure 9-16).

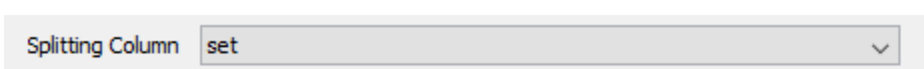


Figure 9-16. Configuring Splitting Column.

When running the experiment, the software will prompt the experimenter at the beginning of the session to select a value from the Splitting Column (see Figure 9-17). Experment Builder will then create a runtime data source using only the data source rows with the value of the “splitting column” matching the value specified.

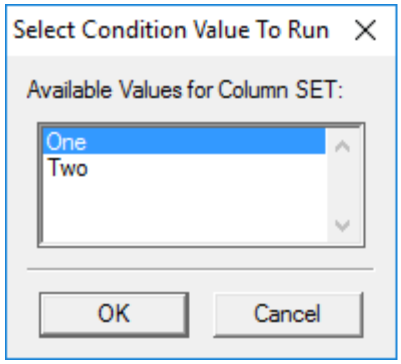


Figure 9-17. Selecting Condition Value to Run.

9.6.1.6 Running Experiment with Internal Randomizer

Once the experiment has been fully tested, deploy the project (Experiment → Deploy). Click the {experiment name}.exe file in the deployed directory to run the experiment. If you have specified a variable for splitting the data source, a dialog box will be displayed at the beginning of the experiment, prompting to choose the level of the splitting variable. Experiment Builder will then randomize the data source using the specified parameters.

At the end of the experiment, a file containing the randomized data source actually used in the session will be saved in the results directory.

9.6.2 External Randomization

In the experiment project, please make sure the "Prompt for Dataset File" box is checked on the sequence the data source is attached to. In the Randomization Setting window of the data source, make sure the "Disable Run-Time Randomization" box is checked so the internal randomization is ignored. (See Figure 9-18.)

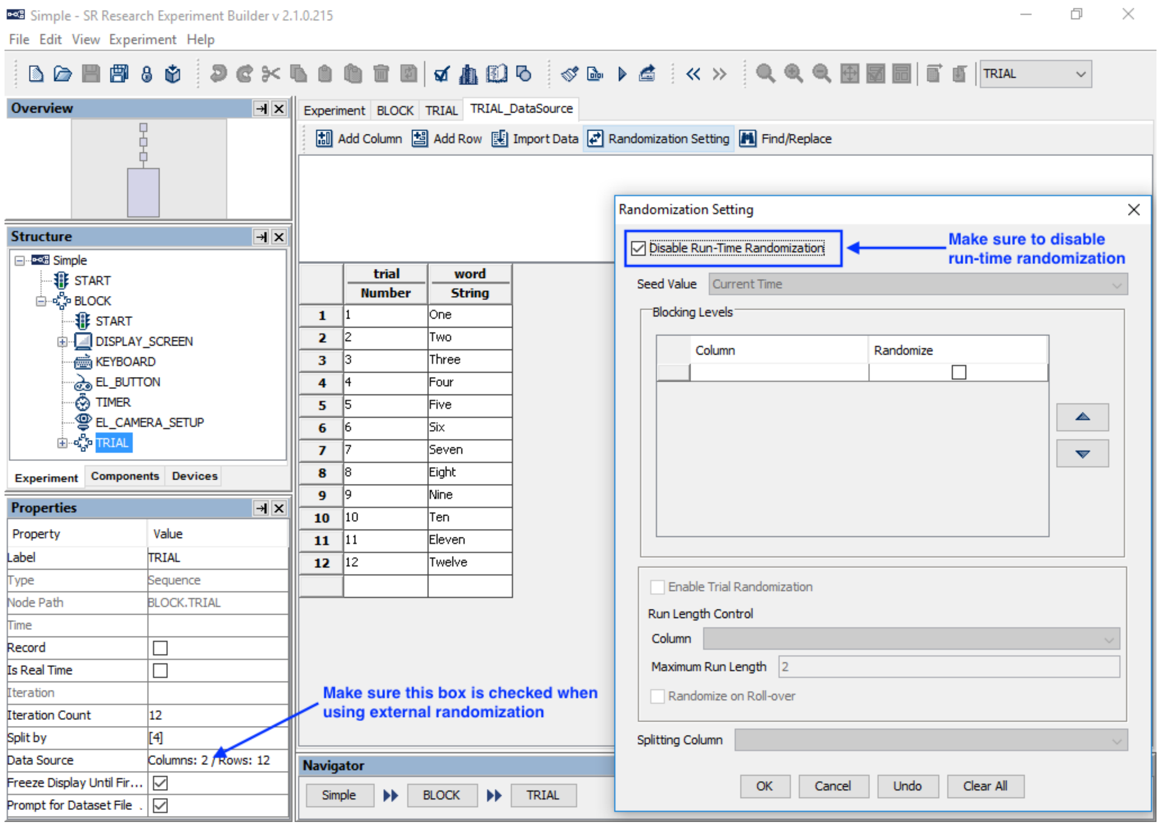


Figure 9-18. Using External Randomization.

(**Important:** Before deploying the project, make sure the data source within the project contains every possible trial instance that may occur in the randomized files to be loaded at runtime. If an external file is used that contains a value not present in the internal data source, the experiment may crash during runtime.)

Once the experiment has been fully tested, deploy the project (Experiment → Deploy). In the intended deploy directory, the project data source will be saved as a .dat file in the "datasets" directory. Perform the randomization using the project data source file and put the randomized copies in the “datasets” directory. (**Important:** When a project is rebuilt by clicking Experiment → Build or Experiment → Test Run ..., all of the files in the "datasets" directory will be deleted. If working on data sets before deploying the project, please back up those files in a different folder, e.g., the "myfiles" directory, before rebuilding the project.)

On Windows, the external Randomizer tool can be found in the Start Menu under SR Research → Experiment Builder → Randomizer, or at {Windows Drive:}/Program Files (x86)/SR Research/Experiment Builder/Randomizer/RandomizerW.exe. On macOS, the Randomizer.app can be found in the "/Applications/ExperimentBuilder" folder. See the Help document in the Randomizer tool for more information.

Users may also create the trial randomization files manually by using a program like Microsoft Excel to create the data source files, then saving them into tab-delimited .txt files.

Once the randomization is done, click the {experiment name}.exe file in the deployed directory to run your experiment. When prompted to load a data source file, choose one of the randomized copies from the "datasets" directory.

10 References

Experiment Builder uses “references” to link an attribute of one experiment component to the value of another component attribute. References are a critical part of Experiment Builder, providing much of the application’s flexibility.

For example, say a sequence has two components, X and Y. Component X has attribute X.a and component Y has attribute Y.b. If attribute X.a is set to reference Y.b, then the value of X.a will always be equal to the value of Y.b. X.a is thus the ‘referencing’ or ‘referring’ attribute, and Y.b is the ‘referenced’ attribute. Even if the referenced attribute Y.b changes value during the experiment, the referencing attribute X.a will always reflect the current value of Y.b.

10.1 Using References

References have the following syntax: “@object_name.attribute_name@”, always starting and ending with a ‘@’ sign. References can easily be added from the Attribute Editor. To open the Attribute Editor, click once in the value field of the property to be edited (see Figure 10-1). If the field supports attribute referencing, a button with three dots […] will be displayed on the right side of the cell. Click on the […] button to open the Attribute Editor. Users can enter a value, reference, or equation into the Attribute field at the top of the editor. Components and their attributes can be referenced from the Node Selection panes at the bottom of the editor.

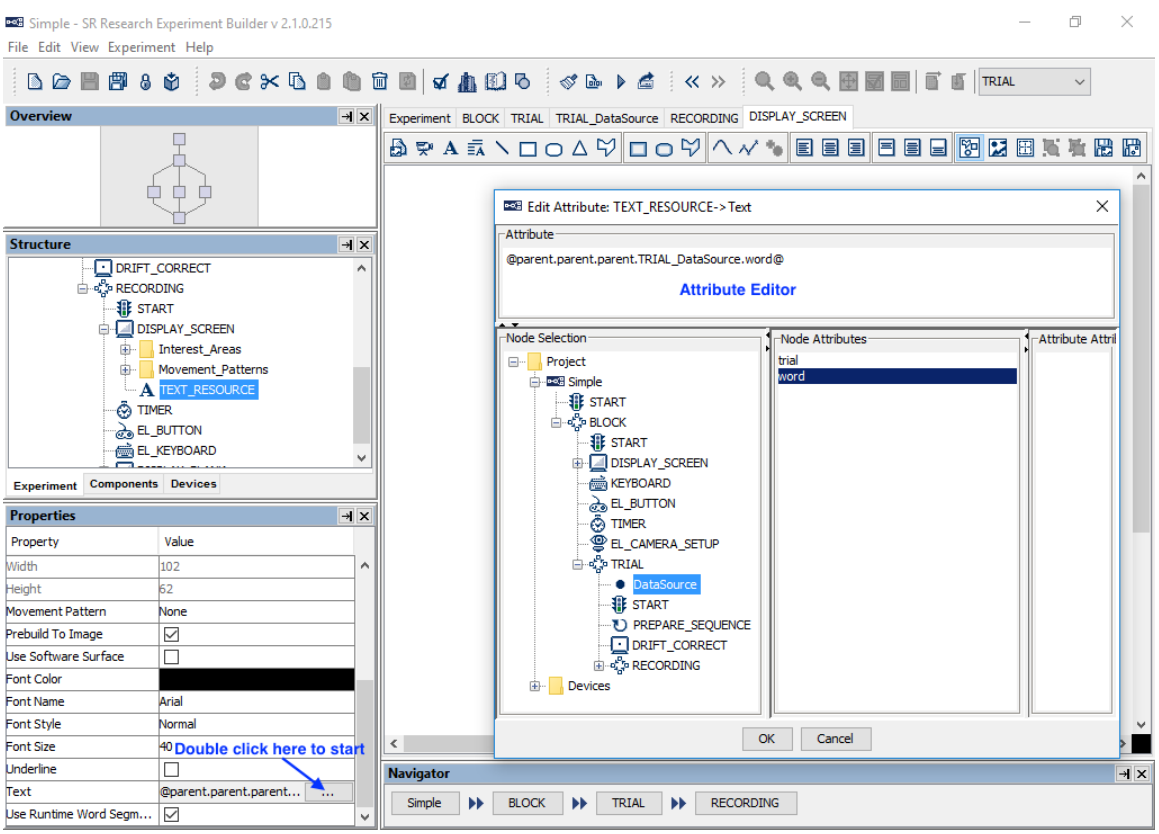


Figure 10-1. Using Attribute References.

10.2 Entering in Values

To enter static values into the attribute editor, simply type the value. Any preceding or trailing white spaces are removed. The following table illustrates how some commonly used data types can be entered in the attribute editor.

Entered value	**Translated type**	**Translated value**	**Usage**
Hello	String	Hello	Label, Message, Text properties
“Hello”	String	“Hello” (Quotes are preserved).	
Hello	String	Hello (The under scores are representing white spaces, which are trimmed)	
1	Number	1.0	Width, Height, Time
1.0	Number	1.0	Width, Height, Time
True	Boolean	True	Check Boxes (Possible values are “True” or “False”)
False	Boolean	False	Check Boxes (Possible values are “True” or “False”)
(100,100)	Screen Point	(100.0,100.0)	Location
[5, 2, 6]	List	[5.0, 2.0, 6.0]	Buttons, keys, Split-by List
(15, 223, 58)	Color	(15, 223, 58)	Color

Please note that all non-string data entries are automatically translated into the appropriate data types, unless the type of the field is already specified as a string.

10.3 Entering in References

The easiest way to enter a reference in the Attribute Editor is navigate to the node in the object tree, select the node, then double click on the desired node attribute or sub-attribute (see Figure 10-1). The reference will then appear in the Attribute window at the top of the editor. If desired, users may also enter in the reference manually without using the object tree.

References have the following constraints:

1. The referred value should match the assigning field’s value type. Suppose object *X* has attribute *p* and object *Y* has attribute *q*. If the type of attribute *X.p* is number, and the value of *Y.q* is the string “5”, *X.p* cannot directly refer to *Y.q* or vice versa. An “Invalid Value” error dialog box will be displayed if wrong type of data is entered in the attribute editor.

2. One attribute cannot refer to itself. In the above example, *Y.q* cannot have reference to *Y.q*. A “Recursive/Invalid reference” error message will be reported during build time.
3. Type conversion is only partially supported. An integer can be assigned to a number (float or non-float) and vice versa. Most conversions, however, will require use of an equation.

10.4 Entering in Equations

Equations are a combination of values and/or references. Equations can be used to calculate data at runtime based on static or dynamic values, or both. All equations start with an ‘=’ sign followed by references and/or values concatenated with operators (+, -, *, /, %). All of these operators support numerical operations, and the ‘+’ sign can also be used for string concatenation. Functions like “str”, “int”, and “float” can be used for data type conversion.

Note: Any valid Python equation is a valid equation in Experiment Builder. For details on Python, the run-time programming environment used by Experiment Builder, visit http://www.python.org/.

Although equations will be evaluated during build time to check for obvious problems, users should always check for the completeness and validity of the equations themselves. In particular, make sure that the data type of the equation created matches the data type required in the attribute field. In the following Example 1 (see Figure 10-2), the “EyeLink Record Status Message” field of a recording sequence expects a string value. Therefore, the equation created in Example 1 must be a string, so it uses the “str” function to convert numerical values to strings). In Example 2, the Location property expects the point data type, so the equation is written as two numerical values separated by a comma inside parentheses.

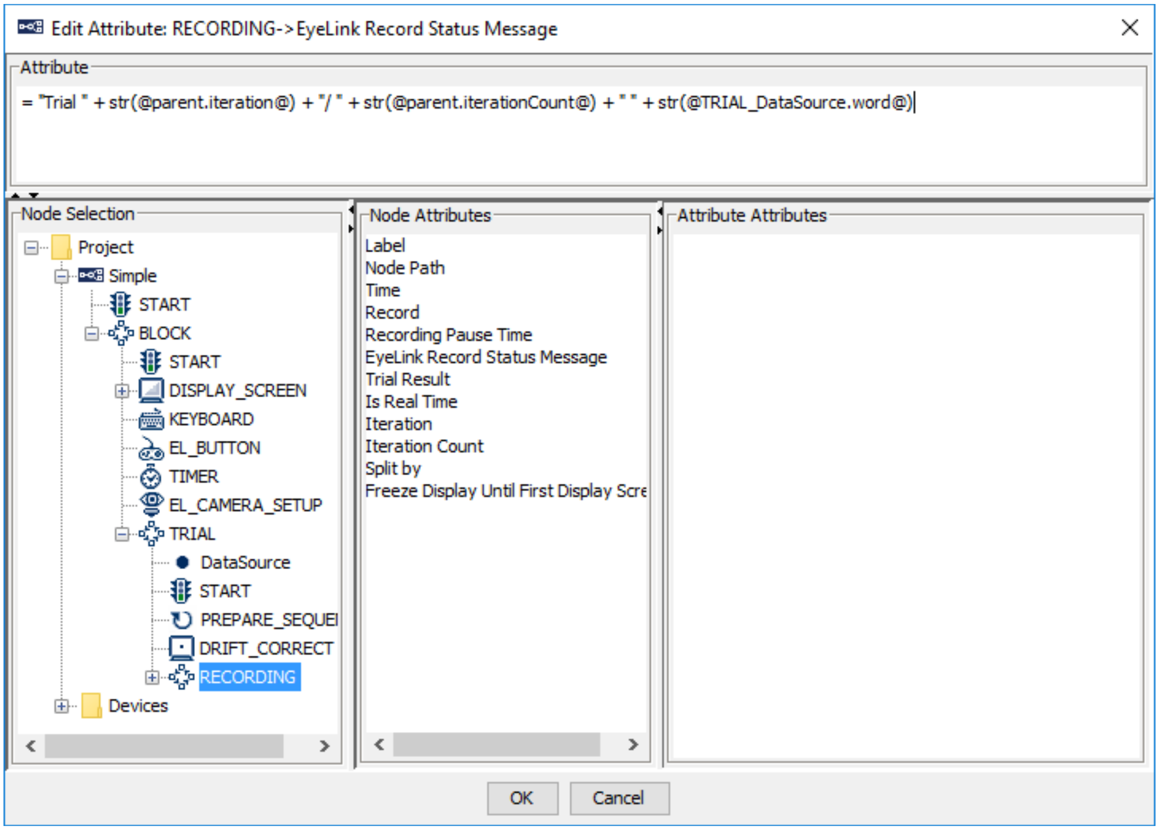


Figure 10-2. Creating Equations in the Attribute Editor.

10.4.1 Creating a Complex String: Formatting and Concatenating

String formatting in Python uses the same syntax (see https://docs.python.org/2.7/library/stdtypes.html#string-formatting-operations) as the sprintf function in C.

="my string %s, %s followed by an integer %d" % (string1, string2, number)

The whole expression evaluates to a string. The first %s is replaced by the value of 'string1'; the second %s is replaced by the value of 'string2'. The %d is replaced by the value of number. All other characters in the string (in this case, the equal sign) stay as they are.

Users can also conveniently creating a string by concatenating string literals. The following illustrates creating the same string by concatenation.

="my string " + string1 + ", " + string2 + " followed by an integer " + str(number)

Please note that:

- equation starts with a =;

- + is the string concatenation operator.
- Trying to concatenate a string with a non-string raises an exception. Unlike string formatting, string concatenation works only when everything is already a string. Therefore, for all non-string data ('number' in this example), users may use str() to do type casting.

10.4.2 Examples

The following is a few examples of equations in Experiment Builder.

- Example 1: During recording, a text message can be displayed at the bottom of the tracker screen (e.g., like "Trial 1/12 One") so the experimenter knows the progress of experiment. To set this message, select the "Recording" sequence node in the structure list. Click the value field of the "EyeLink Record Status Message" property of the sequence once, then click the […] button to bring up the attribute editor. Enter a reference equation such as:

```
="Trial " + str(@TRIAL_DataSource.Trial@) + "/12  "
+@TRIAL_DataSource.Word@
```

- Example 2: To draw a text resource to the center of the display screen ("parent"), the location of the text resource can be referred as:

```
=(@parent.width@/2,@parent.height@/2)
```

- Example 3: To write the position of the text resource ("TEXT_RESOURCE") to the data file using an EyeLink Message action in the same sequence as the display screen (DISPLAY_SCREEN) that contains the text resource, the Message property of the EyeLink Message action can be referred as:

```
= "Text Location " + "x = " +
str(@parent.DISPLAY_SCREEN.TEXT_RESOURCE.location.x@) + " y= " +
str(@parent.DISPLAY_SCREEN.TEXT_RESOURCE.location.y@)
```

  This will record a message like, "MSG 11545029 Text Location x = 512 y= 384" in the EDF file.

- Example 4: This illustrates how to write the reaction time calculation for a button press (EL_BUTTON) following the onset of the display screen (DISPLAY_SCREEN) to the data file, assuming that all actions and triggers are contained in the same sequence. The following equation could be set as the Message field of an EyeLink Message action:

```
="Button pressed time " +
str(@EL_BUTTON.triggeredData.time@-@DISPLAY_SCREEN.time@)
```

  This will record a message like, "MSG 12818953 Button pressed time 1228.0" in the EDF file.

10.5 Reference Manager

All of the references used in the experiment graph can be reviewed and modified in the Reference Manager, which tabulates the source, parent of source, property and value for each reference. The Reference Manager can be accessed by clicking "Edit → Reference Manager" from the application menu bar. To edit a reference through the Reference Manager, click the Value field of the reference once, then click the […] button to bring up the attribute editor.

The Reference Manager has a Find and Replace function to search for any reference entries that contain a given string, and if desired to replace the searched string with different text. To search for a string, enter the text in the "Find What" edit box and press the ENTER key (note that the search is case-sensitive). References containing the searched string will be displayed in the list. To replace a string, enter the text to be replaced in the "Find What" edit box and the new text in the "Replace With" edit box. Make sure the "Replace With" box is selected (the blinking text cursor should be in the box) and press ENTER key to perform the replacement. Click the "Undo Replacement" button () to revert to the original text.

To limit the scope of displayed references, select a sequence from the dropdown list at the upper-left corner. Only references inside that sequence will now be displayed, including any subsequences within the specified sequence, as "Include Subsequence" is checked by default. To display only references within the specified, and not within subsequences, simply uncheck this box. To show only the invalid references, check the "Hide Valid References" box.

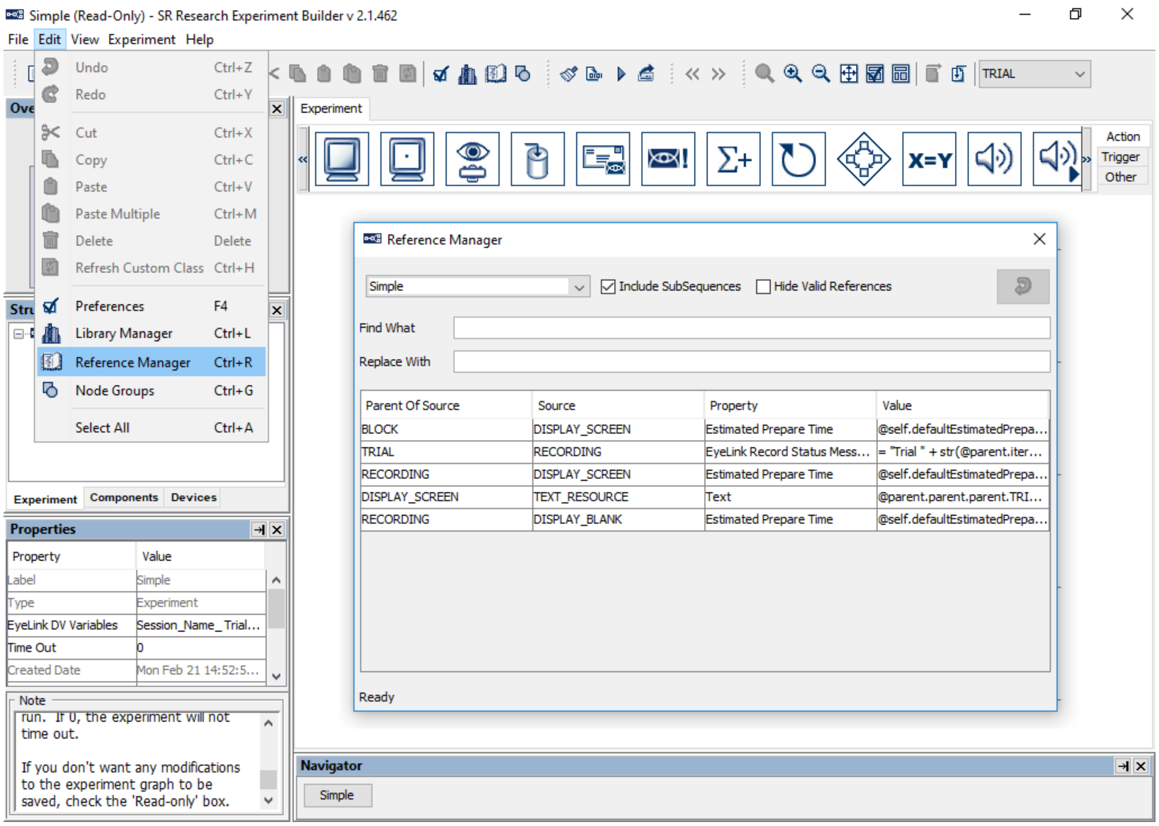


Figure 10-3. Using the Reference Manager.

11 EyeLink Data Viewer Integration

EyeLink recording data, saved as .EDF files, can be conveniently analyzed with the Data Viewer application. A set of messages can be written to the data file so that the Viewer can automate configurations for individual trials. Examples of such messages include specifying trial variables, defining images and simple drawings to be used as background for overlay display, creating interest areas, etc. Experiment Builder automates many of these integration messages, but users may wish to configure what is included in these messages.

It's always a good idea to plan for data analysis while the experiment is still being designed. Spending a short amount of time configuring messages and interest areas at the design stage may save hours in data analysis later. We strongly recommend testing at least one participant after creating the experiment and collecting the recorded data to examine timing accuracy and to check whether any critical information is missing.

11.1 Trial Condition Variables

The "EyeLink DV Variables" property of the experiment is used to send trial condition messages to the EDF file on each trial so users know exactly under which conditions each trial was performed. At the end of each trial recording, a "!V TRIAL_VAR" message will be written to the EDF data file for each of the selected variables and their corresponding values, which Data Viewer will then read automatically as trial variable messages.

The list of possible variables includes columns in the experiment data source as well as Variable nodes created by the user. To open the EyeLink DV Variables selection window, click the experiment node at the very top of the Structure tree, then click the value cell next to the EyeLink DV Variables property.

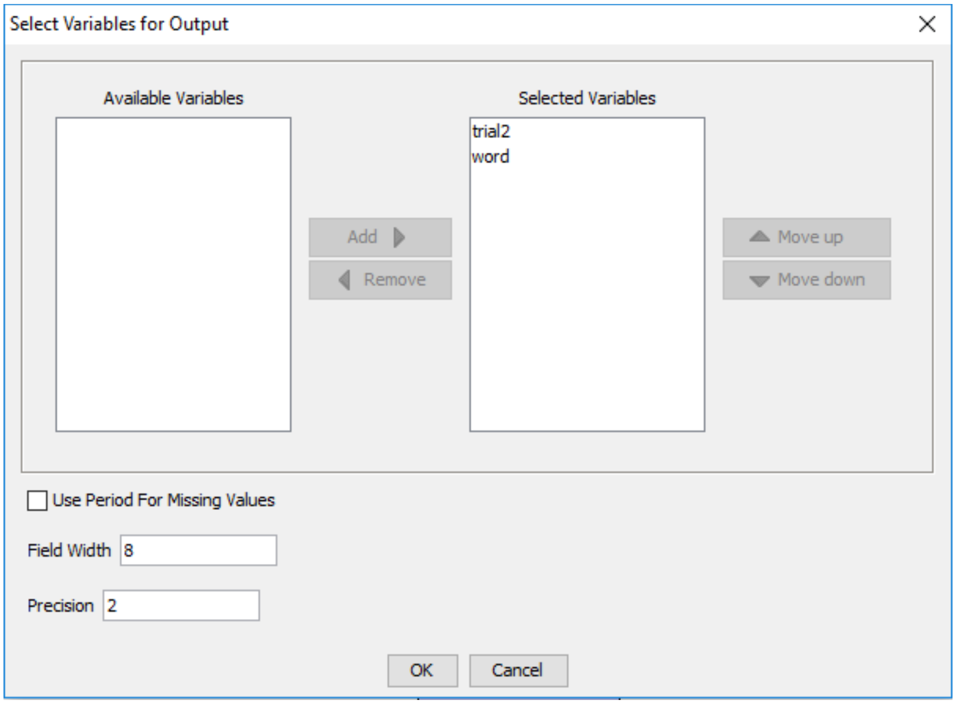


Figure 11-1. Editing Trial ID Message.

The “Selected Variables” panel on the right lists all the data source columns and variables currently selected to be written to the EDF as trial variables, and “Available Variables” will show any variables not selected to be written as trial variables. Version 2.0 of Experiment Builder now automatically adds new variables and data source columns to the Selected Variables list. To add or remove items from the Selected Variables, select the item(s) to be moved, then click the “Add” button (▶) or “Remove” button (◀). To configure the order of the variables in the output, select the item(s) to be moved and click the “Move Up” (▲) or “Move Down” (▼) buttons. Users may also configure the “Field Width”, specifying the minimum number of characters output for numerical values, and “Precision”, specifying the number of digits after the decimal-point character for floating-point values, as well as whether to write out a period (.) for missing values.

11.2 Images and Interest Areas

The Spatial Overlay View in Data Viewer allows users to visualize eye movements over the visual stimuli used in the experiment by reading “DRAW_LIST” messages in the EDF that specify the images and drawings in each trial. By default, Experiment Builder will send a “DRAW_LIST” message to the EDF corresponding to the visual stimuli on all the Display Screen actions within the Recording sequence.

```
MSG 12808461 -9 !V DRAW_LIST graphics/VC_1.vcl
```

The "Send EyeLink DV Messages" property of a Display Screen action, checked by default, controls whether that Display Screen will be included in the “DRAW_LIST” message. If unchecked, the stimuli from this screen will not be visible in Data Viewer. It can be useful to uncheck this property, for instance, if a blank screen at the end of the trial is used to clear the display screen, so the blank screen is not displayed in the Spatial Overlay View in Data Viewer.

Important: Screen resources will only be visible in Data Viewer if the "Prebuild to Image" property of the resource is checked. "Prebuild to Image" builds the screen resource into an image file saved in the "\runtime\images" directory when the experiment is built—unbuilt images will not be visible in Data Viewer. In addition to making resources available for Data Viewer, having "Prebuild to Image" checked ensures a better runtime performance. Version 2.3 of Experiment Builder allows the user to save a capture of any DISPLAY_SCREEN action, which is useful for showing non-prebuild stimuli in Data Viewer.

For some experiments, users may create interest areas to easily determine measures like Dwell Time, First Fixation Time, and Fixation Count within a given region. If a Display Screen contains interest areas, Experiment Builder will write an interest area message to the EDF data file to inform Data Viewer to include those interest areas for analysis.

```
MSG 63036 -13 !V IAREA FILE aoi/IA_1.ias
```

Important: In order for Data Viewer to properly load trial images and interest areas, the file structure of the deployed project directory should be maintained. For instance, if the "results" directory is moved to a new location on the computer, Data Viewer will not be able to find the images in the "\runtime\images" relative to the new location. Similarly, the "aoi" and "graphics" folders in each of the recording session folders contain the integration details for overlaying the interest areas and images in Data Viewer and shouldn't be moved out of the "results/{session}" folder. If performing data analysis on another computer, make sure to copy the entire deployed project directory (the whole {Experiment Name} folder) to the analysis computer. To make the data transfer easier, you may first zip up the {Experiment Name} folder (keeping the directory structure) and then unzip the file on the data analysis computer.

12 Custom Class

In addition to programming through the Graphical User Interface, Experiment Builder allows users to do custom scripting using the Python programming language. This section explains how to create a new custom class, how to define class attributes and methods, how to instantiate a custom class object, and how to use the custom class object in the Experiment Builder GUI.

12.1 Enabling the Custom Class Option

To create a custom class in an Experiment Builder project, please first check the project preference settings to make sure custom class is enabled. Click "Edit → Preferences", select "Experiment Preferences", and check the "Enable Custom Class" box. This will activate several node types for use in the experiment project: "Custom Class Instance", "Execute Action", and the "Custom Class" tab of the Library Manager (see below).

12.2 Creating a New Custom Class

To create a new custom class, click "Edit → Library Manager". Select the "Custom Class" tab and click the "New" button (). In the following "File Name" dialog box, enter the intended custom class file name. To load a python file (.py) as a new custom class, click the "Add" button.

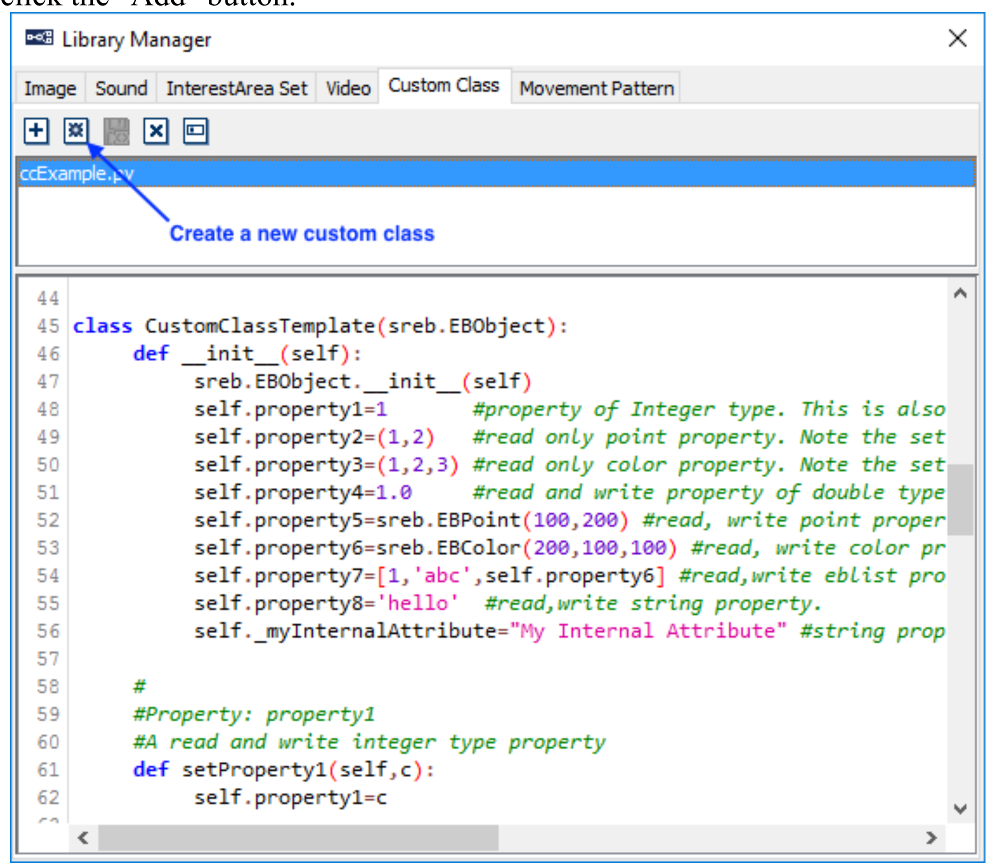


Figure 12-1. Creating a New Custom Class.

There are some restrictions in the file naming:

1) The file name cannot use any of the following reserved words (names of packages that already exist in the python library path): ctypes, numarray, py2exe, pyasio, pygame, pylink, pypsy, pythonwin, serial, sreb, win32, and wxPython.
2) The file name cannot have spaces or non-ANSI characters.
3) The file name cannot contain a period (.) other than for the ".py" extension.

12.3 Syntax of Custom Class

Custom Classes are written using the Python programming language. As such, an understanding of the Python programming language is necessary before creating a Custom Class in Experiment Builder. Please refer to the Python documentation https://docs.python.org/2/ if you are not familiar with the language.

While a custom class is written in Python, a set of rules is used by the Experiment Builder GUI to parse the custom class and display the properties of the class in the Experiment Builder GUI. It is critical that these rules, described later in this section, are understood as you define your custom class so access to class attributes and methods is possible from within the rest of the experiment. The following explains the basics of creating a custom class in Experiment Builder with an example.

12.3.1 Example

```
import sreb

class CustomClassTemplate(sreb.EBObject):
        def __init__(self):
                sreb.EBObject.__init__(self)
                self.property1=1
#property of Integer type. This is also a read,write property. see the getter and setter
                self.property2=(1,2)
#read only point property. Note the setter missing for this property.
                self.property3=(1,2,3)
#read only color property. Note the setter missing for this property.
                self.property4=1.0
#read and write property of double type, also will not accept references or equation.
                self.property5=sreb.EBPoint(100,200)
#read, write point property.
#Note this property is similar to proprty2 except the writeableness.
                self.property6=sreb.EBColor(200,100,100)
#read, write color property.
#Note this property is similar to proprty3 except the writeableness.
                self.property7=[1,'abc',self.property6]
#read,write eblist property.
                self.property8='hello'
#read,write string property.
                self._myInternalAttribute="My Internal Attribute"
#string property, however this is hidden from the interface.

```

```
    #
    #Property: property1
    #A read and write integer type property
    def setProperty1(self,c):
        self.property1=c

    def getProperty1(self):
        return self.property1

    #
    #Property: property2
    #A read only property.  The type will be treated as a point(EBPoint)
    def getProperty2(self):
        return self.property2

    def getProperty3(self):
        return self.property3

    #
    #Callable method using Execute action.
    #Note the default arguments and the doc string
    #to let eb know what is the expected return type.
    def myMethod(self,parm1,parm2=[100,1,1,1], param3=(100,100,50),
param4=(50,75),param5="hi"):
        """RETURN:[1000,2000,3000]""" #The first line of the doc of method
        is used to get the return type of the method. return [1000,2000,3000]


    #internal method
    def _myInternalMethod(self):
        pass

    #
    #Property: property4
    #A read and write float type property
    def setProperty4(self,c=5.7):
        self.property4=c

    def getProperty4(self):
        return self.property4

    #
    #Property: property5
    #A read and write EBPoint type property
    def setProperty5(self,c):
        self.property5=c

    def getProperty5(self):
        return self.property5

    #
    #Property: property6
    #A read and write EBColor type property
    def setProperty6(self,c):
        self.property6=c

```

```
Line 069:         def getProperty6(self):
Line 070:                 return self.property6
Line 071:
Line 072:         #
Line 073:         #Property: property7
Line 074:         #A read and write list type property
Line 075:         def setProperty7(self,c):
Line 076:                 self.property7=c
Line 077:
Line 078:         def getProperty7(self):
Line 079:                 return self.property7
Line 080:
Line 081:         #
Line 082:         #Property: property8
Line 083:         #A read and write string type property
Line 084:         def setProperty8(self,c):
Line 085:                 self.property8=c
Line 086:
Line 087:         def getProperty8(self):
Line 088:                 return self.property8
Line 089:
Line 090:
```

12.3.2 Class Definition

A Python class starts with the reserved word "class", followed by the class name. Each word in a class name is usually capitalized, but this is only a convention, not a requirement. Python functions have no explicit begin or end, and no curly braces to mark where the function code starts and stops. The only delimiter is a colon (:) and the indentation of the code itself. Everything in a class is indented.

```
class ClassName(BaseClasses):
        statement(s)
```

The class name of the above example is CustomClassTemplate (Line 003). In Python, the ancestor of a class is simply listed in parentheses immediately after the class name. All custom classes in Experiment Builder must inherit the sreb.EBObject class (Line 003) and import the sreb module (Line 001). If a class starts with _ then it is considered internal and will not be treated as a custom class.

12.3.3 Class Initialization

The body of the class is where you normally specify the attributes and methods of the class. An Experiment Builder custom class always starts with an __init__(self) method (Line 004). This method is used to initialize the CustomClassTemplate class. The first argument of every class method, including __init__, is always a reference to the current instance of the class. By convention, this argument is always named self. The custom class __init__ method will only use the default constructor (i.e., a constructor with only the self parameter or any other parameter with the default arguments. If any default arguments are passed in, only the default arguments will be used.).

```
def __init__(self):
        sreb.EBObject.__init__(self)

        #list of attributes
        self.identifier = value
```

12.3.4 Class Attributes

Within the __init__ method, the constructor must call sreb.EBObject's constructor (Line 005). Following this, all the possible attributes and methods used in the class should be listed. Attributes of the class are specified by binding a value (1 for Line 006) to an identifier (self.property1 for Line 006). All of the attributes used in the class must start with "self.". The attribute identifier must be an alphanumeric string and start with a lowercase letter; if the property starts with an _(underscore) or an upper-case letter, then the property is treated as internal. For example, "self.thisIsAnExmaple" and "self.example2" are valid custom class attributes whereas "self.2Example", and "self.badString$" are not valid.

The data type of the class attribute is determined by the initial value assigned to the attribute. Supported data types are int, float, string, EBPoint, EBColor, tuple, and list. For example (Line 006), self.property1 attribute has an initial value of 1. As a result, this class attribute is an integer. The following table lists typical data types used in a custom class.

Attribute Value	Data Type	Usage
'Hello'	String	Example: Line 013
"Hello"	String	self.myString = "This is another string"
1	Number (Integer)	Example: Line 006
1.0	Number (Float)	Example: Line 009
True	Boolean	self.property=True
False	Boolean	self.property= False
(100,100)	Point	Example: Line 007 If an attribute's default value is of tuple type and only has two items, the property will be treated as an EBPoint. The parameter of the setX method and the return type of the getX method is expected to be the same as the attribute type.
sreb.EBPoint(100,200)	Point	Example: Line 010
(1,2,3)	Color	Example: Line 008 If an attribute's default value is a tuple of 3 items, the property will be treated as an EBColor. The parameter of the setX method and the output type of the getX

		method is expected to be the same as the type of the attribute.
sreb.EBColor(200,100,100)	Color	Example: Line 011
[1,'abc',self.property6]	List	Example: Line 012
list()	List	self.myList = list() This creates an empty list.
None	Unknown Type	self.unknownType = None

12.3.5 Class Methods

Methods in a class are defined by a def statement. The def statement is a single clause statement with the following syntax:

```
def function-name(self, [parameter list]):
    statement(s)
```

All of the code within the function is indented. Unlike other python functions, a method defined in a class body always has a mandatory first parameter “self”. In addition to the first mandatory parameter “self”, users can pass a variable comma-separated list of parameters to the functions. Zero or more mandatory parameters may be followed by zero or more optional parameters, where each optional parameter has the following syntax:

```
identifier = expression
```

The code segment below illustrates a function named doMyCalculations, which takes three parameters, x, y, and items. The last parameter item is optional as it has a default value.

```
def doMyCalculations(self, x, y, items = 2):
    """RETURN: 1 """

    if items == 2:
        return x
    else:
        return y
```

By default, the return type of a method is string, unless a doc string with the following constraints is available:

- The doc string is a multi-line string flanked by a triple quotes. Everything between the start and end quotes is part of a single string, which documents what the function does. A doc string, if it exists, must be the first thing defined in a function (that is, the first thing after the colon). While a doc string is not technically required in a function, it is good practice and should always be included if the return data type is not a string.
- The doc string should start with a "RETURN:" text (case sensitive).

- Following the "RETURN:" text, provide a default value of the type or the __repr__ value of the class (e.g., str for string).

12.3.6 'setX' and 'getX' Methods

Method names starting with 'set' and 'get' are assumed to operate on the class attributes and are handled differently from regular custom class methods.

```
def __init__(self):
    sreb.EBObject.__init__(self)
    self.myProperty=1

#Property: myProperty
#A read and write integer type property
def setMyProperty(self,c):
    self.MyProperty=c

def getMyProperty(self):
    return self.myProperty
```

To allow the getX and setX methods to operate directly on a class attribute x, the following syntax rules must be followed:

- The class attribute identifier must be an alphanumeric string and start with a lowercase letter (e.g, use self.myProperty instead of self.MyProperty).
- The getX and setX method names should be composed of 'set' and 'get' string and the attribute identifier, with the first letter of the identifier capitalized (e.g., getMyProperty instead of getmyProperty). Any getX and setX methods that do not follow this rule will be treated as regular class methods.
- The getX method shouldn't take extra parameters except for the mandatory parameter self.
- The setX method expects one extra parameter. To support attribute referencing of that property in Experiment Builder, do not give a default value for the parameter. For example,

  ```
  def setEBAttrib(self,value):
  ```

  That is, the attribute EBAttrib should be able to be set to a reference. If a default value is assigned to the setX method, this would tell Experiment Builder that the attribute NonEBAttrib should not be able to be set to a reference. For example,

  ```
  def setNonEBAttrib(self,value=0):
  ```

A class attribute that has a corresponding getX method is a readable attribute. A class attribute that has a corresponding setX method is a writeable attribute. An attribute is a readable and writeable property if it has corresponding getX and setX methods.

12.4 Instantiating Custom Class

Once a custom class is defined, users can instantiate the class by creating a concrete instance of that class in the experiment graph. To instantiate the class, click the Other tab of the component tool box, and drag a Custom Class Instance node into the experiment graph.

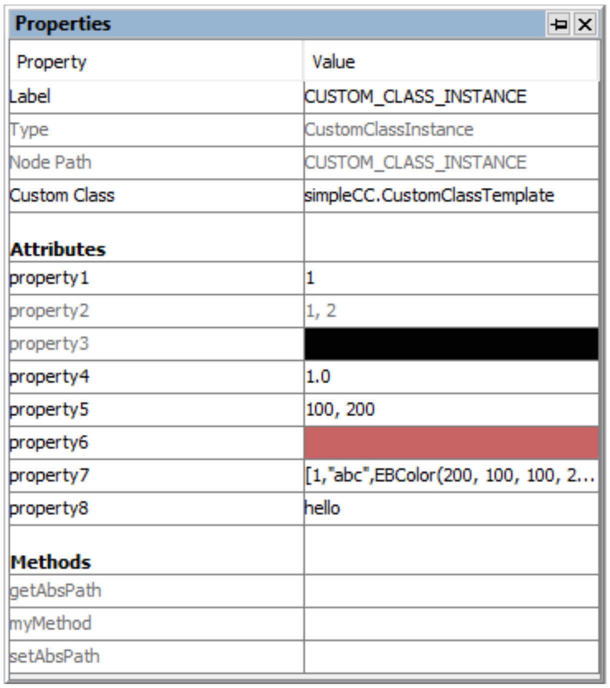


Figure 12-2. Attributes and Properties of a Custom Class Instance.

Select the newly added Custom Class Instance node. Click the value field of the "Custom Class" property, and select the custom class from a dropdown list. Once the class is loaded, attributes and methods will be listed in alphabetical order in the property table. The "Attribute" section lists all of the class attributes that have a corresponding getX method.

- Attributes that have a getX method only, but without a corresponding setX method, will be read-only and are not directly modifiable (see attributes property2 and property3 in the example from section 12.3.1).
- Attributes that have both a getX method and a setX method, without a default value for the parameter, are both readable and writeable. These attributes may be set to a reference (see attributes property1, property5, property6, property7, and property8 in the 12.3.1 example).
- Attributes that have both a getX method and a setX method with a default value are readable and writeable. However, these attributes cannot be set to a reference (see attribute property4 in the 12.3.1 example).
- Attributes that have a setX method but not a getX method will not be displayed in the attribute section. The setX method will be displayed as a regular method.

The "Methods" section lists all methods available for the class (see myMethod of the 12.3.1 example) except for the __init__, getX, and setX methods mentioned above.

12.5 Using Custom Class

The custom class and the Experiment Builder graph may interact through attribute reference, as well as through the Execute, Sequence, and Update Attribute actions. Through these options, users can set values for the class attributes and pass parameters to the class methods, and conversely may retrieve the current value of class attributes and access the return values of class methods.

This bi-directional exchange of data between the custom class attributes and Experiment Builder GUI is enabled by the getX and setX methods. For class attributes with a corresponding setX method (without a default value as the function parameter), users can set a value, an equation, or a reference for the class attribute directly in the custom class instance. Users can may also set a value/reference for a class attribute through an Update Attribute action. Similarly, if a class attribute has a corresponding getX method, its current value can be referenced and used directly much like any other EB component attribute.

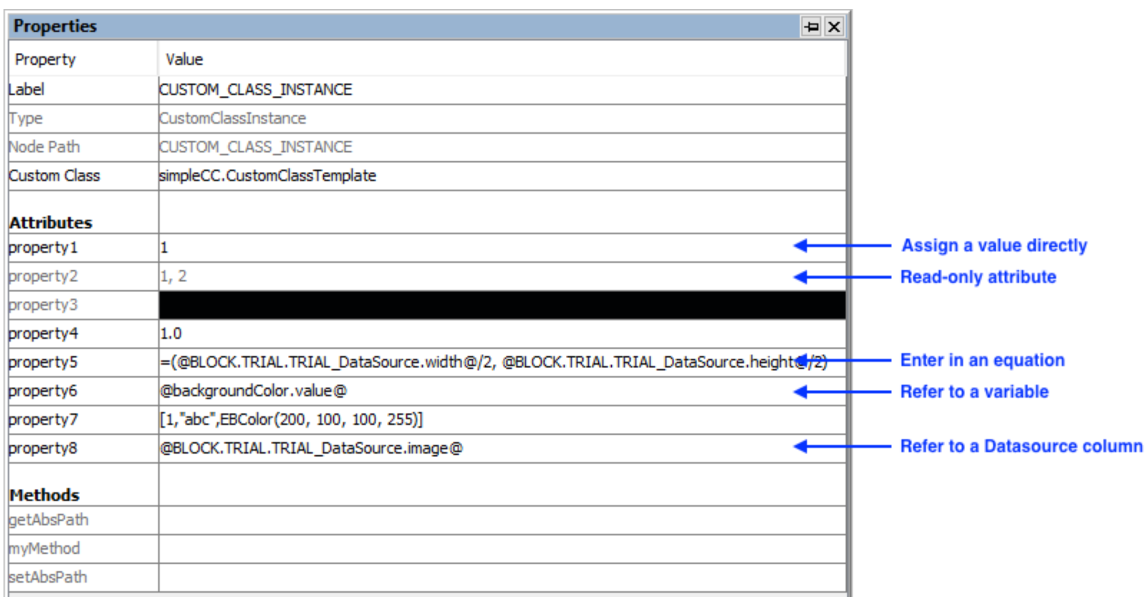


Figure 12-3. Assigning Attribute Values through Custom Class Instance.

Users can call a class method through the Execute action or the "Callback" property of a Sequence. Values can be passed to the argument list of a custom class method from the properties of the Execute action or the Callback sequence (see Figure 12-4).

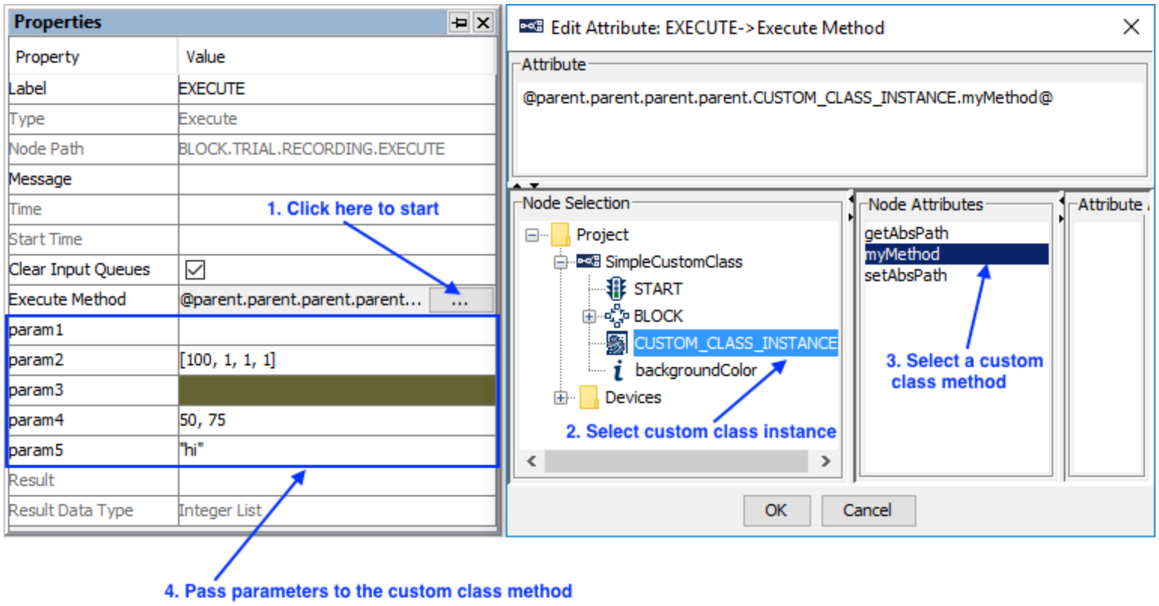


Figure 12-4. Data Exchange through Execute Action.

In addition, a value can be returned from the custom class to the Experiment Builder GUI as the return value of a class method. Please note that the return type of a method is string by default unless a doc string is used to specify the data type of the return value.

12.6 Using the Custom Class Editor

To edit the content of a custom class, double-click the Custom Class Instance node in the experiment graph. This will open the Custom Class Editor as a new tab in the Graph Editor Window. (There is also a simple text editor in the Library Manager for previewing and making basic changes to the custom class.) The following table summarizes the tools available for code editing using the custom class editor.

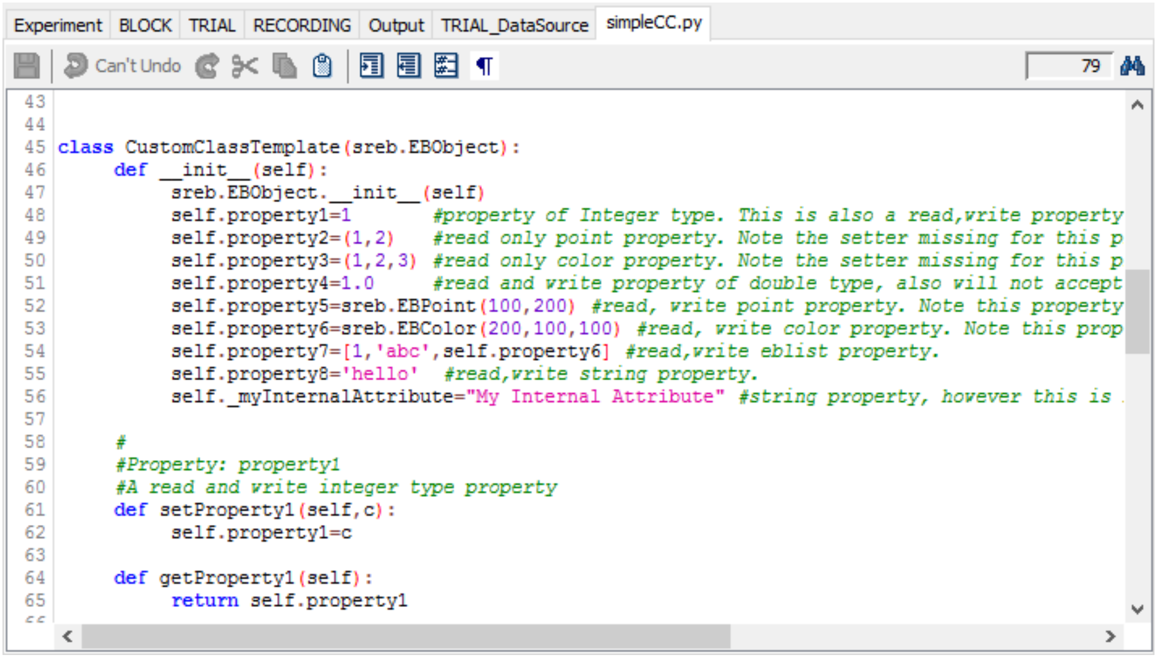


Figure 12-5. Custom Class Code Editor.

Custom Class Editor Toolbar

Operation	Shortcut (Windows)	Shortcut (macOS)	Function
Save Code	Ctrl + S	⌘ + S	Save the custom class code.
Undo	Ctrl + Z	⌘ + Z	Undo the last change made to the custom class editor.
Redo	Ctrl + Y	⌘ + Y	Redo the last change made to the custom class editor.
Cut	Ctrl + X	⌘ + X	Removes a selection from the project and place it into the clipboard.
Copy	Ctrl + C	⌘ + C	Puts a copy of a selection into the clipboard.
Paste	Ctrl + V	⌘ + V	Inserts the previously copied item from the clipboard to the current position.
Increase Indent	Tab	Tab	Inserts a tab space before the current code.
Reduce Indent	Shift + Tab	Shift + Tab	Removes a tab space before the current code.
Comment	Ctrl + /	⌘ + /	Creates comment. This will add a comment symbol "#" in front of the current line of code.
¶ Visible Space			Click to toggle on/off the visibility of space and tab characters in the custom class code.
112 Go to Line Number			Go to a specified line.
Find/Replace	Ctrl + F	⌘ + F	Search or replace a specified text string in the custom class code.

Clicking on the button opens the Find/Replace dialog box for the custom class editor.

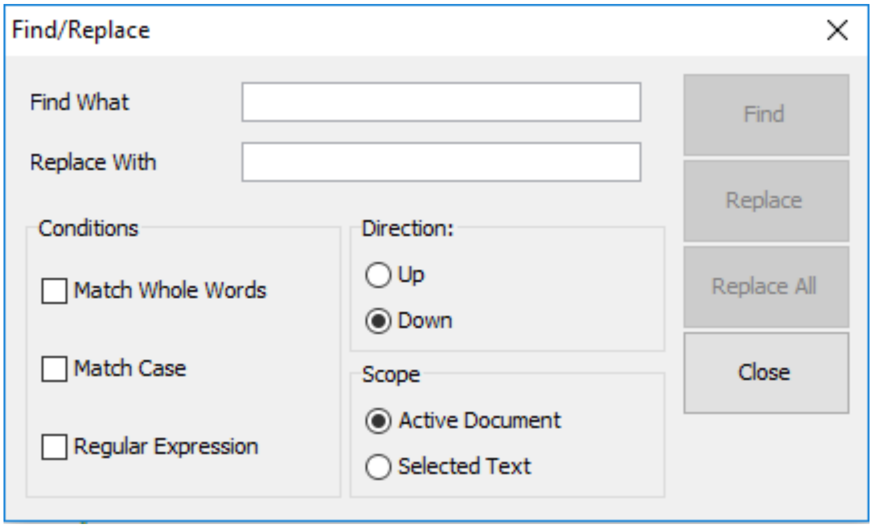


Figure 12-6. Custom Class Find/Replace Dialog Box.

13 Creating Experiments: Overview

The easiest way to start developing EyeLink experiments is to study the supplied templates included with the Experiment Builder software, installed at:

- Windows 7, 8 and 10: "C:/Users/{User Name}/Documents/ExperimentBuilder Examples"
- macOS: "Documents\ExperimentBuilder Examples"

Each of these experiment templates illustrates a typical experimental paradigm. The following table provides a brief description of the experiments. A detailed analysis of each template's operations is documented in the following sections. More examples can be found in the Experiment Builder Examples discussion forum (https://www.sr-support.com/forum/experiment-builder/examples).

Experiment	**Purpose**
Simple	The basic experiment template, displaying a single word in the center of the screen in each trial. This example is used to introduce how to create an experiment with SR Research Experiment Builder step-by-step.
Stroop	The basic template for creating non-EyeLink experiments. This template illustrates the use of a results file, RT calculation, and audio feedback.
Picture	Displays an image on the screen
TextLine	Experiment to show a single line of text, illustrating the use of runtime interest area segmentation.
TextPage	Experiment to show a full screen of text using a multi-line text resource.
GCWindow	Demonstrates how to use real-time gaze position to display a gaze-contingent window.
Track	Displays the user’s current gaze position during recording and illustrates how to set the resource position contingent on the current gaze position.
Change	Displays several almost identical screens rapidly, and illustrates use the of the fixation trigger.
Saccade	Illustrates the creation of a simple experiment for saccade/anti-saccade research.
Video	Illustrates creating an experiment display video clips using xvid codec.
Pursuit	Illustrates several kinds of sinusoidal movement in a pursuit task.
InfantVideo	Performs calibration and drift correction/check using animated calibration targets.
VisualWorld	Illustrates the implementation of the popular Visual World Paradigm. Audio is played through ASIO driver on Windows or OSX driver on Mac. Positions of the screen resources are set through an UPDATE_ATTRIBUTE action.
EEG Integration	This folder contains examples and instruction docs to illustrate integration with EEG systems from Biosemi, Brain Products, Neuroscan, and Philips-EGI. All of the examples are based on the “Simple” and “Stroop” templates.

The discussion of the “simple” template should be read before working with any of other templates, as it illustrates most of the shared operations for all experiments. You may go over the “Stroop” example for creating non-eye tracking experiments. In general, we recommend reading through all of the templates before programming your own experiment. When creating your experiment, you may also refer to the Experiment Builder Project Checklist in Chapter 16.

Before making any changes to the existing examples, we suggest you first make a copy of the examples and then uncheck the "Read-only" box of the topmost experiment node.

14 Creating EyeLink Experiments: The First Example

To illustrate the use of Experiment Builder, we are going to create a very simple eye-tracking experiment that runs 12 trials. In each trial, a single word is displayed in the center of the screen (much like the "SIMPLE" template of the EyeLink C Programming API).

Creating an Experiment with SR Research Experiment Builder, consists of the following three overall steps:

- Create an Experiment
- Build and test run the Experiment
- Deploy the Experiment

Deploying the experiment generates a set of files used to run the experiment for data collection without relying on the Experiment Builder application.

14.1 Creating the Experiment

This section provides a step-by-step tutorial to walk you through the basics of creating an experiment with SR Research Experiment Builder.

14.1.1 Creating a New Experiment Project

To open Experiment Builder, in Windows click Start → All Applications → SR Research and choose "Experiment Builder". On macOS, go to the "Applications/Experiment Builder/" folder, and open the "ExperimentBuilder" application.

When the application starts:

1) Click "File → New" on the application menu bar.
2) In the following "New Project" dialog box, enter "Simple" in the "Project Name" edit box.
3) Click the button on the right end of the "Project Location" to browse to the directory where the experiment project should be saved. If manually entering the "Project Location" field, please make sure that the intended directory already exists.
4) Make sure the "EyeLink Experiment" box is checked for an EyeLink experiment.
5) Select the eye tracker version from the dropdown menu (EyeLink I, EyeLink II, EyeLink 1000, EyeLink 1000 Plus, or EyeLink Portable Duo). Or select "Current" to allow any EyeLink eye tracker (See Figure 14-1).

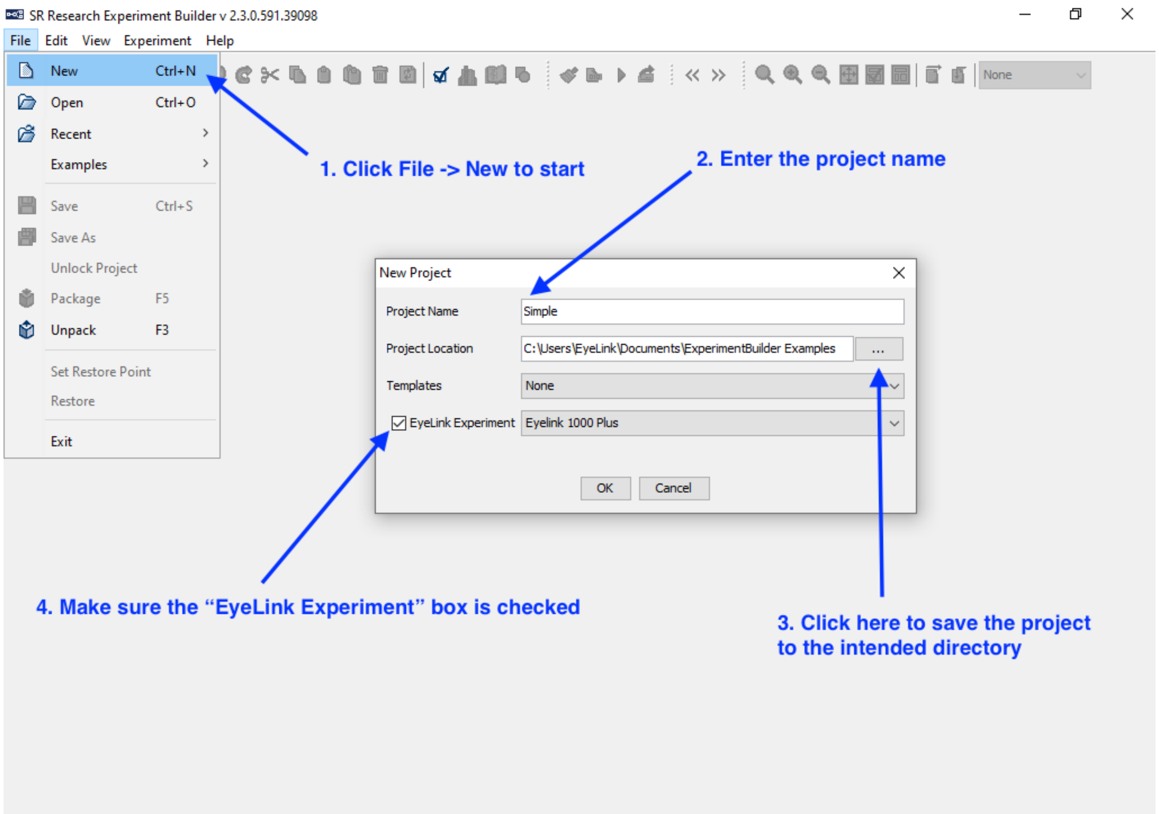


Figure 14-1. Creating a New Experiment Builder Project.

Important: Users should not manually add or remove files in the experiment directory. To maintain file integrity for the experiment projects created, any changes made to the experiment directory will be overwritten by Experiment Builder. Any image files, audio files, video files, etc., should be added or removed from the project through the Library Manager.

14.1.2 Configuring Experiment Preference Settings

After creating a new experiment session, check whether the default display and screen preference settings are appropriate for the experiment to be created.

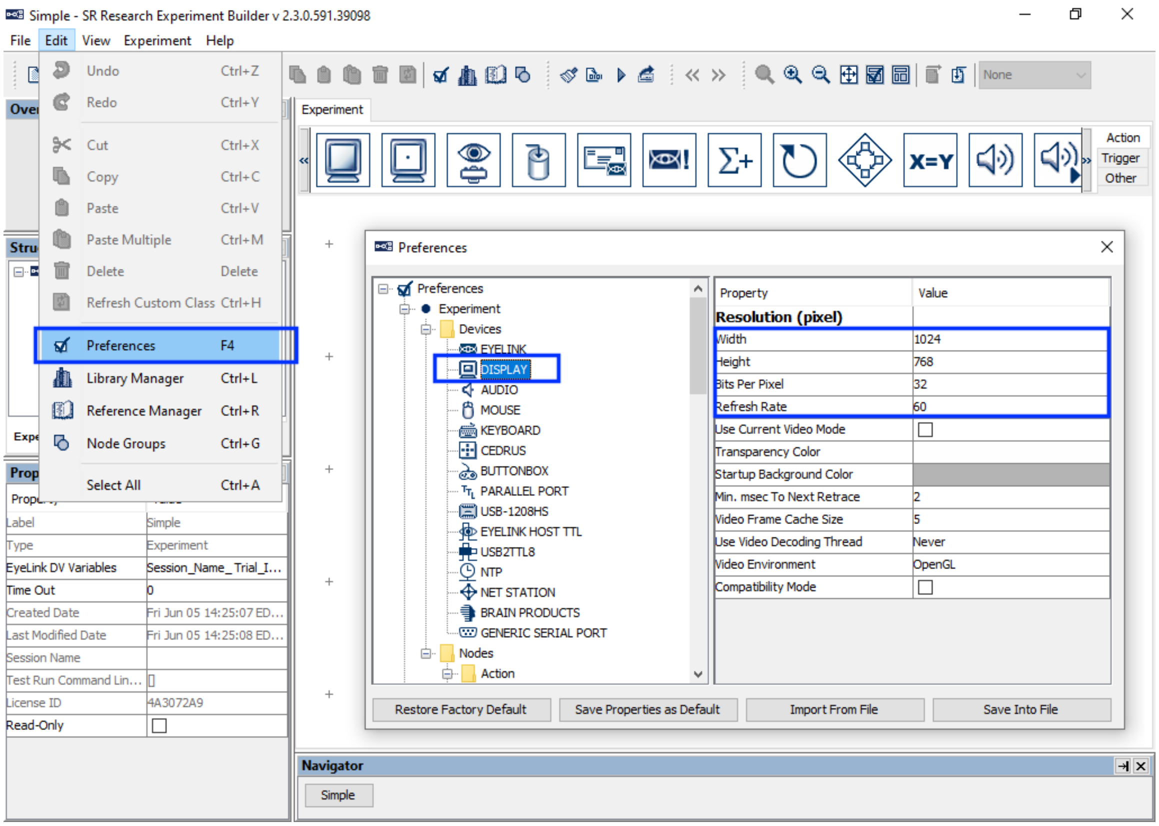


Figure 14-2. Configuring Preference Settings.

1) Select "Edit → Preferences" from the application menu bar or press the shortcut key "F4" on Windows. On macOS, click "ExperimentBuilder → Preferences" from the application menu bar or press Command ⌘+" ,".
2) Click "Preferences → Experiment → Devices → Display" to check display settings. Make sure the settings (Width, Height, Bits per Pixel, and Refresh Rate) used in the current example are supported by your video card and monitor. Here the default values 1024 x 768 x 32 x 60 Hz are used. Keep the "Video Environment" to "OpenGL" as DirectDraw graphics are not supported in EB 2.3.
3) Click "Preferences → Screen" to check Screen Builder settings. Set the Location Type as "Center Position" and check the "Antialis Drawing" box.

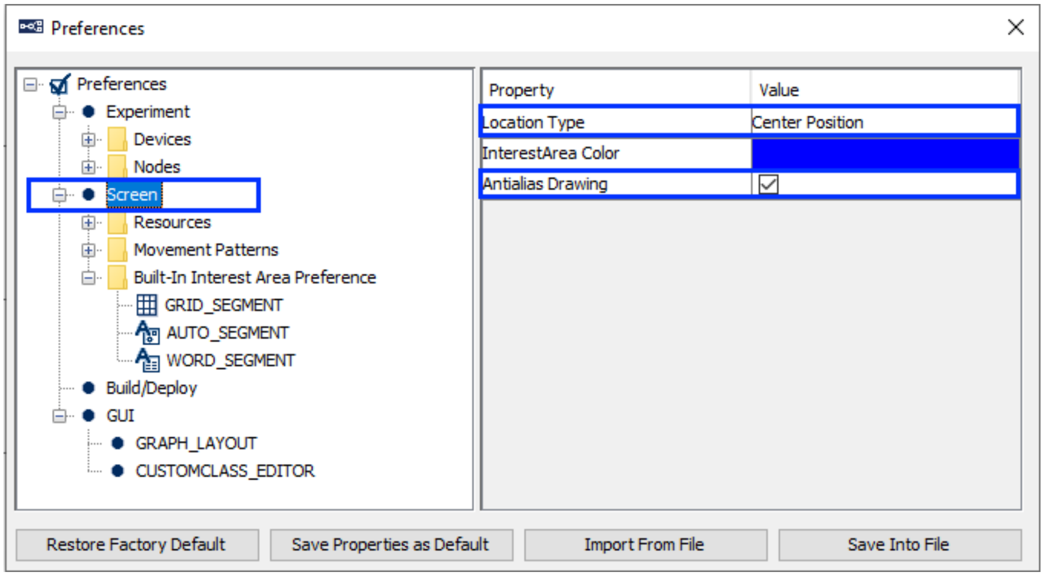


Figure 14-3. Setting the Screen Preferences.

4) **EyeLink I, II, 1000, and Portable Duo users:** The default tracker version is set to EyeLink 1000 Plus. EyeLink I, II, 1000, and Portable Duo users should also make sure the "Tracker Version" setting in the "Preferences -> Experiment -> Devices -> EyeLink" preferences is set to EyeLink I, EyeLink II, EyeLink 1000, or EyeLink Portable Duo. If you use EyeLink 1000, 1000 Plus, or Portable Duo, please make sure you configure the correct "Camera Mount" and "Mouse Usage setting.

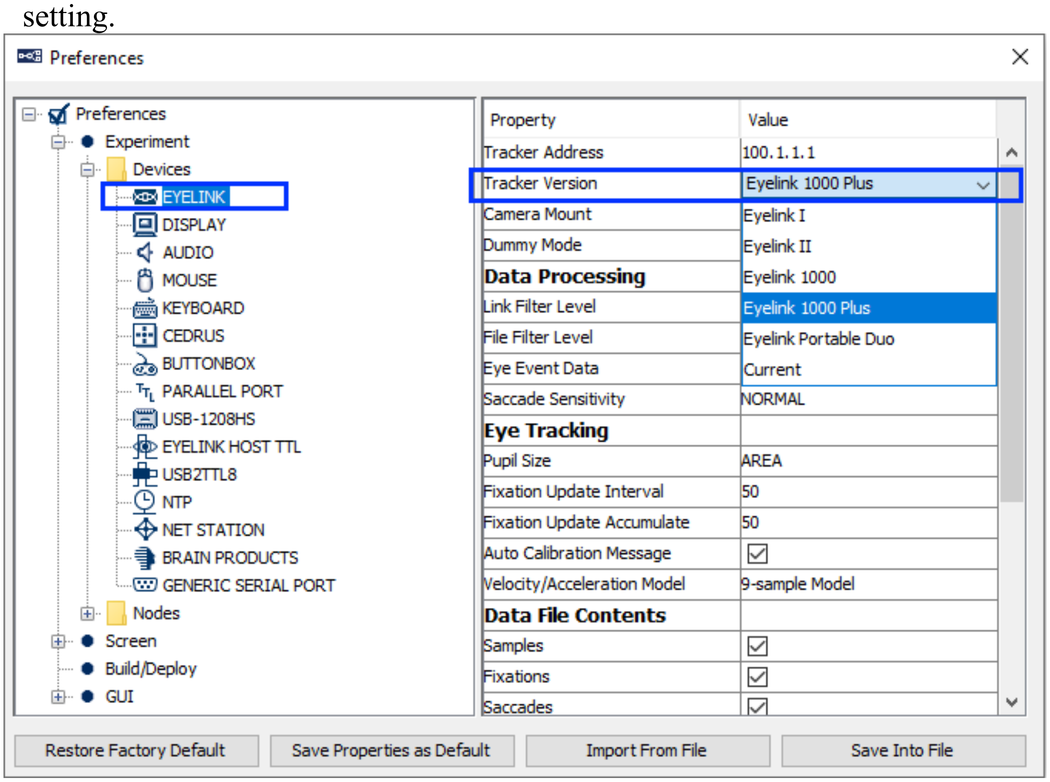


Figure 14-4. Setting the Tracker Version for the Experiment.

5) After changing any preference settings, if you would like to keep the new settings as defaults for all of your future experiments, click the "Save Properties as Default" button.
6) Once finished, press the close button on the dialog box.

If intending to use any characters that do not fit in the ASCII encoding range, including non-English characters (eg. à, è, ù, ç), special curved quotes, and any non-European language characters (e.g., Chinese characters), please also make sure the "Encode Files as UTF-8" box of the Build/Deploy node is checked (enabled by default in later versions of Experiment Builder; see Figure 14-5).

Failing to enable UTF-8 encoding when non-ASCII characters are used will result in the following build/run time warning:

WARNING: warning:2001 You are using characters that ascii encoding cannot handle! Please change your encoding!

Likewise, if Chinese, Japanese, or Korean characters are used and UTF-8 encoding is not enabled, this will result in the following error:

ERROR: error:2070 Internal Error. Could not create script. Please contact SR Research! Sorry: MemoryError: ().

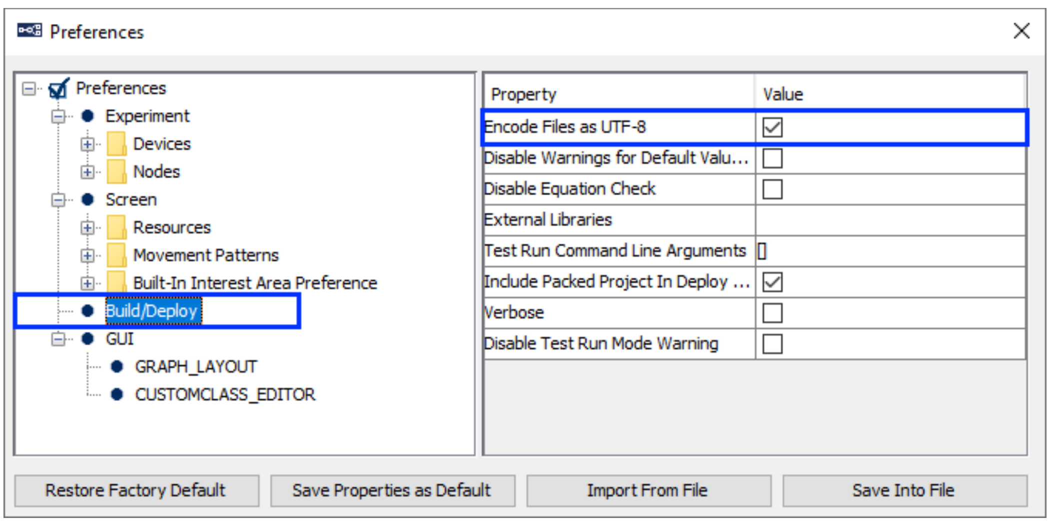


Figure 14-5. Setting the File Encoding for the Project.

14.1.3 The Topmost Experiment Layer

In this simple example, we start the experiment by displaying an instruction screen, perform a calibration, and then run 12 trials, with each trial showing a single word on the screen. We can start by adding the necessary nodes to the workspace of the topmost experiment layer:

1) Open the "Action" Tab of the component toolbox, then click and drag a "Display Screen" action into the work area.
2) Open the "Trigger" Tab of the component toolbox, then drag a "Keyboard" trigger into the work area.

3) Add an “EyeLink Button” trigger to the work space.
4) Add a “Timer” trigger to the work space.
5) Click the Timer trigger and set the duration to 20000 msec.
6) Open the “Action” Tab of the component toolbox and add a “Camera Setup” action to the work space.
7) Add a “Sequence” node to the work space. This will be our trial-level sequence.

Then we can continue by drawing the connections between the nodes in the BLOCK sequence:

8) Click and drag from the START node to the DISPLAY_SCREEN node.
9) Draw three connections from the DISPLAY_SCREEN action to the KEYBOARD, EL_BUTTON, and TIMER triggers. When a single action connects to several triggers, a number is added to each connection indicating the evaluation order among the three trigger types. In this experiment, it doesn’t matter which order the nodes are connected in.
10) Draw a connection from each of the three triggers to the EL_CAMERA_SETUP node, then from EL_CAMERA_SETUP to the SEQUENCE node.

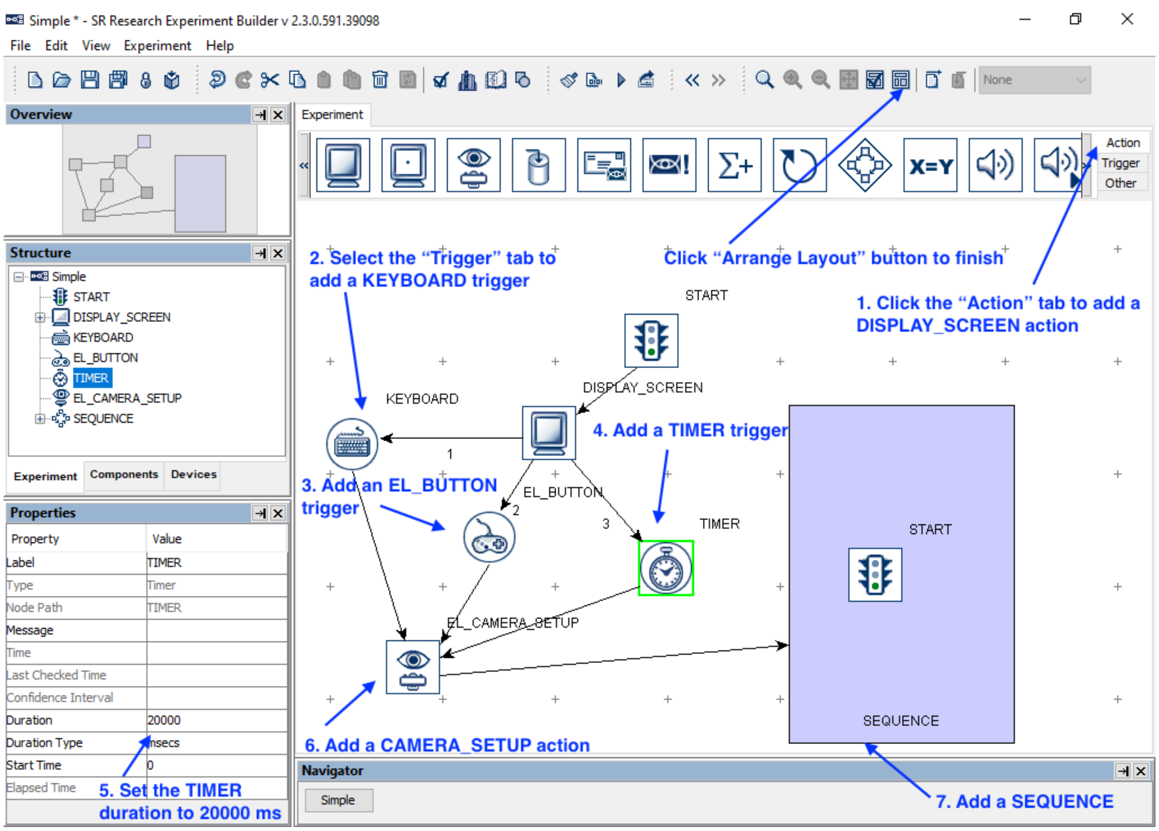


Figure 14-6. Adding Instruction to Block Sequence.

11) Right-click any blank area in the work window and select "Arrange Layout" in the popup menu or click the “Arrange Layout” button in the application toolbar.

14.1.4 Creating the Instructions Screen

Next we can configure the DISPLAY_SCREEN node to display a set of instructions at the beginning of the experiment. In this example, we will create the instructions by adding a MultiLine Text Resource to the Display Screen; users may also create the instructions as an image file and use the Display Screen to display the image.

To start editing the screen, open the Screen Builder by double-clicking the DISPLAY_SCREEN node in the workspace.

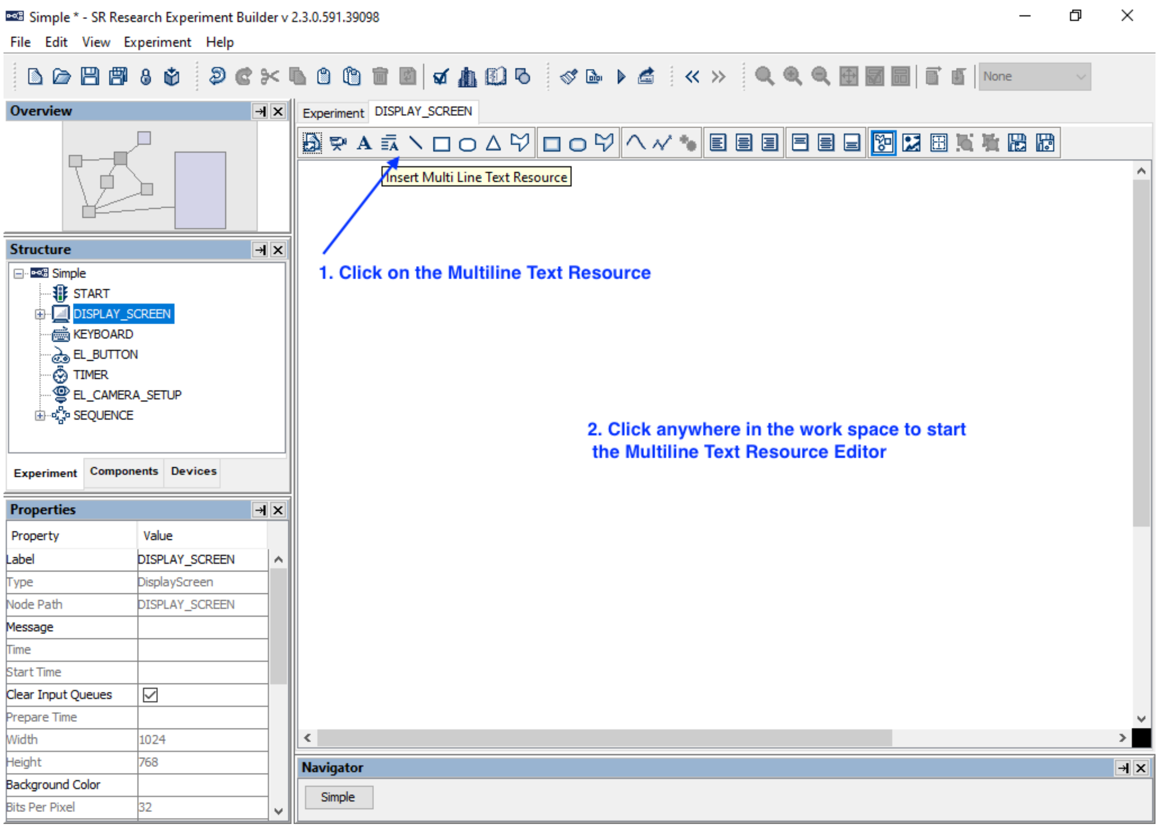


Figure 14-7. Adding Multiline Text Resource onto a Display Screen.

1) Once you've opened the Screen Builder, click the multiline text resource ( ) button on the screen builder toolbar to select the resource to add.
2) Click anywhere on the screen to add the resource.

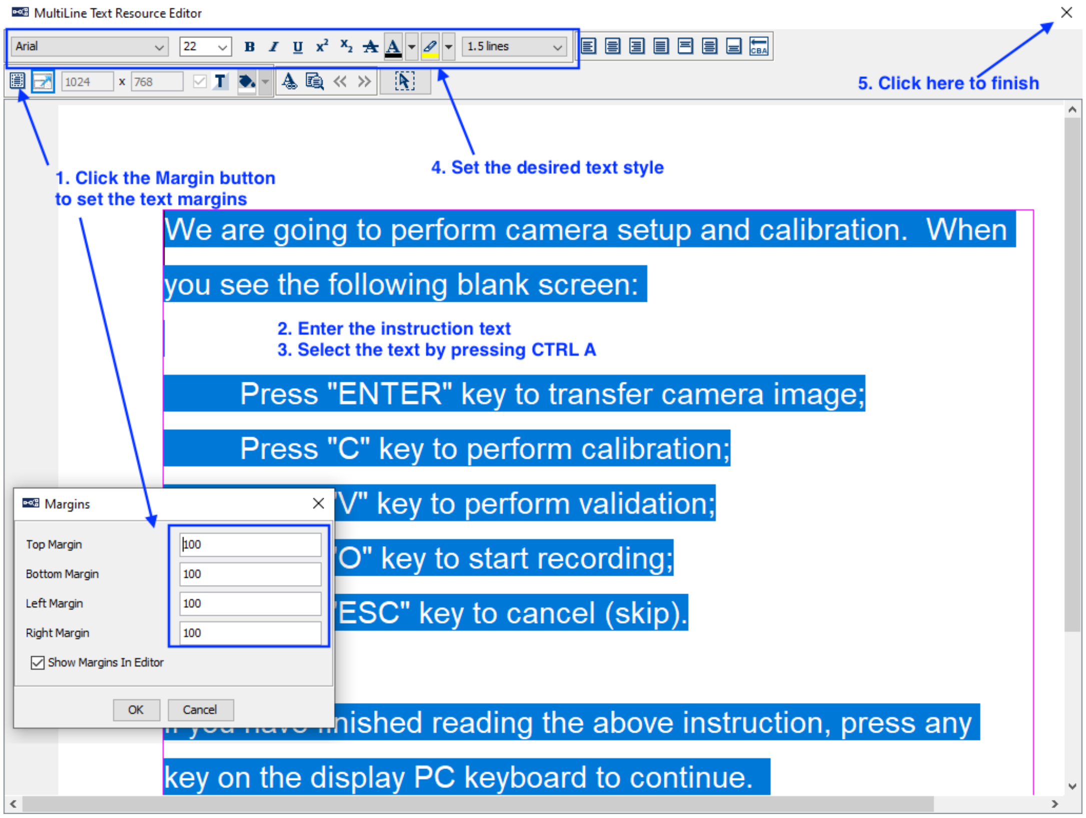


Figure 14-8. Create Instruction Screen.

In the following Multi-Line Text Resource Editor,

1) Click the “Margins” button in the toolbar to set the text margins. Enter 100 in all fields. Click the "OK" button on the dialog box.
2) Enter the desired instruction text.
3) Press Ctrl + A on Windows (Command ⌘ + A on macOS) to select all text entered.
4) Then click the buttons on the toolbar to set the desired text appearance (font name, font size, font style, alignment style, line spacing, and text color).
5) Click the “Close” button (☒) at the top right corner of the Multi-Line Text Resource Editor to finish.

14.1.5 Editing the Trial Sequence: Data Source

Next, we will design the Trial sequence, which will contain all the necessary triggers and actions in each trial. We will first create a data source to set the parameters in individual trials (see Figure 14-9). In this experiment, we will add two columns to the data source: “trial”, to serve as a trial identifier variable, and “word”, to determine the text displayed on each trial.

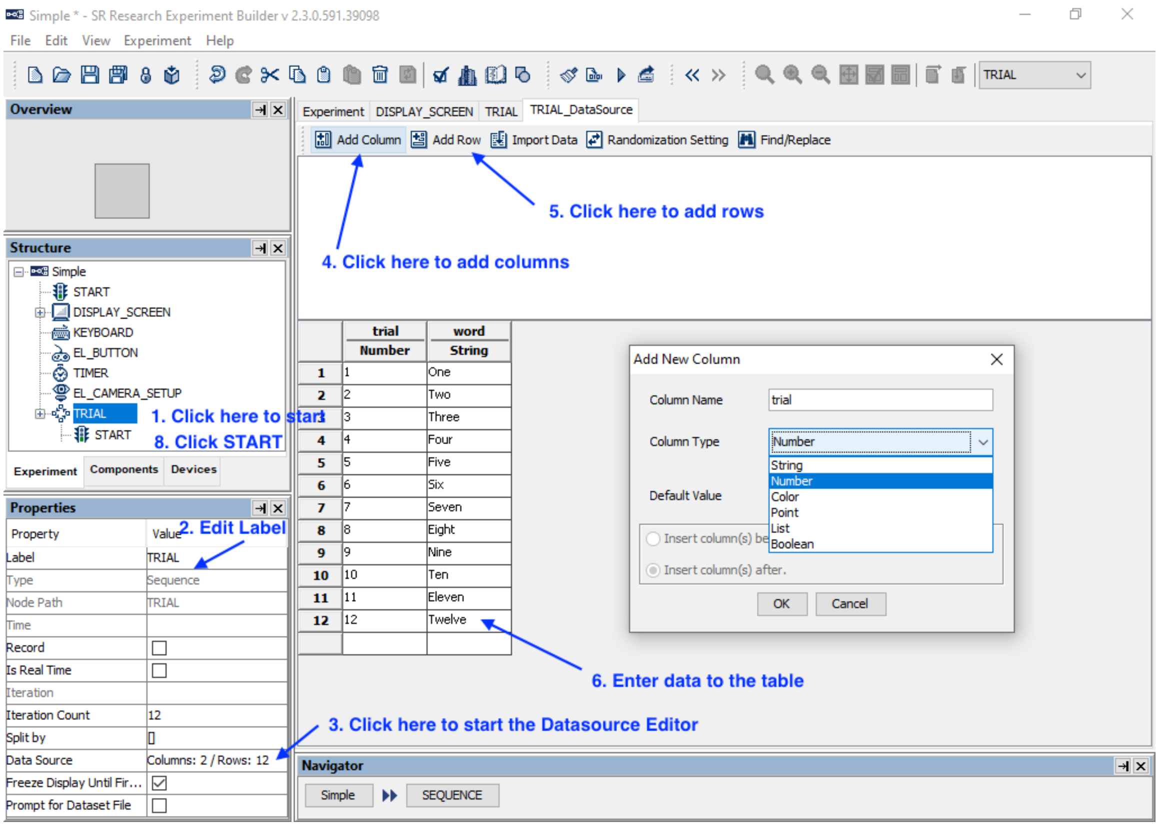


Figure 14-9. Creating Data Source.

1) First, select the last "SEQUENCE" node in the structure list.
2) In the Properties table, enter a new value for the Label, e.g., "TRIAL".
3) Click the value cell of the "Data Source" property (where it says "Columns: 0 / Rows: 0") to bring up the Data Source Editor.

Next we can create the Data Source columns and enter our values.

4) Click the "Add Column" button. Type "trial" (without quotes) in the Column Name box, and set the Column Type to "Number". Click the "OK" button to finish. Click the "Add Column" button again. Enter the Column Name as "word" and set Column Type to "String". Click "OK" to finish.
5) Click the "Add Row" button. Set the "Number of Rows" to 12 to add 12 rows of empty cells, then click "OK".
6) To add a value to the Data Source, simply click in one of the empty cells, type the value into the editor, then press the Enter key. Set the values of the "trial" column as 1, 2, 3, … 12, and in the "word" column, enter the words "One", "Two", "Three", etc., all the way to "Twelve".
7) To enter the TRIAL sequence, double-click the TRIAL sequence node in the project workspace.

14.1.6 Editing the Trial Sequence: Preparing Sequence and Drift Correction

Next we can start filling the contents of our TRIAL sequence.

Each trial should begin with a Prepare Sequence action, followed by a Drift Correct action, and then by the actual trial recording sequence (see Figure 14-10). The Prepare Sequence action preloads any image files or audio clips in the trial for real-time image drawing or sound playing, draws feedback graphics on the Host PC to evaluate participants' performance, and reinitializes trigger settings. Users should typically call the Prepare Sequence action before performing a drift correction.

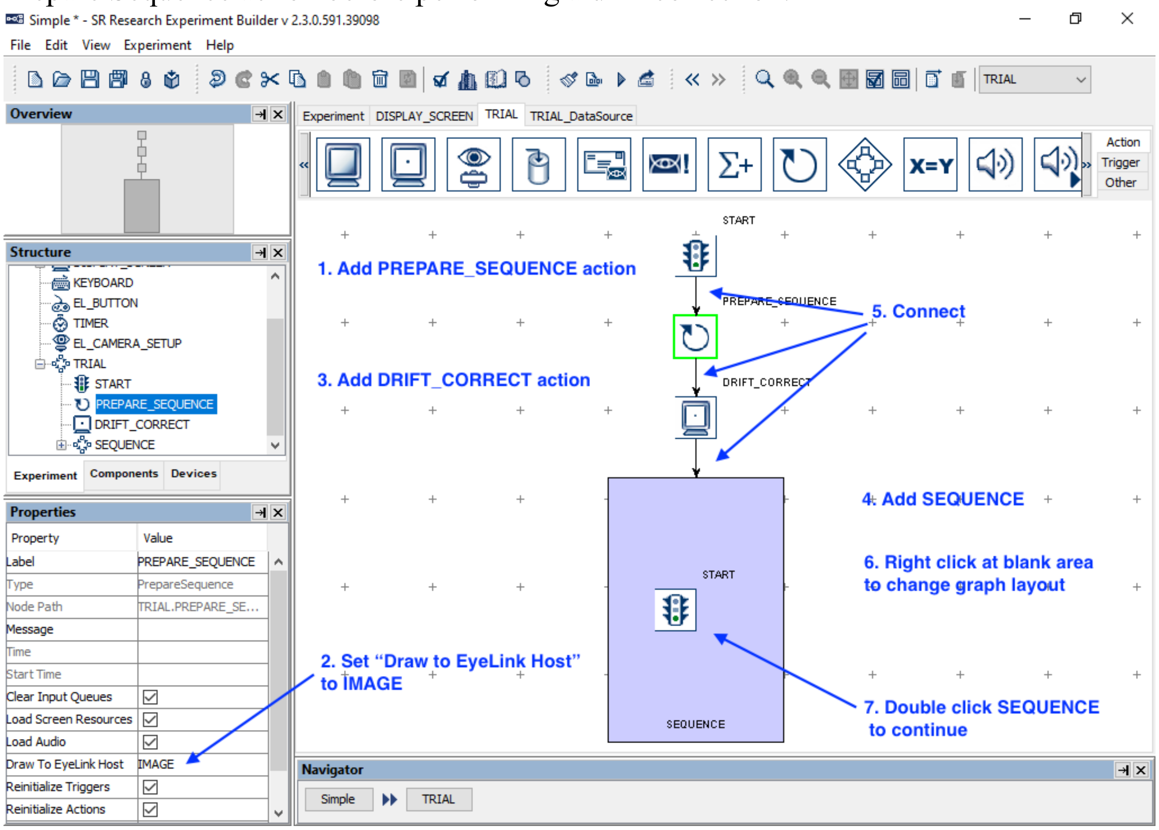


Figure 14-10. Editing Trial Sequence.

1) Open the "Action" Tab of the component toolbox, then drag a "Prepare Sequence" action into the workspace.
2) Select the added PREPARE SEQUENCE action and review the settings in the properties table. To draw an image from the trial or simple feedback graphics on the host screen to evaluate the participants' gaze position during recording, make sure the "Draw To EyeLink Host" field is set to "IMAGE" or "PRIMITIVE".
3) Drag a "Drift Correction" action into the workspace.
4) Then drag a "Sequence" node into the workspace.
5) Click and drag to draw a connection from the "START" node to "PREPARE_SEQUENCE", then from "PREPARE_SEQUENCE" to "DRIFT_CORRECTION", then from "DRIFT_CORRECT" to the "SEQUENCE" node.
6) Right-click any blank area in the work window and select "Arrange Layout" in the popup menu.

14.1.7 Editing the Recording Sequence

We will start by setting the properties of the recording sequence, as well as the actual contents of the trial recording (see Figure 14-11). In this simple recording sequence, we will display a screen and then wait for a button press response from the participant. The trial times out automatically if no response is made within 10 seconds. After the response or time out, the display screen is cleared. It is critical within the Recording sequence to fill in the "Message" field of action and trigger nodes corresponding to stimulus presentation and participant response so the timing of these events will be marked in the EDF.

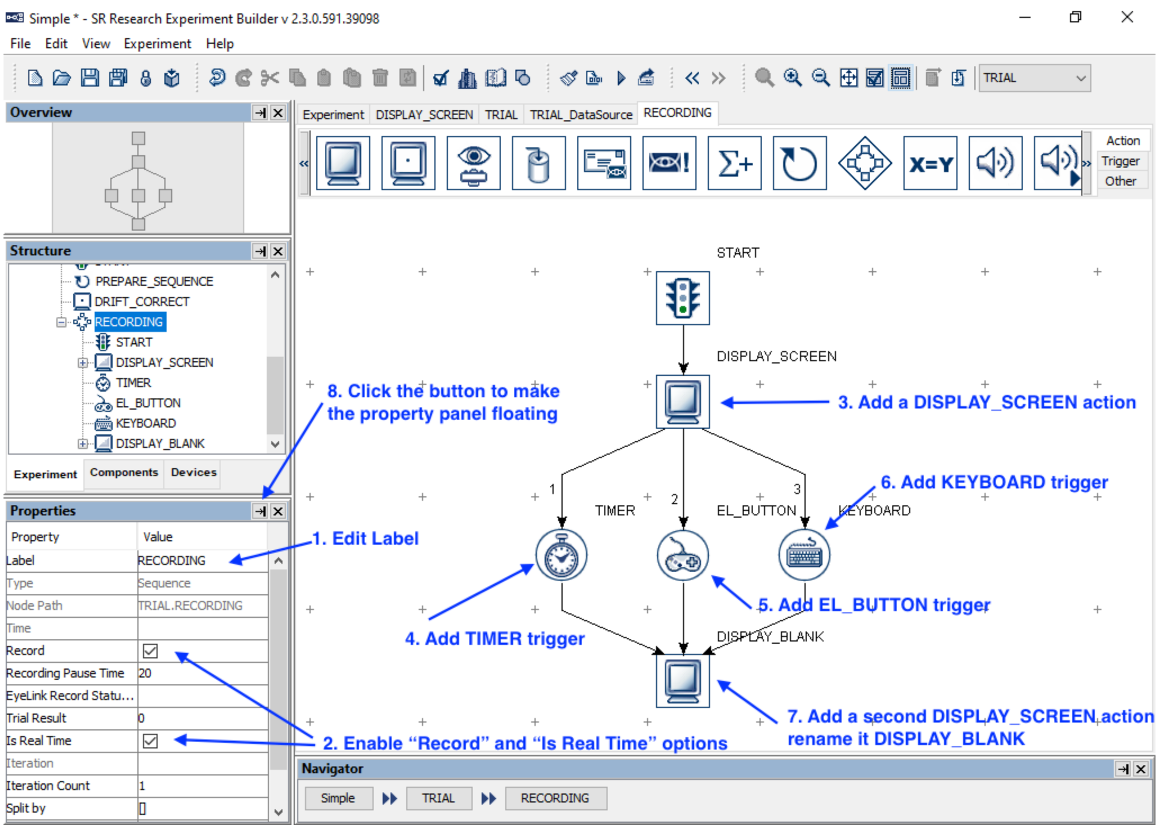


Figure 14-11. Editing Recording Sequence.

1) Select the newly added "Sequence" node and enter a new value for the Label, e.g., "RECORDING".
2) Make sure that the "Record" and "Is Real Time" checkboxes are checked. Double-click the "RECORDING" node in the structure list until seeing a "START" node under it. As we double click the "START" node, the content of the work area window is also updated.
3) Open the "Action" Tab of the component toolbox and drag a "Display Screen" action into the work area.
4) Then open the "Triggers" tab and drag a "Timer" trigger into the work space. Select the Timer object. In the "Duration" field enter 10000, and in the "Message" field, enter "Time out" (without quotes).
5) Drag an "EyeLink Button" trigger into the workspace.

6) Open the "Action" tab and drag a second "Display Screen" action into the workspace. Select the second Display Screen action, then set its Label, e.g., as "DISPLAY_BLANK", and uncheck the "Send EyeLink DV Messages" box.
7) Draw connections from the "START" node to "DISPLAY_SCREEN", from "DISPLAY_SCREEN" to both "TIMER" and "EL_BUTTON", and from both "TIMER" and "EL_BUTTON" to "DISPLAY_BLANK".
8) Right-click any blank area in the work space and select "Arrange Layout" in the popup menu to re-arrange the nodes.
9) Click the ⇥ button in the properties window to make it a free-floating window.

14.1.8 Modifying the Properties of a Display Screen

We can next configure the property settings of the display screen actions in the Recording sequence (see Figure 14-12). For Data Viewer integration and for reaction time calculation, we can set a message to be written to the EDF file to indicate the time when the stimulus was visible to the participant. We can also configure which screen's graphics are drawn the host screen so that the participants' gaze position can be evaluated during recording.

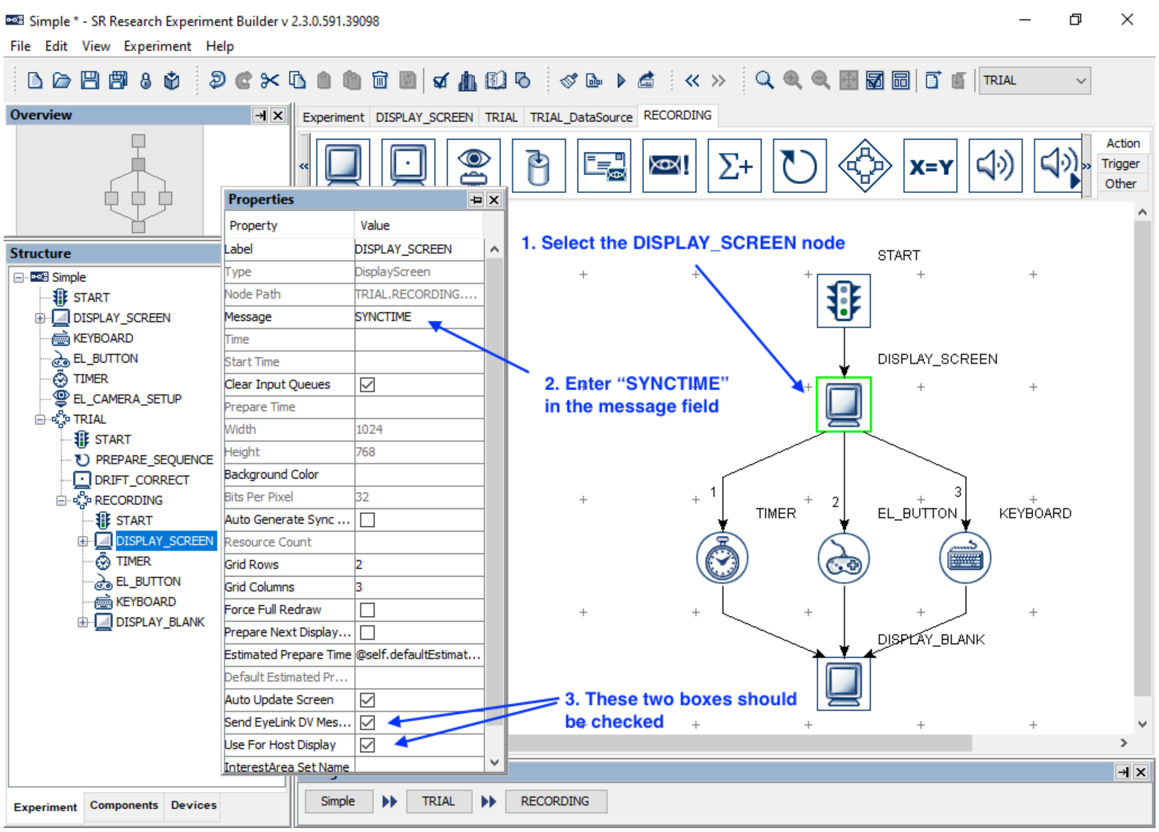


Figure 14-12. Modifying the Properties of DISPLAY_SCREEN Action.

1) Select the first DISPLAY_SCREEN node. In the properties window, double-click the value field of the "Message" property. Type in a message, e.g., "SYNCTIME", to mark the screen presentation, then press the Enter key.

2) Make sure the “Send EyeLink DV Messages” and “Use for Host Display” properties are checked.
3) Next, select the “DISPLAY_BLANK” action. Double click the value field of the “Message” property Type in a message, e.g., “blank_screen”, and then press the Enter key.
4) Make sure both the “Send EyeLink DV Messages” and the “Use for Host Display” checkboxes for the “DISPLAY_BLANK” action are unchecked.

14.1.9 Creating the Display Screen

We will next add a text resource to the display screen and modify the properties of the text resource, such as the text to be displayed, font name, size, and alignment style. We will also create an interest area for the text (see Figure 14-13). To open the Screen Builder window, double-click the “DISPLAY_SCREEN” object in the work space (***not in the structure list!***).

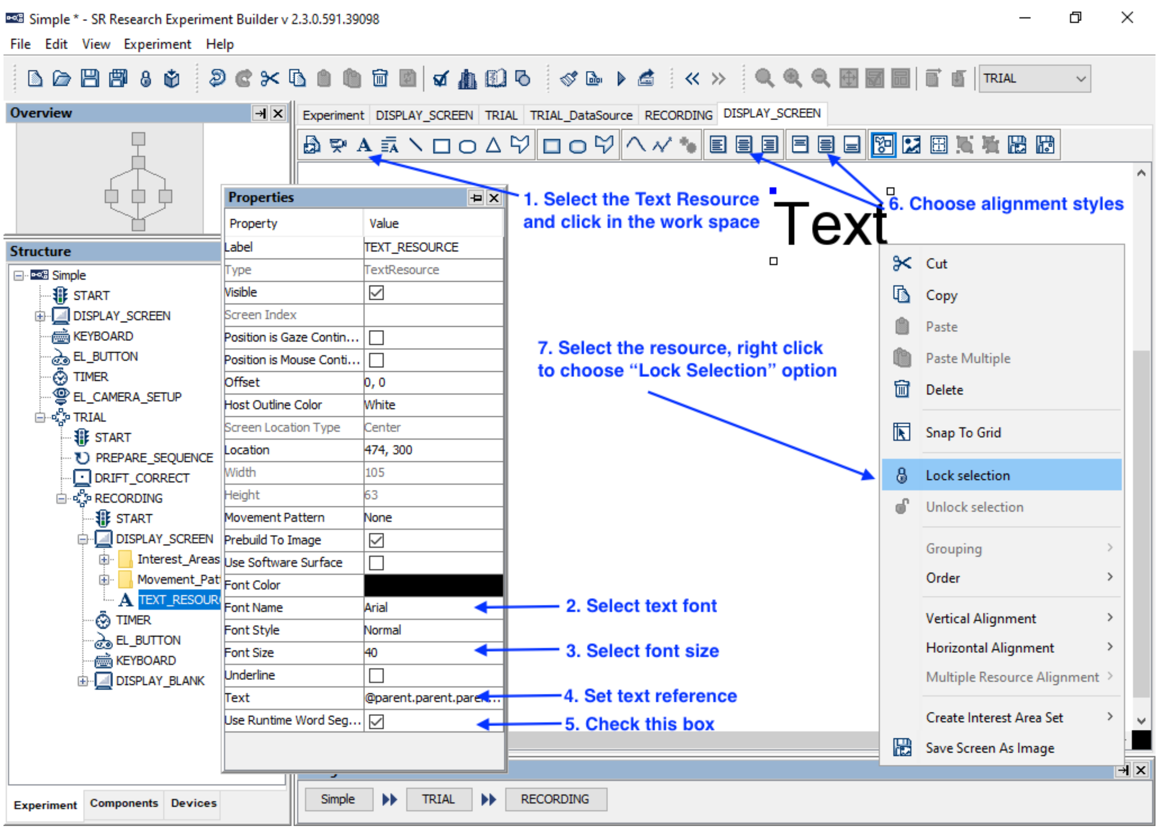


Figure 14-13. Adding Text to Display Screen.

1) Click the “Insert Text Resource” button (A) on the Screen Builder tool bar, then click any position in the screen area to add the resource.
2) Double click the Value of the Font Name property (e.g., “Times New Roman”). Select the desired font from the dropdown list—we’ll be using “Arial”.
3) Double click the value of Font Size (20). Enter the desired text size (40) in the text editor.

4) To set the text resource to load the text from the data source, click the value field of the "Text" property once, then click the […] button to open the Attribute Editor dialog (see Figure 14-14).
   a. Click the DataSource node under the "TRIAL" sequence in the Node Selection list.
   b. Double click the "word" attribute in the Node Attributes panel. This will update the contents of the "Attribute" panel as "@parent.parent.parent.TRIAL_DataSource.word@".
   c. Click the "OK" button to finish.

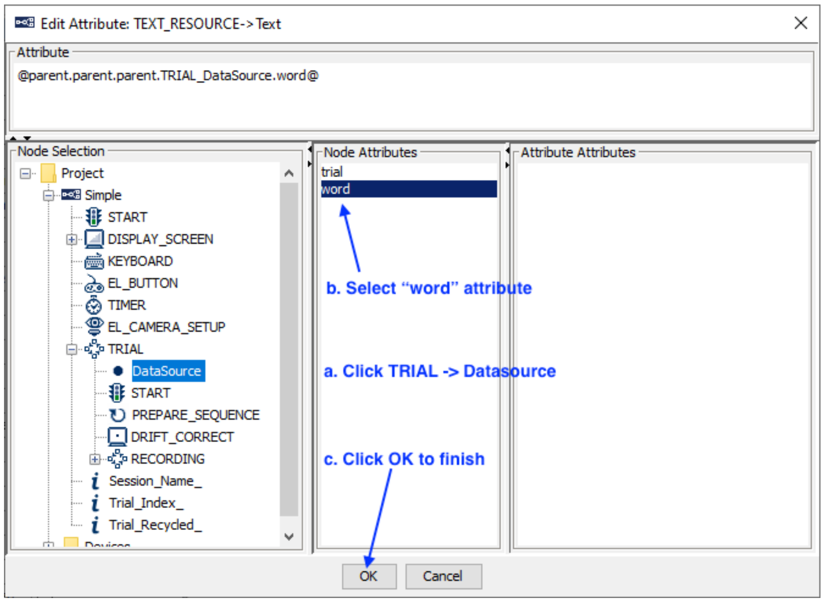


Figure 14-14. Showing Text by Referring to Data Source.

5) Check the "Use Runtime Word Segment" box. This will create interest areas automatically for the text used.
6) Select the newly added text resource, click both the "Horizontal Center Alignment" and "Vertical Center Alignment" () buttons to place the text in the center of the screen.
7) Select the text resource in the work area, then right-click the resource and select the "Lock Selection" option so that the resource will not be moved accidentally.

14.1.10 Writing Trial Condition Variables to EDF file

Users may configure which variables, including variable nodes and data source columns, should be written to the EDF file so the experimental conditions of each trial can be identified during analysis (see Figure 14-15). In Experiment Builder 2.0, all newly-added variable nodes and data source columns will automatically be added to the list of trial variables.

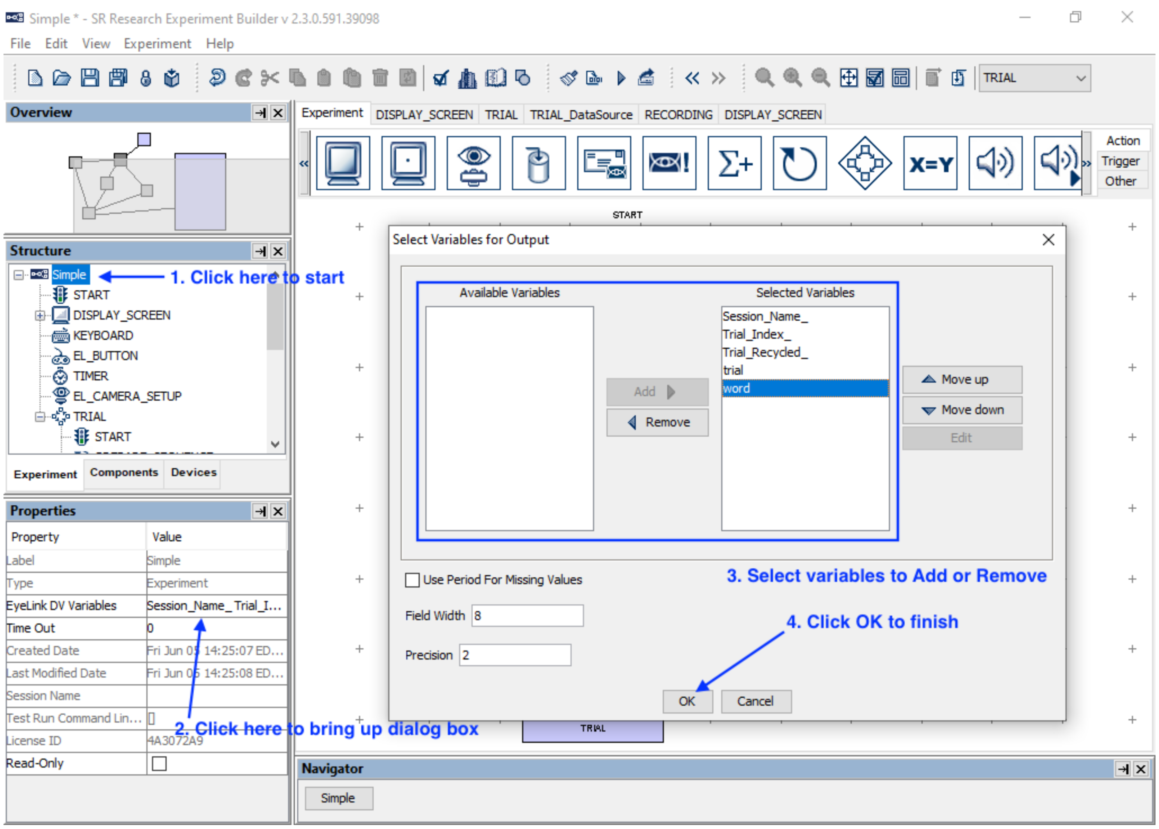


Figure 14-15. Configuring the EyeLink DV Variables.

1) Click the Experiment node in the structure list (the topmost node in the tree).
2) In the properties table, click the value field of the “EyeLink DV Variables” property.
3) In the following dialog box, the “Selected Variables” panel on the right lists all the data source columns and variables currently selected to be written to the EDF as trial variables, and “Available Variables” will show any variables not selected to be written as trial variables. To add or remove items from the Selected Variables, select the item(s) to be moved, then click the “Add” button ( ) or “Remove” button ( ). To configure the order of the variables in the output, select the item(s) to be moved and click the “Move Up” ( ) or “Move Down” ( ) buttons. In this example, make sure both the “Trial” and “Word” columns are included in the Selected Variables list.
4) Click “OK” to finish.

14.1.11 Showing Experiment Progress Message on Tracker Screen

During trial recording, a text message can be displayed at the bottom of the tracker screen so the experimenter can be informed of the experiment progress (see Figure 14-16). In this example, we will display a text message like “Trial 1/12 One” on the tracker screen, indicating the current trial and the word displayed.

1) Select the “RECORDING” sequence node in the structure list.

2) In the properties panel, click the value field of the "EyeLink Record Status Message" property once, then click the […] button to open the Attribute Editor dialog.
3) In the attribute editor, enter the following equation:

```
= "Trial " + str(@parent.iteration@) + "/ " + str(@parent.iterationCount@)
+ " " + str(@TRIAL_DataSource.word@)
```

4) Click the "OK" button to finish.

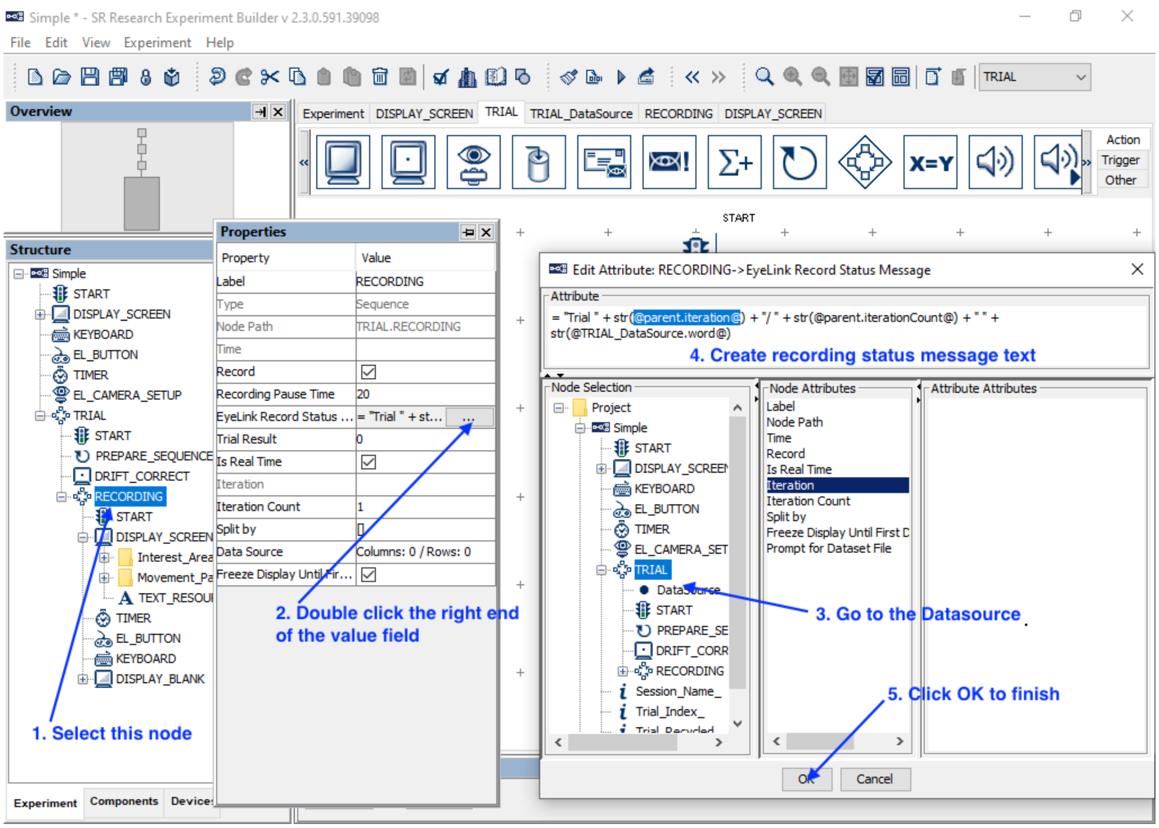


Figure 14-16. Creating Trial Recording Status Message.

14.2 Building the Experiment

Now your first experiment is created. If you haven't saved your experiment project yet, click the Save ( ) button on the application tool bar. Click "Experiment → Build" to build the experiment. An "Output" tab will be opened in the Graph Editor Window and build information will be displayed. Watch for error messages (displayed in red) and warning messages (in brown) during building. If any error or warning messages appear, double-click on an error or warning message in the output tab to highlight the node or screen resource that produced the error/warning.

Once the project builds successfully, users may test run the experiment by clicking on "Experiment → Test Run" from the application menubar. This will try connecting the Display PC to the Host PC to run the experiment code, so the Display PC must have an Ethernet connection to the Host PC (or Dummy Mode may be enabled). Please note that the "Test Run" should only be used for testing and debugging experiment code, and not for actual data collection. To collect experiment data, users should run the deployed version of the experiment (see the next section).

14.3 Deploying the Experiment

After the experiment is built, users must "deploy" the experiment into a new folder by clicking Experiment → Deploy (see Section 4.12). This will create an executable version of the experiment so it can run without relying on the Experiment Builder application. If a data source is used, this will create a "datasets" subdirectory with a copy of the data set file in it. If desired, users may create several data set files with the external randomizer application (see Section 9.6.2).

14.4 Running the Experiment

To run the experiment, first make sure the EyeLink host software is running, and the network connection between the host and display computers has been established. Then go to the directory where the experiment was deployed and click "simple.exe" to start the experiment. A dialog box will prompt for an EDF file name (the name should be no more than 8 characters, featuring only letters, numbers and the underscore "_" character). Click the "OK" button to continue. Following the initial welcome message, the participant will be shown the camera setup and calibration screen; the recording can be started following a calibration, validation, and pre-trial drift correction. After running all of the trials, an EDF file will be transferred to the display computer. It may take some time to complete the file transfer, so please be patient.

The following sections list some common errors while attempting to run an experiment.

14.4.1 Error in Initializing Graphics

If you start the experiment and see an "Could not initialize display to ***" error, please check whether the display settings (screen resolution, color bits, and refresh rate) specified for the experiment are supported by your video card and monitor (see Figure 14-17). If not, please set the correct display settings in "Preferences → Experiment → Devices → DISPLAY".

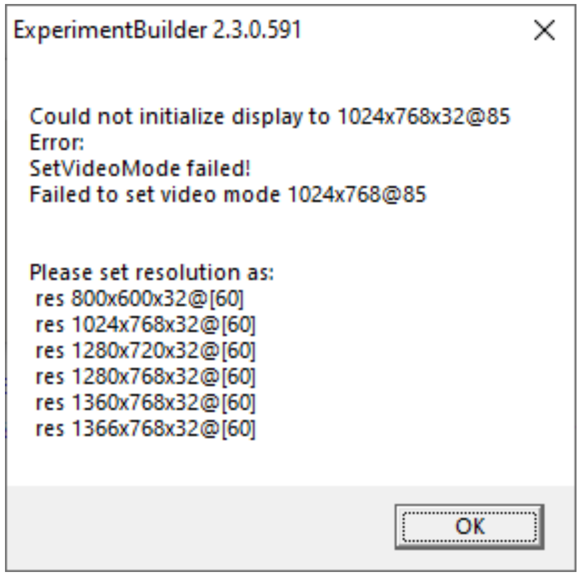


Figure 14-17. Error in Initializing Graphics.

14.4.2 Invalid Tracker Type

SR Research Experiment Builder is compatible with EyeLink I, EyeLink II, EyeLink 1000, EyeLink 1000 Plus, and EyeLink Portable Duo eye trackers. The default tracker version is set to EyeLink 1000 Plus (see “Preferences → Experiment → Devices → EYELINK”). If the eye tracker specified in the preferences doesn’t match the eye tracker being used, Experiment Builder will display an error message like the one pictured in Figure 14-18—if you see this message, please set the correct tracker version in the device settings (see Figure 14-4).

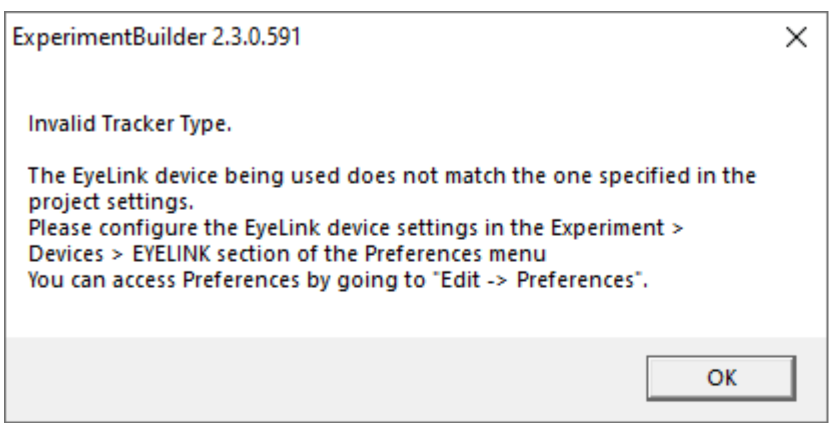


Figure 14-18. Error in Tracker Version.

15 Creating Non-EyeLink Experiments: Stroop Effect

This chapter illustrates using SR Research Experiment Builder to create a non-eye-tracking experiment. This Stroop sample experiment demonstrates testing the Stroop Effect with keyboard response: the participant is asked to respond to the colors of the words as quickly and as accurately as possible. For example, for the word "BLUE", the participant should respond "RED" instead of "BLUE".

15.1 Creating a New Experiment Project

To open Experiment Builder in Windows click Start → All Applications → SR Research and choose "Experiment Builder". On macOS, go to "Applications/ExperimentBuilder", then open the "ExperimentBuilder" application. When the application starts:

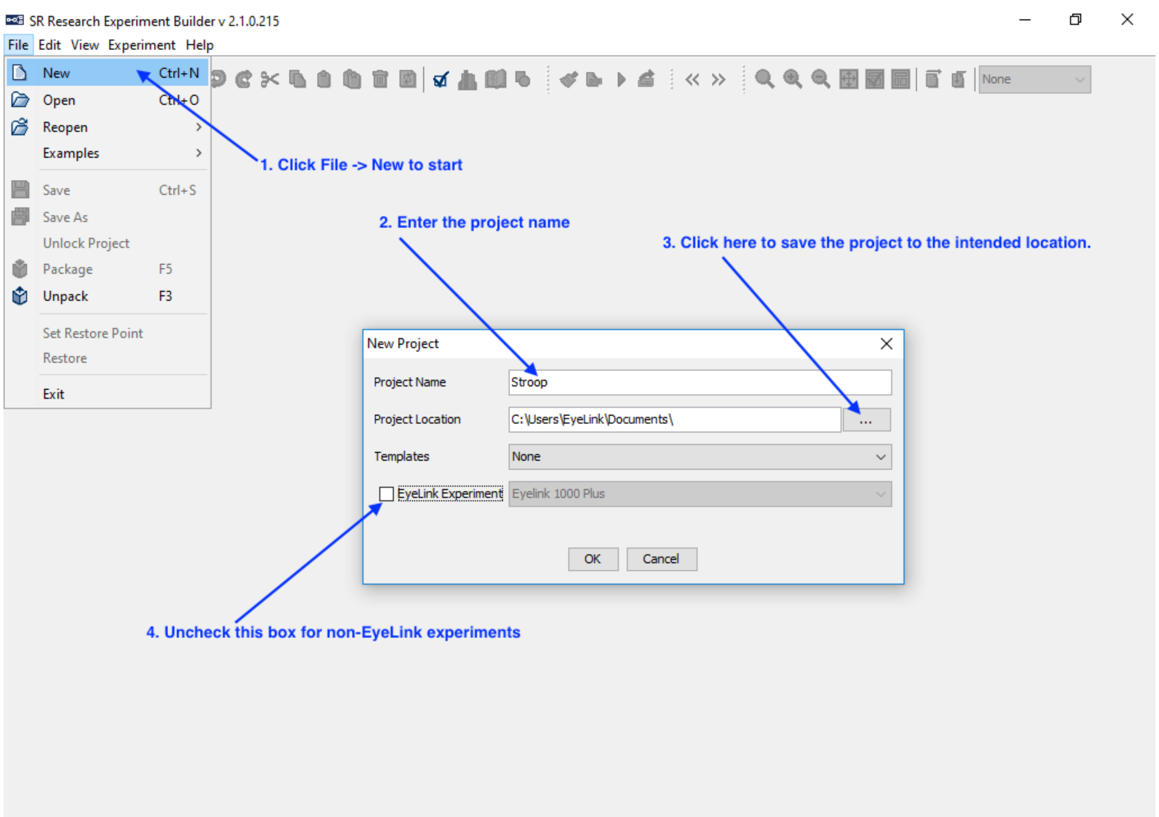


Figure 15-1. Creating a New Experiment Builder Session.

1) Click "File → New" on the application menu bar.
2) In the following "New Project" dialog box, enter "Stroop" in the "Project Name" edit box.
3) Click the button on the right end of the "Project Location" to browse to the directory where the experiment project should be saved. If manually entering the "Project Location" field, please make sure that the intended directory already exists.

4) Make sure the "EyeLink Experiment" box is unchecked for a non-EyeLink experiment.

15.2 Configuring Experiment Preference Settings

After creating a new experiment session, check whether the default display and screen preference settings are appropriate for the experiment to be created.

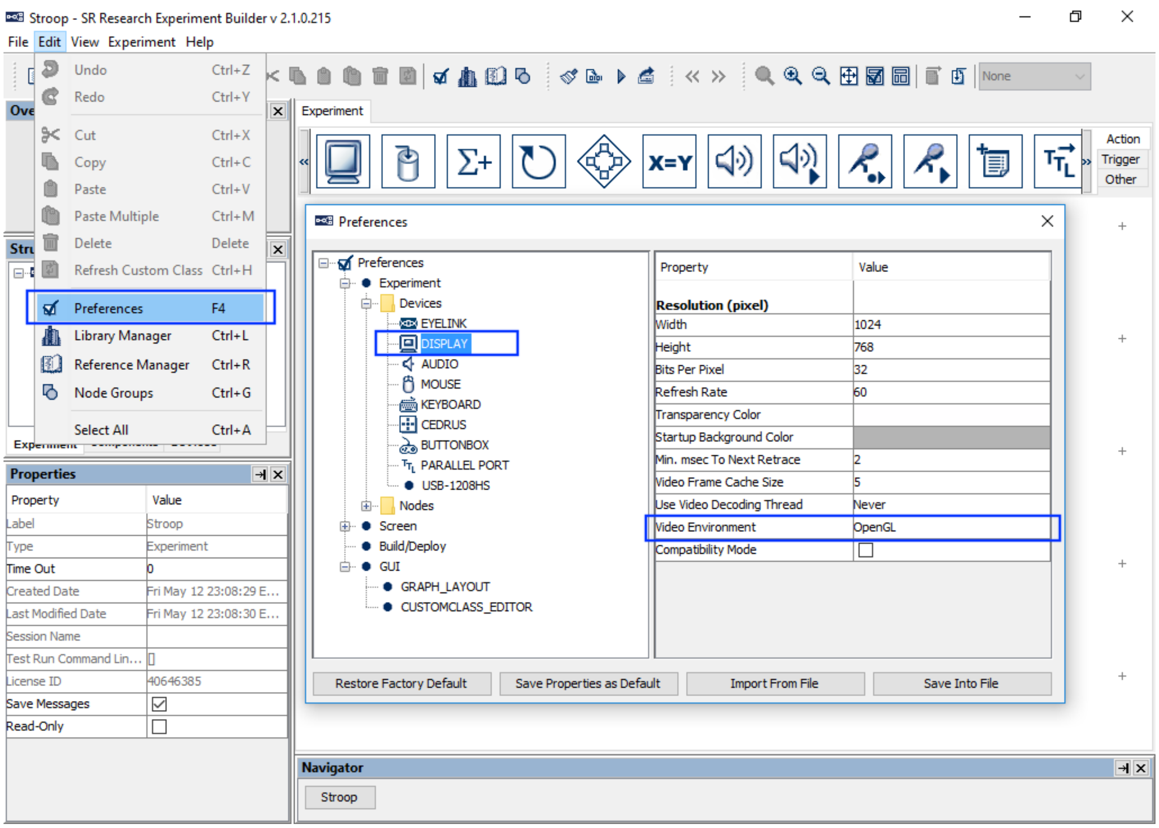


Figure 15-2. Editing Project Display Preferences.

1) Select "Edit → Preferences" from the application menu bar or press the shortcut key "F4" on Windows. On macOS, click "ExperimentBuilder → Preferences" from the application menu bar or press Command ⌘+" ,".
1) Click "Preferences → Experiment → Devices → Display" to check display settings. Make sure the settings (Width, Height, Bits per Pixel, and Refresh Rate) used in the current example are supported by your video card and monitor. For this example, set the "Video Environment" to "OpenGL". If using the DirectDraw graphics, additionally set the "Transparency Color" of the project close to (but not identical to) the background color of the display screens to make the text look better. For example, this experiment has a white background (255, 255, 255), so you may set the RGB value of the transparency color to (251, 250, 251). It is not

necessary to set the Transparency Color when using the "OpenGL" video environment.

2) Click "Preferences → Screen" to check Screen Builder settings. Set the Location Type as "Center Position" and check the "Antialis Drawing" box.

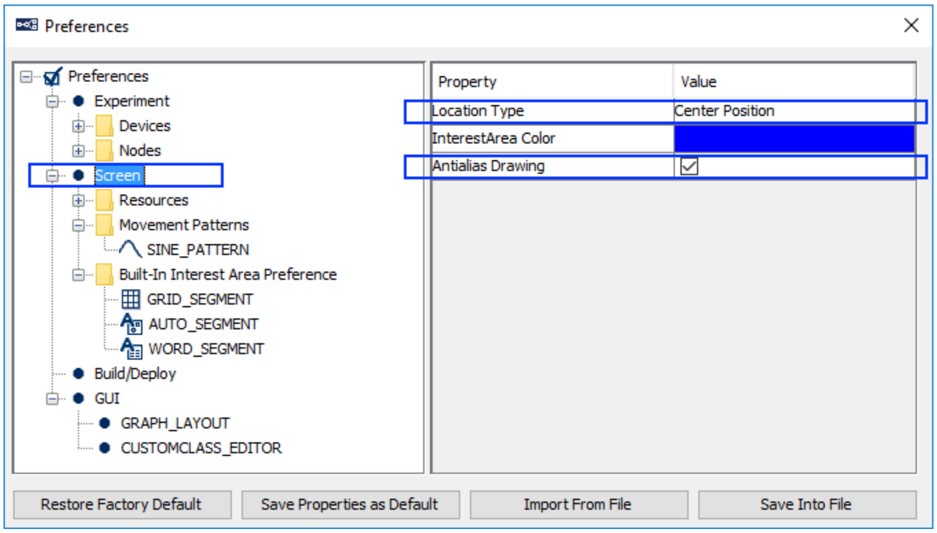


Figure 15-3. Setting the Screen Preferences.

3) After changing any preference settings, if you would like to keep the new settings as defaults for all of your future experiments, click the "Save Properties as Default" button.

4) Once finished, press the close button on the dialog box.

If intending to use any characters that do not fit in the ASCII encoding range, including non-English characters (eg. à, è, ù, ç), special curved quotes, and any non-European language characters (e.g., Chinese characters), please also make sure the "Encode Files as UTF-8" box of the Build/Deploy node is checked (enabled by default in later versions of Experiment Builder; see Figure 15-4).

Failing to enable UTF-8 encoding when non-ASCII characters are used will result in the following build/run time warning:

WARNING: warning:2001 You are using characters that ascii encoding cannot handle! Please change your encoding!

Likewise, if Chinese, Japanese, or Korean characters are used and UTF-8 encoding is not enabled, this will result in the following error:

ERROR: error:2070 Internal Error. Could not create script. Please contact SR Research! Sorry: MemoryError: ().

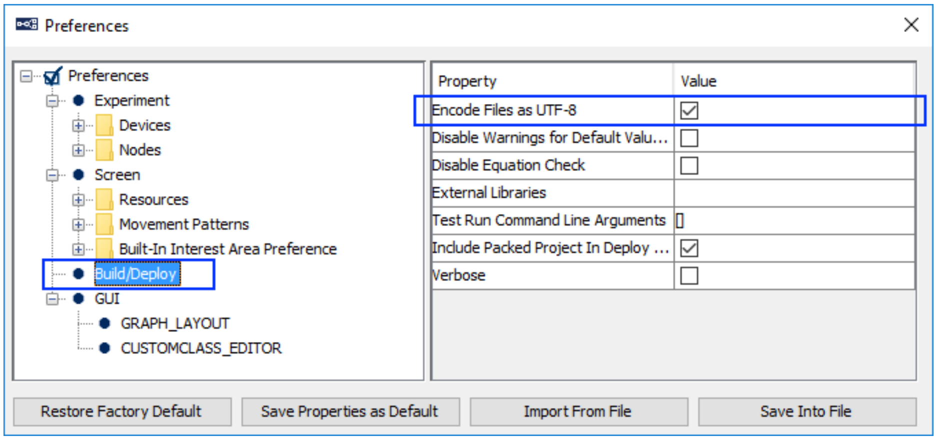


Figure 15-4. Editing Project Build/Deploy Preferences.

15.3 Creating the Experiment Block Sequence

In this example, we are going to run two blocks of nine trials each. The first step is to add a block sequence for repeating blocks (see Figure 15-5). Then we will add a results file to save data output.

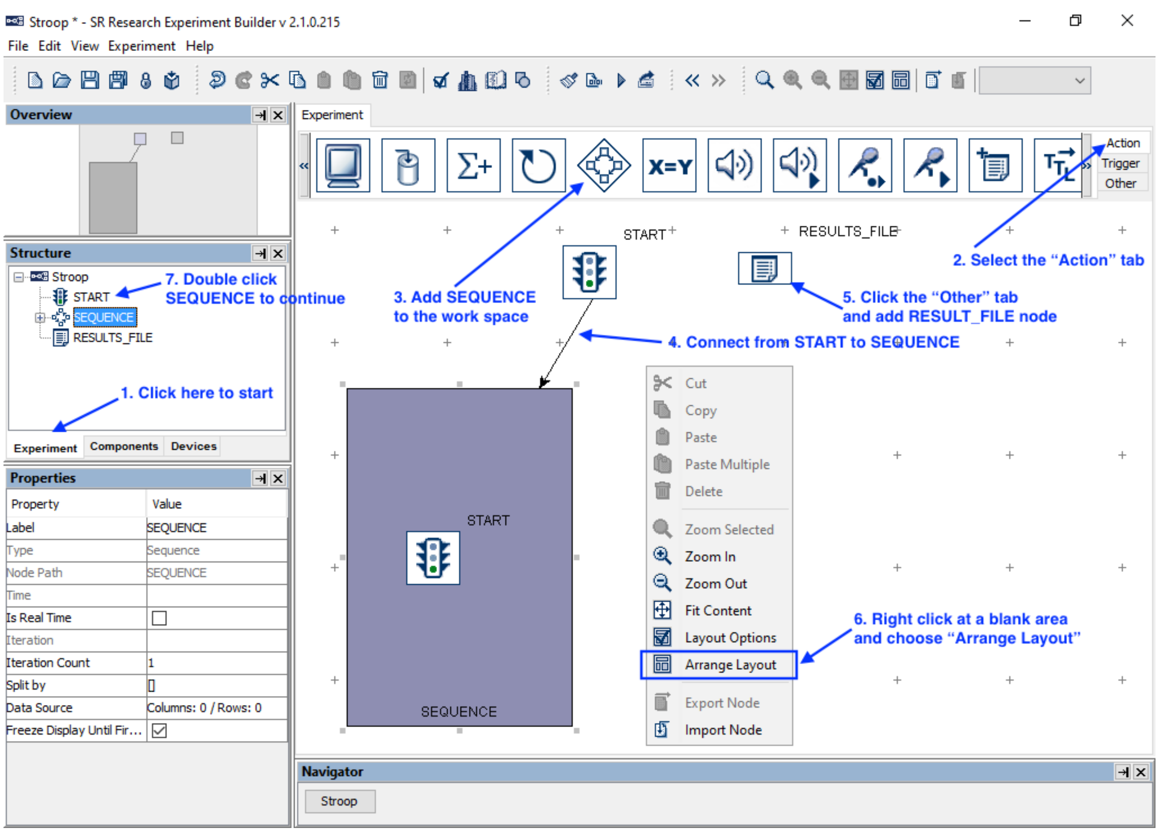


Figure 15-5. Creating Experiment Block Sequence.

1) Click the Experiment Tab in the Project Explorer Window to start.
2) Open the "Action" Tab of the component toolbox.

3) Click and drag the "Sequence" node from the component toolbox into the work space.
4) Connect the "START" and "SEQUENCE" nodes by clicking and dragging the mouse from the "START" node to the "SEQUENCE" node. (**Note:** If the "START" node is selected, clicking and dragging will move the node instead of drawing an arrow. To de-select the node, simply click in an empty area of the work space.)
5) Open the "Other" Tab of the component toolbox and add a "RESULTS_FILE" node to the graph.
6) To rearrange the nodes into an orderly layout onscreen, right-click any blank area in the work window and select "Arrange Layout" in the popup menu.
7) Select the SEQUENCE node in the structure list to continue.

15.4 Editing the Block Sequence

Next, we can edit the properties of the Block Sequence. We will first set the "Label" of the sequence to give it a meaningful name, then set the "Iteration Count" to the number of blocks to be tested (see Figure 15-6). (We do not edit the "Split by" field for the block-level sequence; we will instead set the "Split by" of the trial-level sequence.)

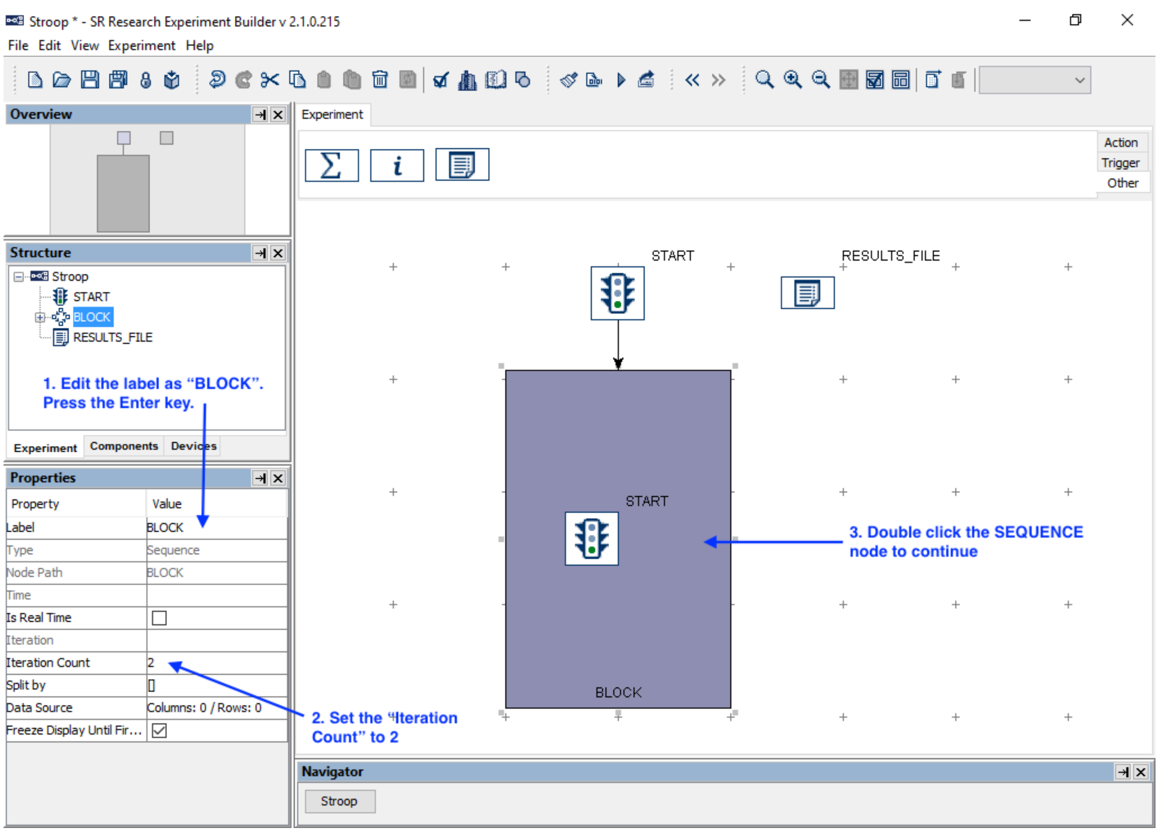


Figure 15-6. Editing Block Sequence.

1) Click the value field of the "Label" property of the Sequence created. Type a new label, e.g., "BLOCK", into the text editor and press the Enter key to finish.

2) Click the “Iteration Count” value field and enter “2” as the total number of loops to execute.
3) Double-click the BLOCK Sequence object in the work space to enter the sequence.

In each block, we will first display some instructions onscreen and then run nine trials (see Figure 15-7). We can start by adding the necessary nodes to the workspace within the BLOCK sequence:

1) Open the “Action” Tab of the component toolbox, then click and drag a “Display Screen” action into the work area.
2) Open the “Trigger” Tab of the component toolbox, then drag a “Timer” trigger into the work space.
3) Select the Timer trigger and set the duration to 120000 msec.
4) Add a “Keyboard” trigger to the work space.
5) Open the “Action” Tab of the toolbox and add a “Sequence” node to the workspace. This will be our trial-level sequence.

Then we can continue by drawing the connections between the nodes in the BLOCK sequence:

6) Click and drag from the START node to the DISPLAY_SCREEN node.
7) Draw two connections from the DISPLAY_SCREEN action to the KEYBOARD and TIMER triggers. When a single action connects to multiple triggers, a number is added to each connection indicating the evaluation order among the two trigger types. In this experiment, it doesn’t matter which order the nodes are connected in.
8) Draw a connection from each of the two triggers to the trial-level SEQUENCE node.
9) Right-click any blank area in the work window and select "Arrange Layout" in the popup menu.

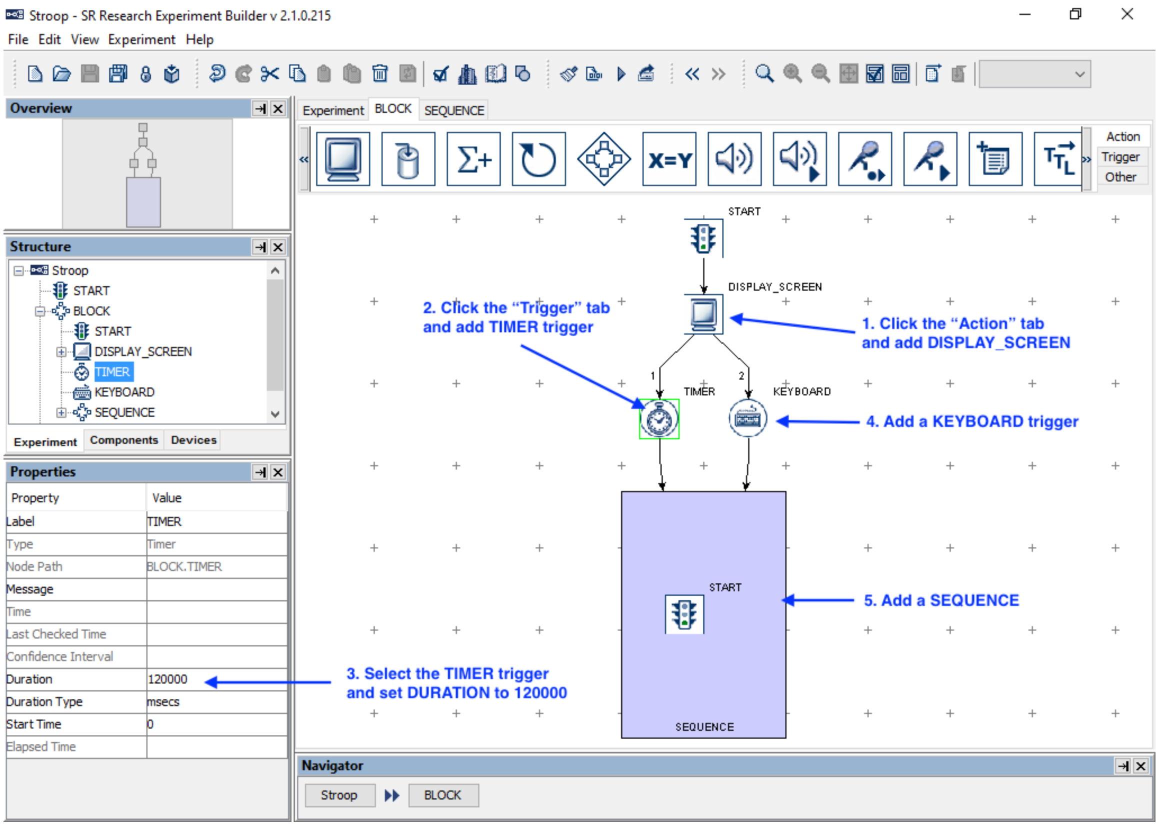


Figure 15-7. Adding Instruction to Block Sequence.

15.5 Creating the Instruction Screen

Next we can configure the DISPLAY_SCREEN node to display a set of instructions at the beginning of the experiment. In this example, we will create the instructions by adding a Multi-Line Text Resource to the Display Screen; users may also create the instructions as an image file and use the Display Screen to display the image.

To start editing the screen, open the Screen Builder by double-clicking the DISPLAY_SCREEN node in the workspace.

1) Once you've opened the Screen Builder, click the multiline text resource () button on the screen builder toolbar to select the resource to add.
2) Click anywhere on the screen to add the resource.

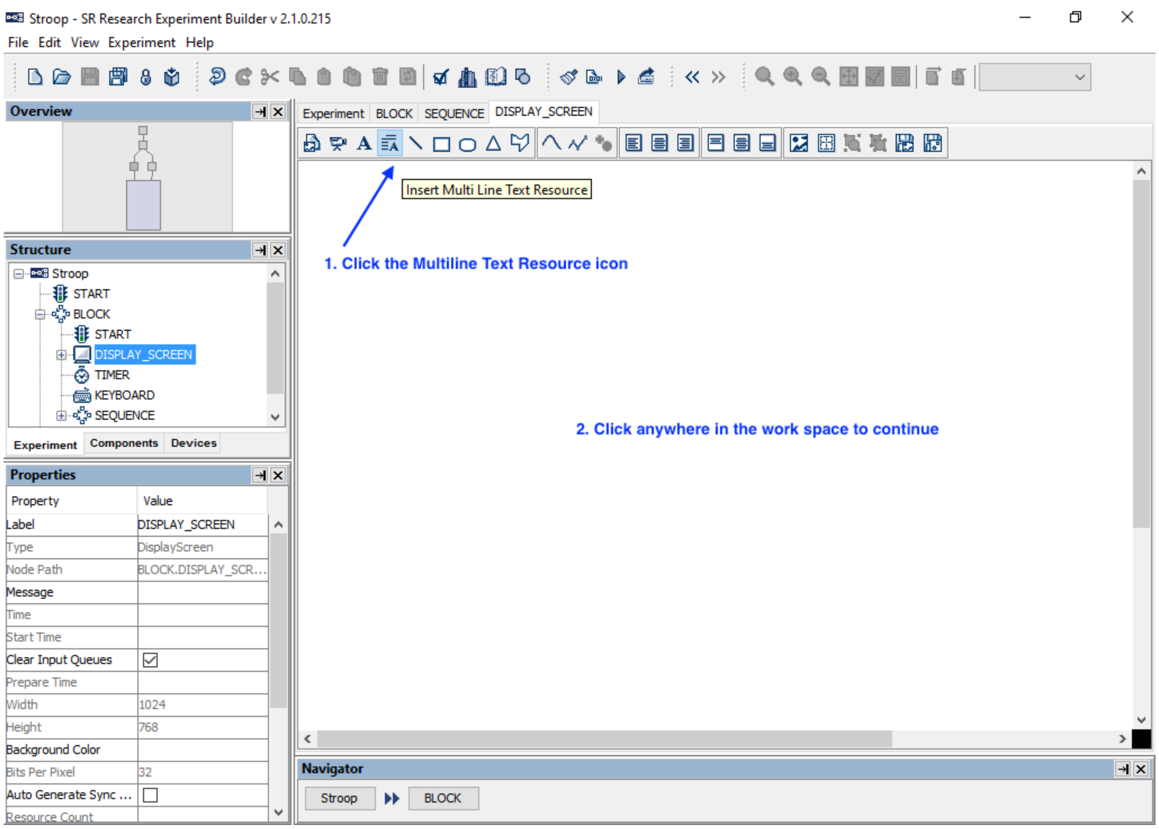


Figure 15-8. Adding Multiline Text Resource onto a Display Screen.

In the following Multiline Text Resource Editor,

1) Click the “Margins” button in the toolbar to set the text margins. Enter 100 in all fields. Click the "OK" button on the dialog box.
2) Enter the desired instruction text (see Figure 15-9).
3) Press Ctrl + A on Windows (Command ⌘ + A on macOS) to select all text entered.
4) Then click the buttons on the toolbar to set the desired text appearance (font name, font size, font style, alignment style, line spacing, and text color).
5) Select the example word “Green” in the text and set its color to blue and text size to 50.
6) Click the “Close” button () at the top right corner to close the Screen Builder.

Please note that, instead of using a multi-line text resource, users can also present the instruction text by using an image resource (see Section 8.1.1).

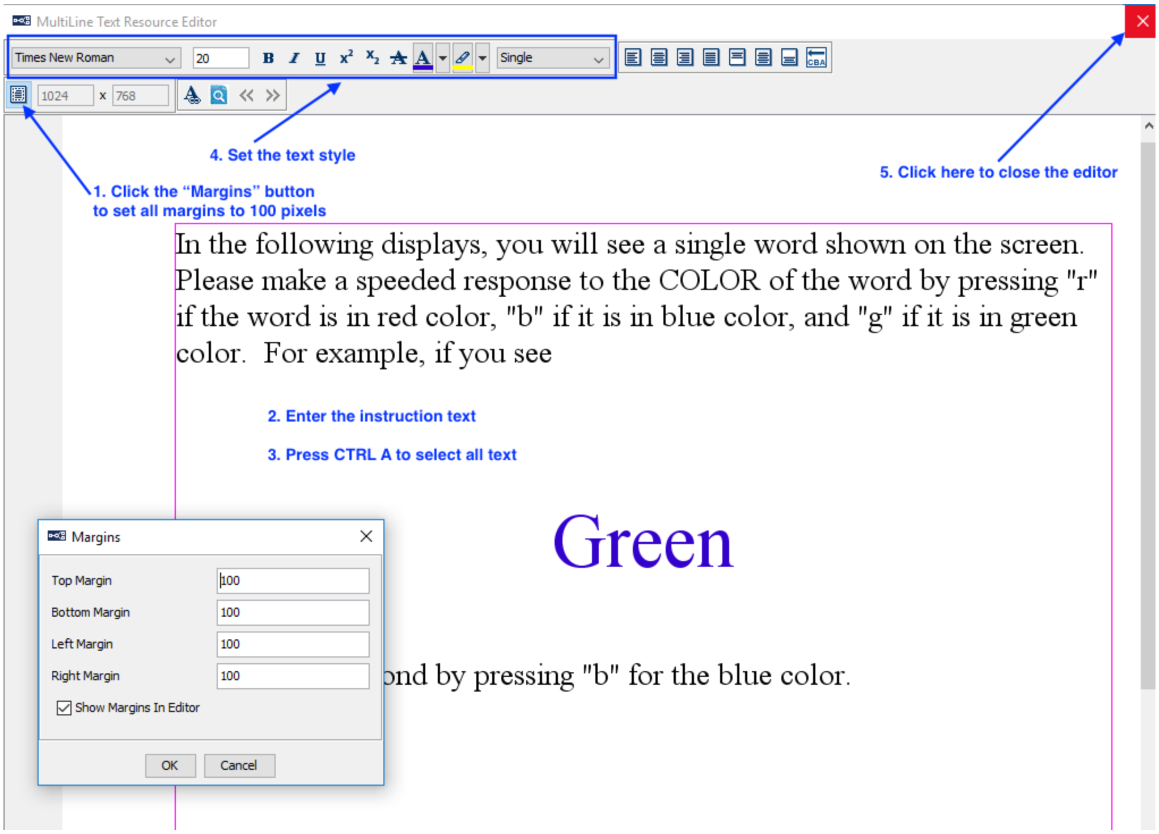


Figure 15-9. Create Instruction Screen.

15.6 Editing the Trial Sequence: Data Source

Next, we will design the Trial sequence, which will contain all the necessary triggers and actions in each trial. We will first create a data source to set the parameters in individual trials (see Figure 15-10). In this experiment, we will add four columns to the data source: "Color", to speciy the color of the text; "Word", to specify the text displayed on each trial; "Expected", to specify the expected keyboard response; and "Compatible", to specify whether the text color matches the word.

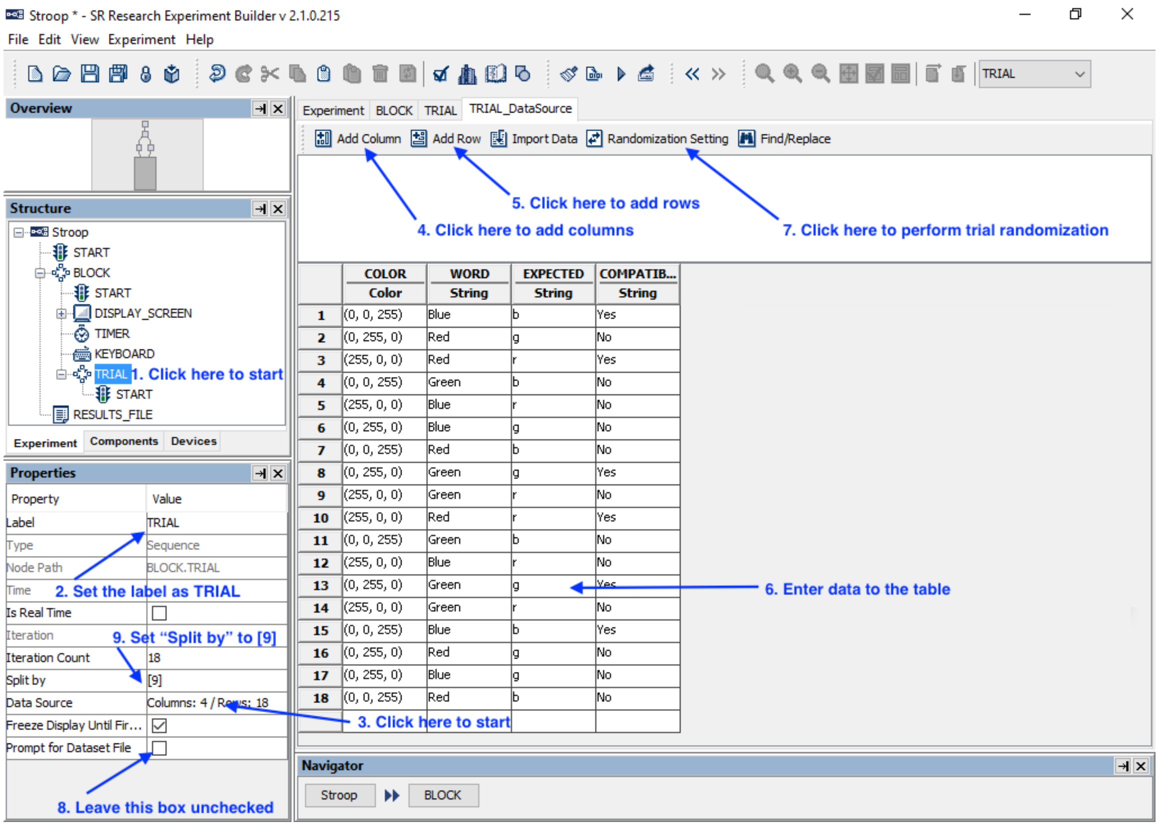


Figure 15-10. Creating Data Source.

1) First, select the last "SEQUENCE" node in the structure list (the one we added within the BLOCK sequence).
2) In the Properties table, enter a new value for the Label, e.g., "TRIAL".
3) Click the value cell of the "Data Source" property (where it says "Columns: 0 / Rows: 0") to bring up the Data Source Editor.

Next we can create the Data Source columns and enter our values.

4) Click the "Add Column" button. Type "COLOR" (without quotes) in the Column Name box, and set the Column Type to "Color". Click the "OK" button to finish. Click the "Add Column" button again, to create three more columns. Set the Column Names as "WORD", "EXPECTED", and "COMPATIBLE", and set these Column Types as "String". (**Important:** Your experiment may not run if inappropriate column types are used for the data source.)

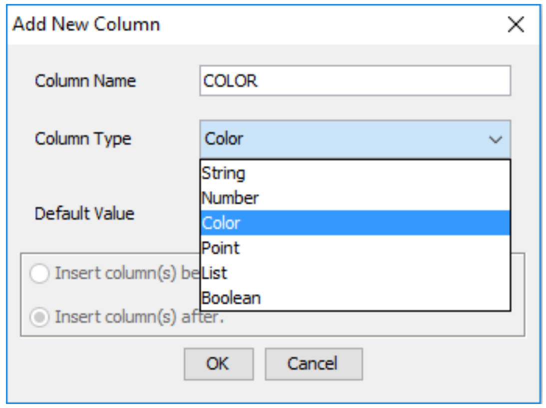


Figure 15-11. Adding a New Data Source Column.

5) Click the “Add Row” button. Set the “Number of Rows” to 18 to add 18 rows of empty cells, then click “OK”.
6) Add the following data to the table just created. For cells expecting Color data, enter the RGB values as three integers (between 0-255) separated by commas; Experiment Builder will automatically append a fourth alpha value of 255.

	Color	**WORD**	**EXPECTED**	**COMPATIBLE**
data type	Color	String	String	String
1	(0, 0, 255)	Blue	b	Yes
2	(0, 255, 0)	Red	g	No
3	(255, 0, 0)	Red	r	Yes
4	(0, 0, 255)	Green	b	No
5	(255, 0, 0)	Blue	r	No
6	(0, 255, 0)	Blue	g	No
7	(0, 0, 255)	Red	b	No
8	(0, 255, 0)	Green	g	Yes
9	(255, 0, 0)	Green	r	No
10	(255, 0, 0)	Red	r	Yes
11	(0, 0, 255)	Green	b	No
12	(255, 0, 0)	Blue	r	No
13	(0, 255, 0)	Green	g	Yes
14	(255, 0, 0)	Green	r	No
15	(0, 0, 255)	Blue	b	Yes
16	(0, 255, 0)	Red	g	No
17	(0, 255, 0)	Blue	g	No
18	(0, 0, 255)	Red	b	No

7) Click the "Randomization Setting" button to configure randomization settings. In the Randomization Setting window, set the randomization Seed Value to "Session Label" so the same trial sequence will be presented when the same recording session label is used. Check the "Enable Trial Randomization" box, and set the Run Length Control column to "WORD" and Maximum Run Length to 2. This ensures that the trial presentation order is randomized, with a restriction that the

same "WORD" value will not be shown on three consecutive trials. Press the OK button to finish.

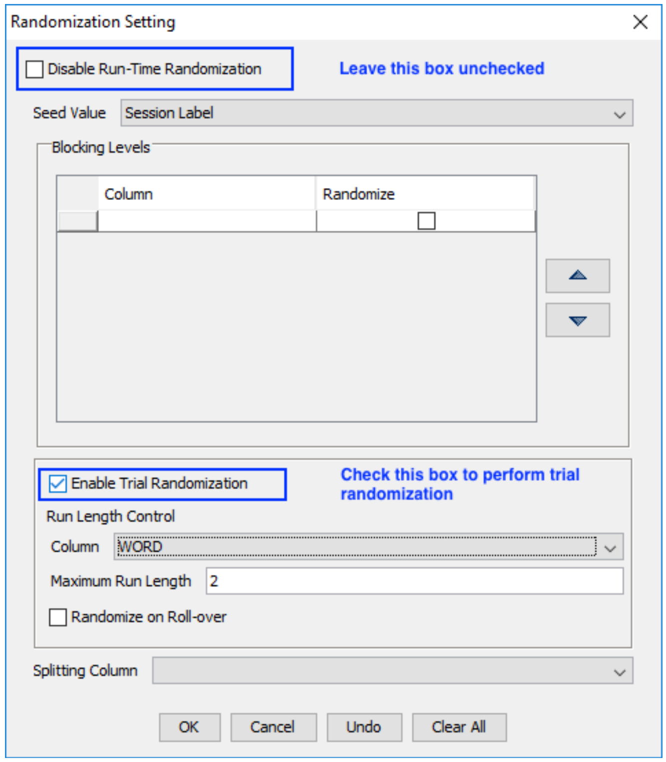


Figure 15-12. Data Source Randomization.

8) In the properties table of the TRIAL sequence, leave the "Prompt for Dataset File" box unchecked so you will not be prompted to select a data source file at the beginning of the experiment.
9) Click the "Split by" value field. Enter a value of [9] so 9 trials will be run in each block.
10) Double click the "TRIAL" sequence node in the workspace to enter the sequence.

15.7 Editing the Trial Sequence: Setting Initial Values and Preparing Sequence

Each trial should begin with a Prepare Sequence action, followed by the actual trial recording (see Figure 15-13). In a non-EyeLink experiment, the Prepare Sequence action preloads any image files or audio clips in the trial for real-time image drawing or sound playing and reinitializes trigger settings. We will also add several variables to store dependent data (e.g., RT, key press, and trial response accuracy) for each trial.

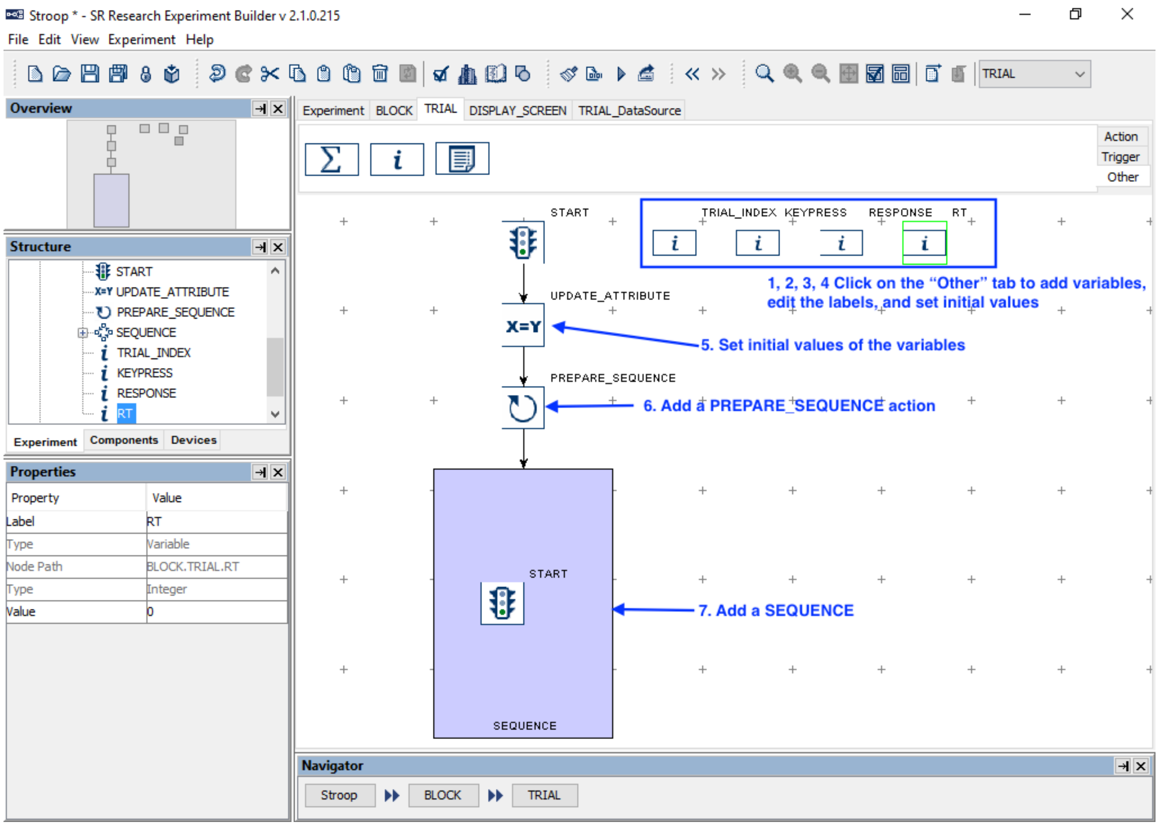


Figure 15-13. Editing Trial Sequence.

1) Open the "Other" Tab of the component toolbox and drag a "Variable" node into the work space. Select the newly added VARIABLE node, change its label to "TRIAL_INDEX" and set the initial value as "0". This variable will be used to keep track of the current trial index. The data type will automatically changed to "Integer" upon setting the initial value of "0".
2) Add another variable to the workspace, then set its label to "KEYPRESS" and its initial value to ".". This variable will be used to record the participant's key press for the trial.
3) Add a third variable, then set its label to "RESPONSE" and its initial value to ".". This variable will be used to check whether the response recorded is correct or not.
4) Add in a fourth variable, then set its label to "RT" and its initial value to "0.0". This variable will be used to store reaction time for the trial.
5) Open the "Action" Tab of the component toolbox, then drag an Update Attribute action into the work space. Select the Update Attribute node (step A1 of the figure below) and set the initial values of the following four variables, TRIAL_INDEX, RT, RESPONSE, and KEYPRESS:
    a. Click the value field of the "Attribute-Value List" property (step A2) to open the "Attribute-Value List" window.
    b. Click once in the first cell under the "Attribute" column (step A3), then click the […] button to open the Attribute Editor window. In the "Node Selection" panel on the left, select the TRIAL_INDEX variable node under the "TRIAL" sequence (step A4). In the middle "Node Attributes"

panel, double-click the "Value" attribute (step A5). This will set the contents of the "Attribute" panel on top as "@TRIAL_INDEX.value@". Click the "OK" button to finish. This will fill in the first cell of the Attribute-Value list dialog.

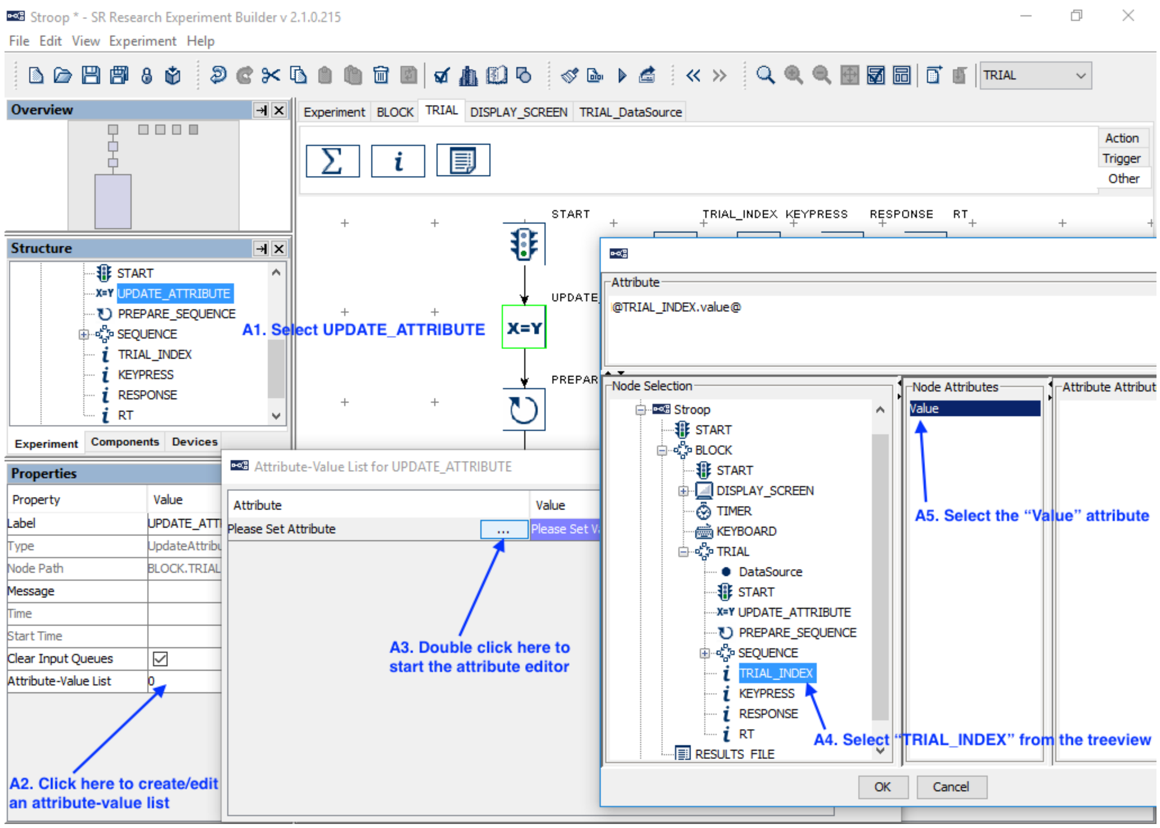


Figure 15-14. Updating Trial Index.

c. Next, click the first cell under the "Value" column once, then press the […] button (See B1 of the figure below). In the "Node Selection" panel of the attribute editor, click the "TRIAL" sequence (see B2). In the middle "Node Attributes" panel, double click the "Iteration" attribute (B3). This will update the contents of the top "Attribute" editor dialog as "@parent.iteration@". Click the "OK" button to finish (B4).

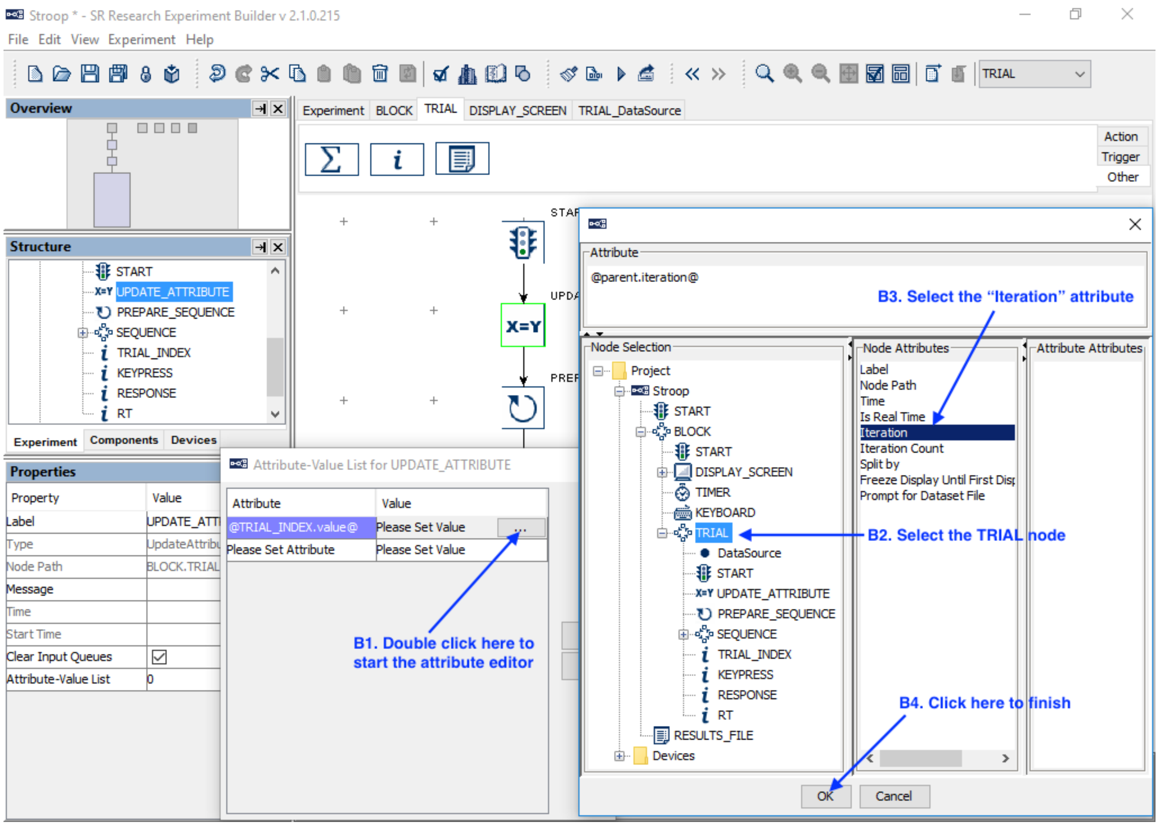


Figure 15-15. Update Trial Iteration.

d. Similarly, set the second cell of the "Attribute" column to @RT.value@. Double-click in the left side of the corresponding "Value" cell, then type in "-32768" (without quotes; this is equivalent to a "missing value" for Integer data) and press Enter to register the change (see Figure 15-16).
e. Set the Attribute 3 to "@KEYPRESS.value@" and value 3 to ".".
f. Set the Attribute 4 to "@RESPONSE.value@" and value 4 to ".".

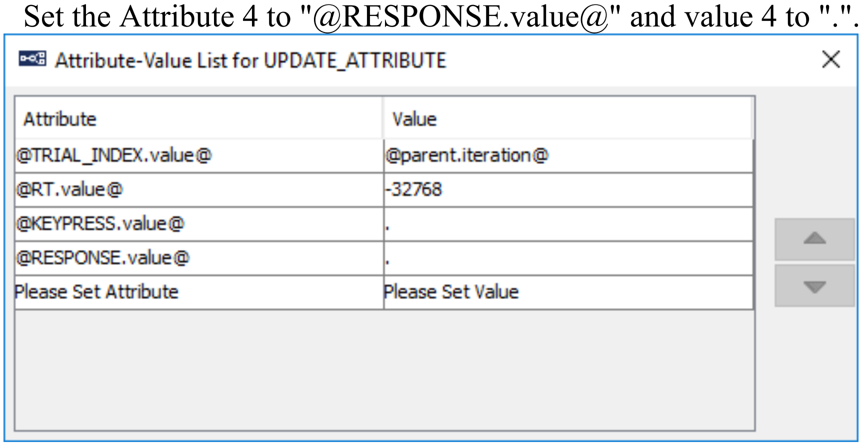


Figure 15-16. Updating the Attribute of RT.

6) Next, drag a "Prepare Sequence" action into the work space. Click the added action and review the settings in the property table—make sure the "Flush Log" box is checked so data output for the previous trial is completed before starting a new trial.
7) Then drag a "Sequence" node into the work space.
8) Click and drag to draw a connection from the "START" node to "UPDATE_ATTRIBUTE", from "UPDATE_ATTRIBUTE" to "PREPARE_SEQUENCE", and from "PREPARE_SEQUENCE" to the "SEQUENCE" node. The four variable nodes (RT, KEYPRESS, RESPONSE, and TRIAL_INDEX) should not be connected to other nodes.
9) Right-click any blank area in the workspace and select "Arrange Layout" in the popup menu.

15.8 Editing the Trial Event Sequence – Part 1

The next step is to design the actual display presentation in a trial. In this example, we first show a fixation cross in the center of the screen for one second, followed by the presentation of the Stroop word. We then wait for a keyboard response by the participant or for the trial to time out in eight seconds, and finally the display is cleared.

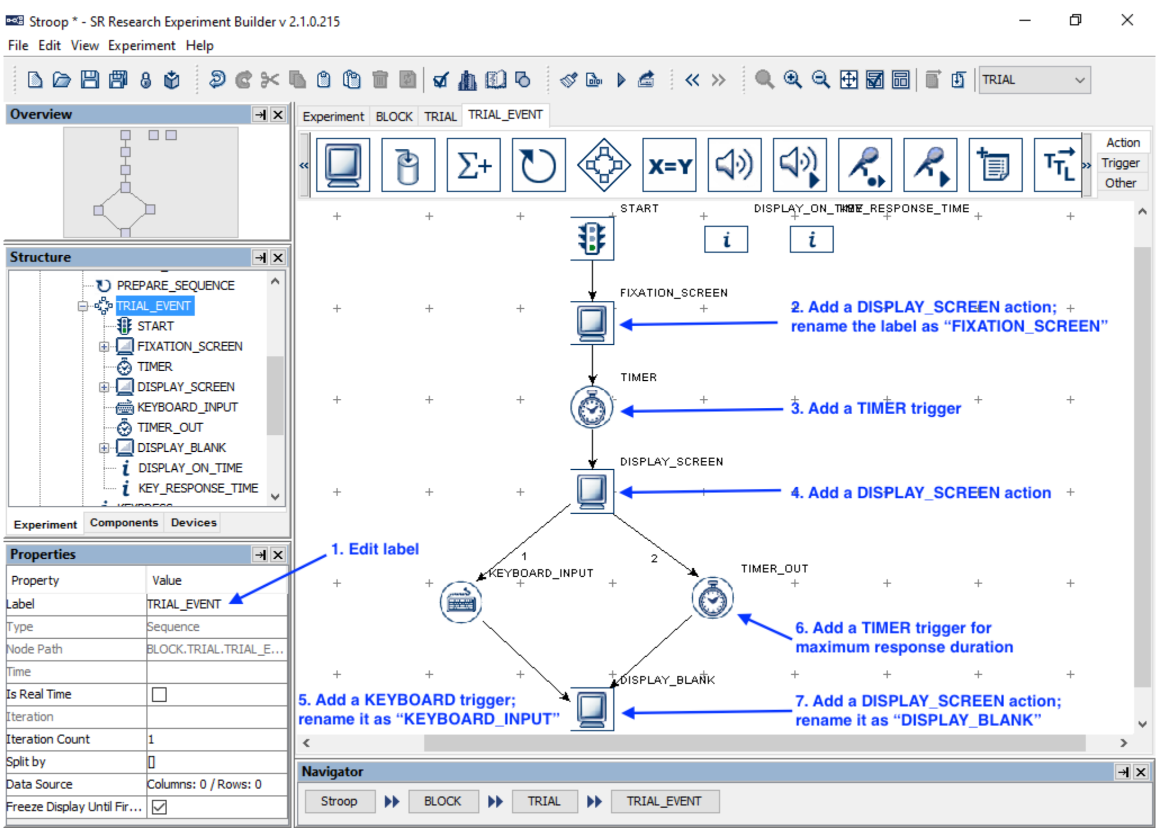


Figure 15-17. Editing Recording Sequence.

1) Select the newly added "Sequence" node and enter a new value for the Label, e.g., "TRIAL_EVENT". If using an older computer with a single-core processor, make sure the "Is Real Time" box is **not checked,** as this may prevent the keyboard

from functioning. Then double-click the TRIAL_EVENT sequence in the workspace to enter the sequence.

2) Open the "Action" Tab of the component toolbox and drag a "Display Screen" action into the work area. Select the newly added Display Screen node and enter a new label, e.g., "FIXATION_SCREEN". We will later add a fixation cross in this screen (see Section 15.8.1).
3) Then open the "Triggers" tab and drag a "Timer" trigger into the work space. Select the Timer node, and enter "1000" in the "Duration" field.
4) Open the "Action" tab and drag a second "Display Screen" action into the workspace. This will be the screen showing the Stroop word (see Section 15.8.2). Set the "Message" property to "target_display" (without quotes) and press the Enter key.
5) Add a Keyboard Trigger. Select the trigger and set the Label, e.g., as "KEYBOARD_INPUT". Then set the "Message" property, e.g., as "keyboard_response". Double-click the left part of the value field for the "Keys" attribute to bring up a menu to choose the possible response keys. To select multiple response keys, hold the Ctrl key (Command ⌘ on macOS) and click on the desired keys. In this experiment, choose the following keys: b (for blue color), r (for red color), and g (for green color). Then click the "Close" button (X) at the upper right corner of the dialog box to finish. The "Keys" property of the trigger will now be [b, g, r].

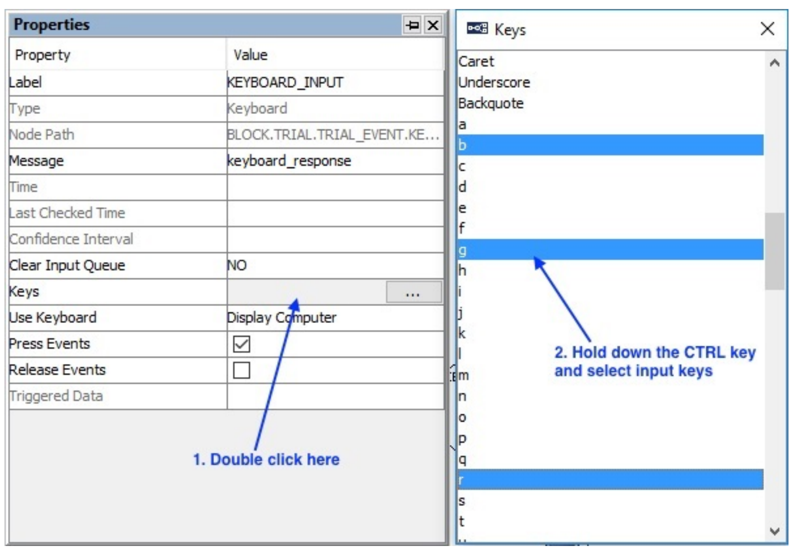


Figure 15-18. Setting Response Keys.

6) Add another Timer trigger to the work space. Set its Label as "TIME_OUT" and set the Duration as 8000 msec. Update the "Message" property of the trigger as "TIME_OUT".
7) Add another "DISPLAY_SCREEN" action and set its label as "DISPLAY_BLANK". This will be the blank screen to clear the Stroop word. Set the "Message" property as "DISPLAY_BLANK".

8) Draw a connection from the “START” node to “FIXATION_SCREEN”, from “FIXATION_SCREEN” to “TIMER”, from “TIMER” to “DISPLAY_SCREEN”, from “DISPLAY_SCREEN” to both “KEYBOARD_INPUT” and “TIME_OUT”, and from the last two triggers to “DISPLAY_BLANK”.
9) Right-click any blank area in the work space and select “Arrange Layout” in the popup menu to re-arrange the nodes.

15.8.1 Creating the Fixation Screen

We can now create the fixation screen. In this example, we will use an image to serve as the fixation target. (Alternatively, a text resource with a “+” may be used.) Images must be loaded into the Library Manager before they can be used. Follow the steps below to add the included image FIXATION.bmp to the resource library (see Figure 15-19):

1) From the application menu bar, select “Edit → Library Manager”.
2) In the Library Manager, select the “Image” tab.
3) Click the Add button to load in an image—the example image “FIXATION.bmp” can be found at “Documents\ExperimentBuilder Examples\Resources\Images\”. (Alternatively, click and drag the image file from Explorer in Windows or Finder in Mac into the Library Manager.) The image file properties and a preview of the image will then be displayed in the Library Manager.
4) Click the button on the Library Manager to finish.

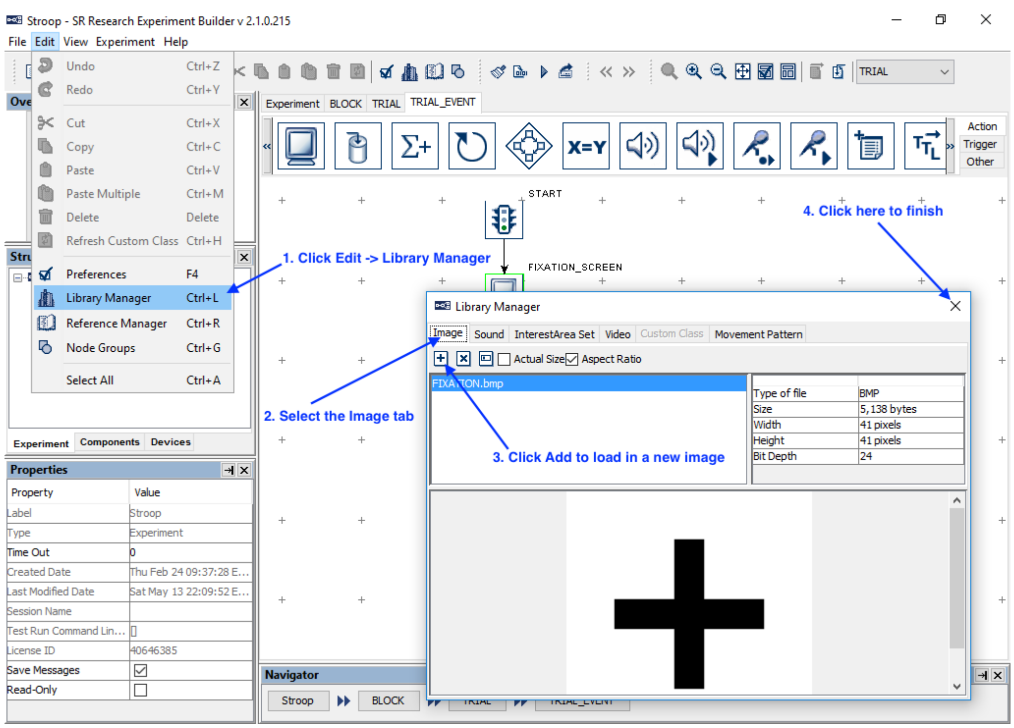


Figure 15-19. Loading Resources to Image Library.

5) Double click the FIXATION_SCREEN action in the graph workspace to open the Screen Builder.

6) Click the “Insert Image Resource” ( ) button on the Screen Builder toolbar, then click anywhere on the screen to add the image resource. In the following “Select Image” dialog, select “FIXATION.bmp”, then click the “OK” button.

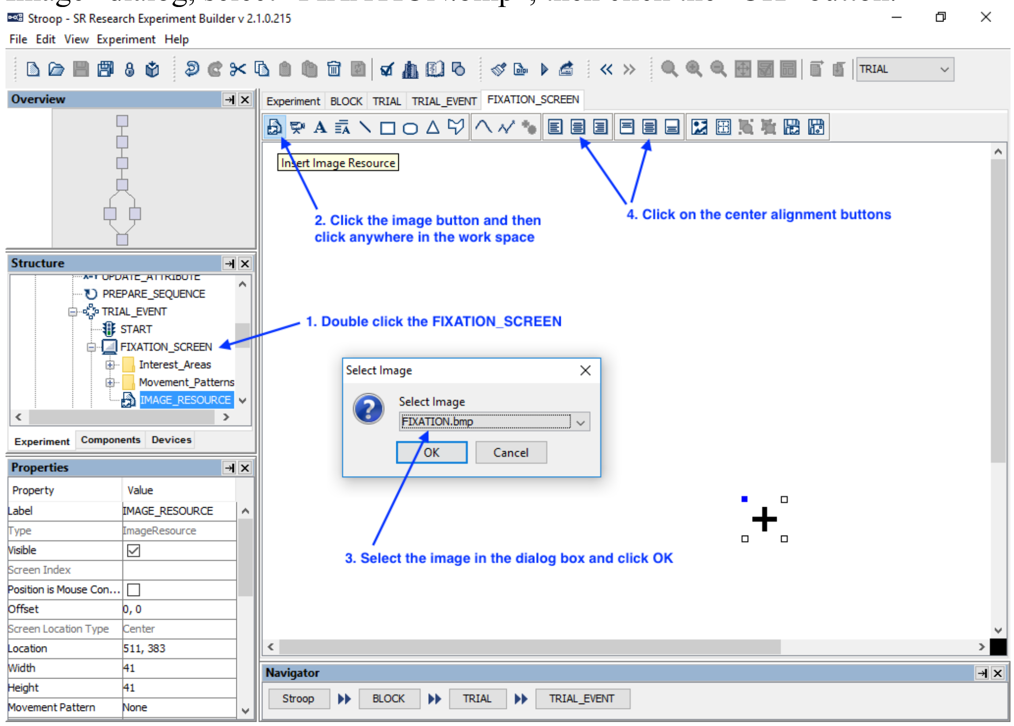


Figure 15-20. Loading Resources to Image Library.

7) Select the image resource. Click both the “Horizontal Center Alignment” and “Vertical Center Alignment” ( ) buttons to place it in the center of the screen. Right-click on the resource and choose “Lock Selection” in the popup menu to prevent the image from being accidentally moved in the Screen Builder.

15.8.2 Creating the Stroop Display Screen.

Next we will create a screen containing the Stroop color word. We will add a text resource to the display screen and modify the properties of the text resource, such as the text to be displayed, text color, font name, size, and alignment style. We will also create an interest area for the text (see Figure 15-21). To open the Screen Builder window, double-click the “DISPLAY_SCREEN” object in the work space.

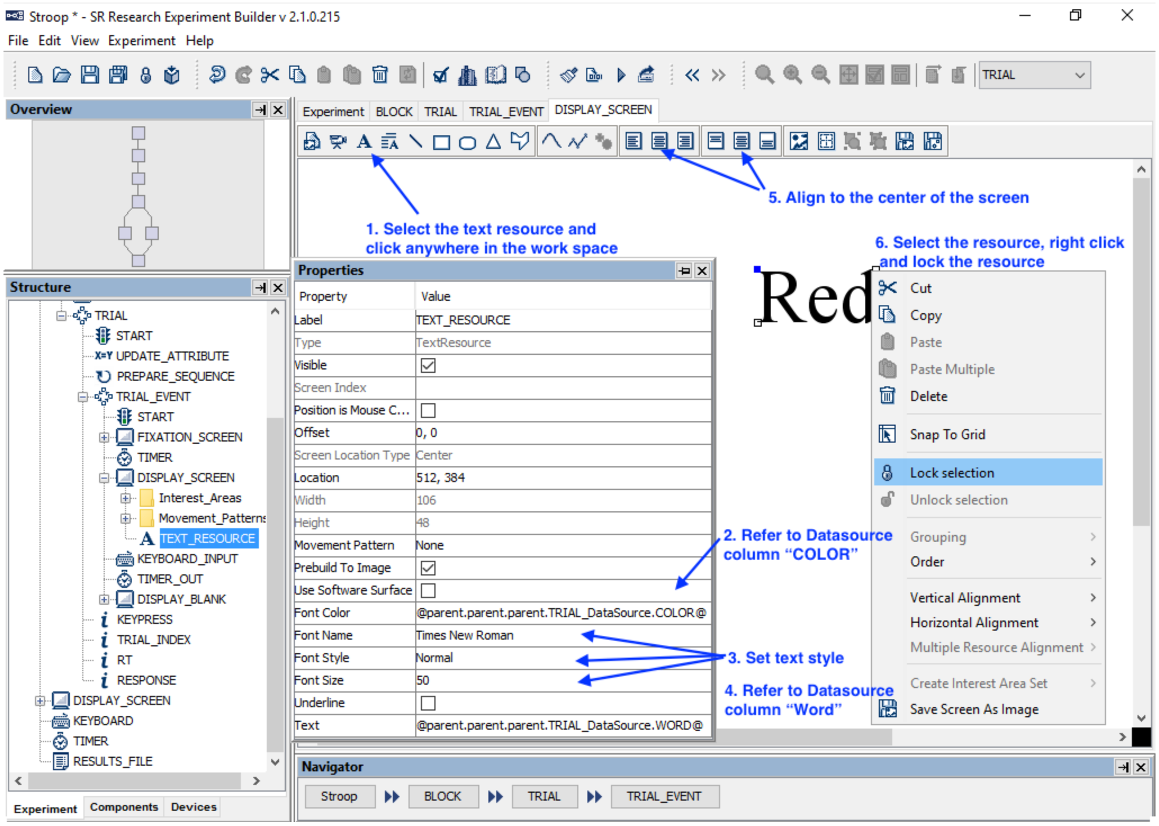


Figure 15-21. Adding Text to Display Screen.

1) Click the "Insert Text Resource" button (A) on the Screen Builder toolbar, and click any space in the work area to add the resource.
2) To set the Font Color to refer to the "COLOR" column of the Data Source, click the value field of the "Font Color" property once, then click the […] button to open the Attribute Editor dialog (see Figure 15-22).
    a. Click the DataSource node under the "TRIAL" sequence on the Node Selection list.
    b. Double click the "COLOR" node in the Node Attributes panel. This will update the contents of "Attribute" panel as @parent.parent.parent.TRIAL_DataSource.COLOR@".
    c. Click the "OK" button to finish.

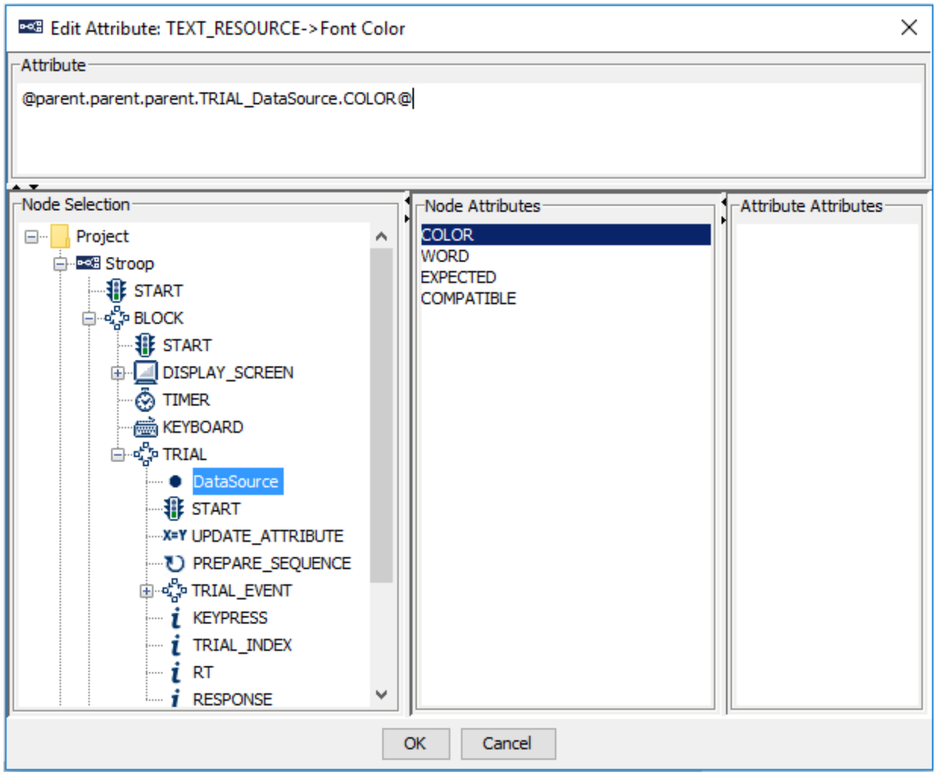


Figure 15-22. Showing Text by Referring to Data Source.

3) Set the appearance of the Text by choosing the desired font name, style and size. In this example, we will set the "Font Name" to "Times New Roman", the "Font Style" to "Normal", and the "Font Size" to "50".
4) Then set the "Text" property to refer to the "WORD" column of the Data Source. The Attribute panel should list the reference as "@parent.parent.parent.TRIAL_DataSource.WORD@".
5) Select the newly added text resource, and click both the "Horizontal Center Alignment" and "Vertical Center Alignment" ( ) buttons to place the text in the center of the screen.
6) Right-click the resource and choose "Lock Selection" so the resource will not be moved accidentally.

15.9 Editing the Trial Event Sequence – Part 2

Following the presentation of the Stroop word, we will check for the participant's response and calculate the reaction time for the trial. We will then add a Conditional trigger to check the response, and nodes to record and give feedback on the participant's performance (see Figure 15-23).

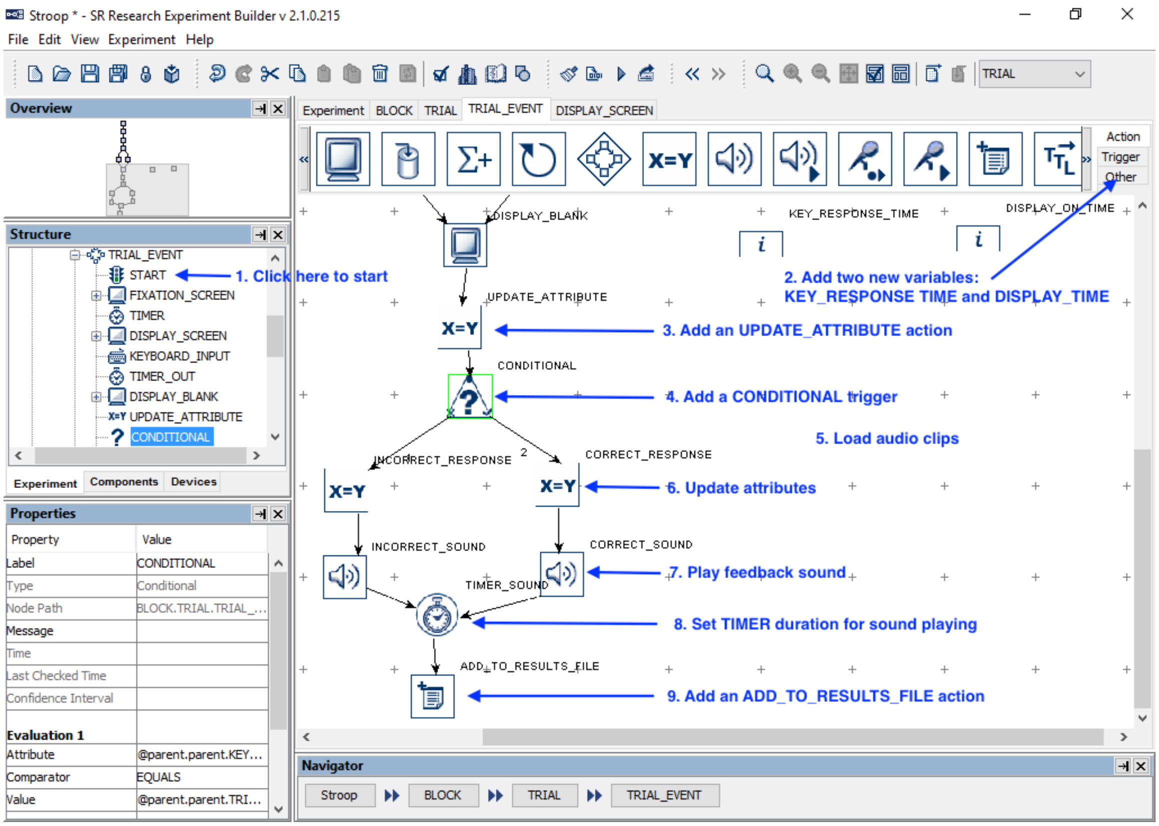


Figure 15-23. Editing the Trial Event Sequence.

1) Make sure Graph Editor view is within the "TRIAL_EVENT" sequence.
2) Add two new variables into the workspace and rename them as "DISPLAY_ON_TIME" and "KEY_RESPONSE_TIME". Set the initial values of both variables to 0.0.
3) Add an Update Attribute action to record the time for the target display onset, the time of the response, and the key pressed. Double-click the Update Attribute node and add the following attribute-value pairs to the table (see Figure 15-24):

Attribute	@KEY_RESPONSE_TIME.value@
Value	@KEYBOARD_INPUT.triggeredData.time@
Attribute 2	@DISPLAY_ON_TIME.value@
Value 2	@DISPLAY_SCREEN.time@
Attribute 3	@parent.parent.RT.value@
Value 3	= int(@KEY_RESPONSE_TIME.value@- @DISPLAY_ON_TIME.value@)
Attribute 4	@parent.parent.KEYPRESS.value@
Value 4	@KEYBOARD_INPUT.triggeredData.key@

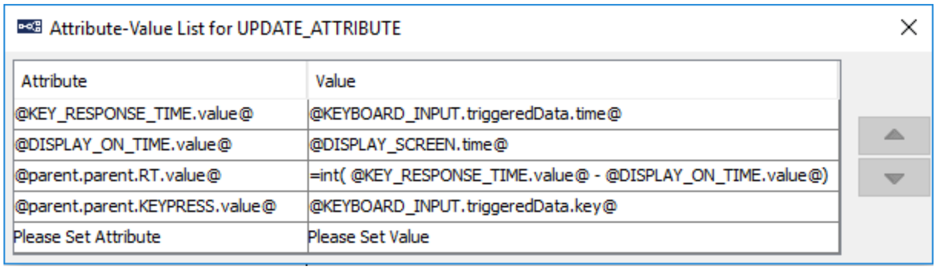


Figure 15-24. Add Attribute-Value Pairs to the UPDATE_ATTRIBUTE Node.

Note that the actual time when the Stroop display is presented is @DISPLAY_SCREEN.time@, not @DISPLAY_SCREEN.startTime@—the latter is the time when the DISPLAY_SCREEN action starts preparing the screen to be flipped. The time of the keyboard response should be the @KEYBOARD_INPUT.triggeredData.time@ from the “Attribute Attributes” panel instead of @KEYBOARD_INPUT.time@ from the “Node Attributes” panel—the triggeredData.time is the time when the response key is pressed, where the latter is the time when the KEYBOARD_INPUT trigger fires (see Figure 15-25). Note also that an "=" sign is added before "int(@KEY_RESPONSE_TIME.value@-@DISPLAY_ON_TIME.value@)" so an equation can be created in the cell.

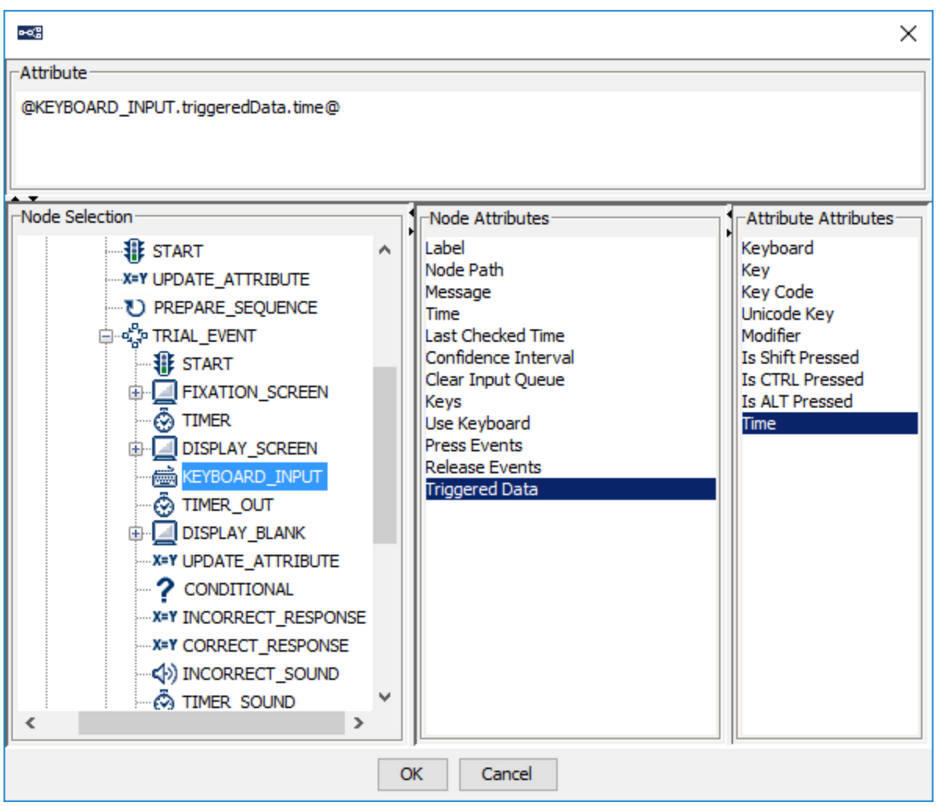


Figure 15-25. Accessing the TriggeredData Attribute.

4) Drag a Conditional trigger into the workspace to determine whether a correct response has been made. To check whether the key pressed is the desired keyboard response, select the conditional trigger, then set the following properties:
   a. Attribute to "@parent.parent.TRIAL_DataSource.EXPECTED@".
   b. Comparator to "EQUALS"
   c. Value to "@parent.parent.KEYPRESS.value@".

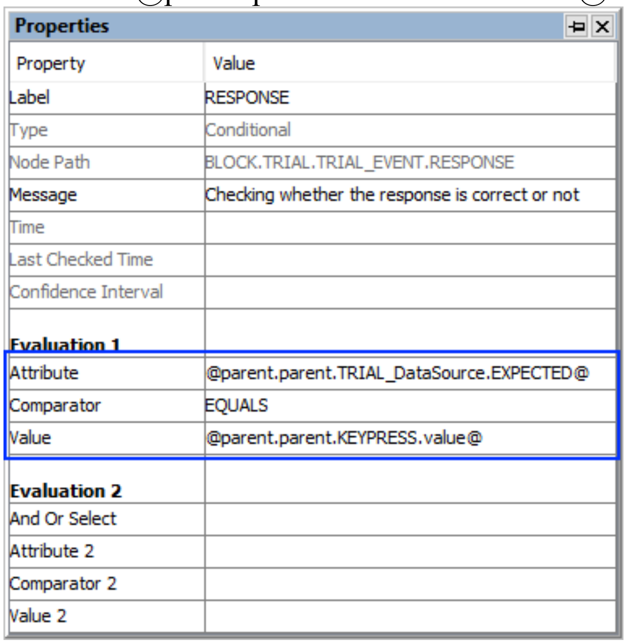


Figure 15-26. Evaluating the Accuracy of the Response Using a Conditional Trigger

The Conditional trigger yields a True result when the key pressed is the same as the expected key response set in the Data Source, and otherwise yields a False result. For each branch of the conditional trigger, we will set a value for the RESPONSE variable and provide audio.

5) Before working on each branch of the CONDITIONAL trigger, load audio clips for the feedback into the Library Manager. Click Edit → Library Manager from the Experiment Builder menu bar, then do the following (see Figure 15-27):

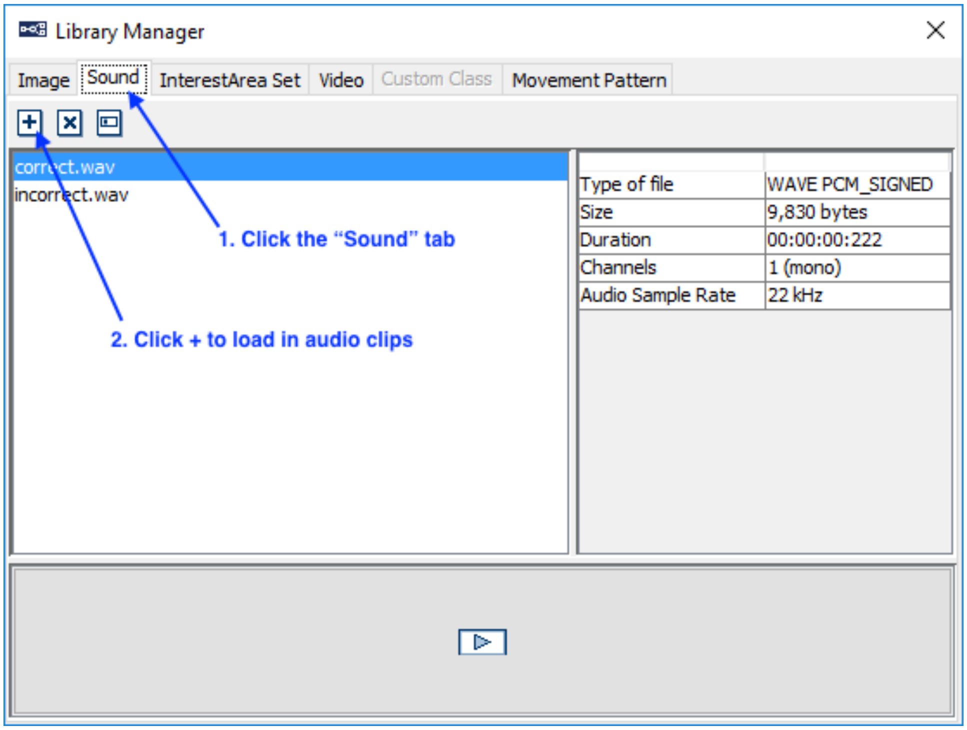


Figure 15-27. Loading Feedback Audio Clips.

a. Select the "Sound" Tab
b. Click the "Add" button [+] and load in the desired audio files. The example audio files "correct.wav" and "incorrect.wav" can be found at "Documents\ExperimentBuilder Examples\Resources\Audio\". (Alternatively, click and drag the audio files from Explorer in Windows or Finder in Mac into the Library Manager.)
c. Click the "close" button at the upper right corner of the Library Manager.

6) Add an Update Attribute action and a Play Sound action:
   a. Select the Update Attribute action and set the Label to "CORRECT_RESPONSE". Click the Value cell of the "Attribute-Value List" property, then in the Attribute-Value List editor, set the Attribute field to "@parent.parent.RESPONSE.value@" and the Value field to "Correct".
   b. Select the Play Sound node and rename it to "CORRECT_SOUND". Select "Correct.wav" from the dropdown list of the "Sound File" property.

7) Add another pair of Update Attribute and Play Sound actions:
   a. Select the Update Attribute action and rename it to "INCORRECT_RESPONSE". Set the Attribute field to "@parent.parent.RESPONSE.value@" and the Value field to "Incorrect".
   b. Select the Play Sound action and rename it to "INCORRECT_SOUND". Select "Incorrect.wav" from the dropdown list of the "Sound File" property.

8) Add a Timer trigger and edit its Label to "TIMER_SOUND". Set the Duration of the Timer to 500 msec so the feedback sound can be played completely before the trial ends.
9) From the "Action" tab of the component toolbox, add an Add to Results File action into the workspace. Select the node and set the "Results File" to the RESULTS_FILE we added earlier.

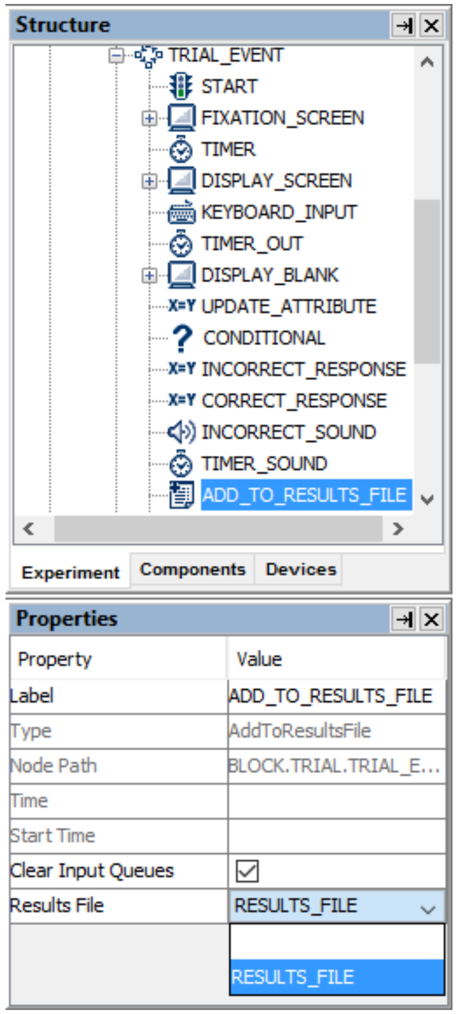


Figure 15-28. Send Results to a Results File.

10) Draw the following connections in the experiment graph:
   a. from DISPLAY_BLANK to the UPDATE_ATTRIBUTE action;
   b. from UPDATE_ATTRIBUTE to the CONDITIONAL trigger;
   c. from the left (X) branch of the CONDITIONAL trigger to INCORRECT_RESPONSE;
   d. from INCORRECT_RESPONSE to INCORRECT_SOUND;
   e. from INCORRECT_SOUND to TIMER_SOUND;
   f. from the right (V) branch of the CONDITIONAL trigger to CORRECT_RESPONSE;

g. from CORRECT_RESPONSE to CORRECT_SOUND;
h. from CORRECT_SOUND to TIMER_SOUND; and
i. from TIMER_SOUND to ADD_TO_RESULTS_FILE.

11) Right-click any blank area in the work space and select "Arrange Layout" in the popup menu to re-arrange the nodes.

15.10 Outputting Data to the Results File

Finally, variables should be added to the results file (see Figure 15-29). Users may configure which variables, including variable nodes and data source columns, should be written to the results file so the experimental conditions of each trial can be identified during analysis (see Figure 15-29). In Experiment Builder 2.0, all variable nodes and data source columns will automatically be added to the Results File.

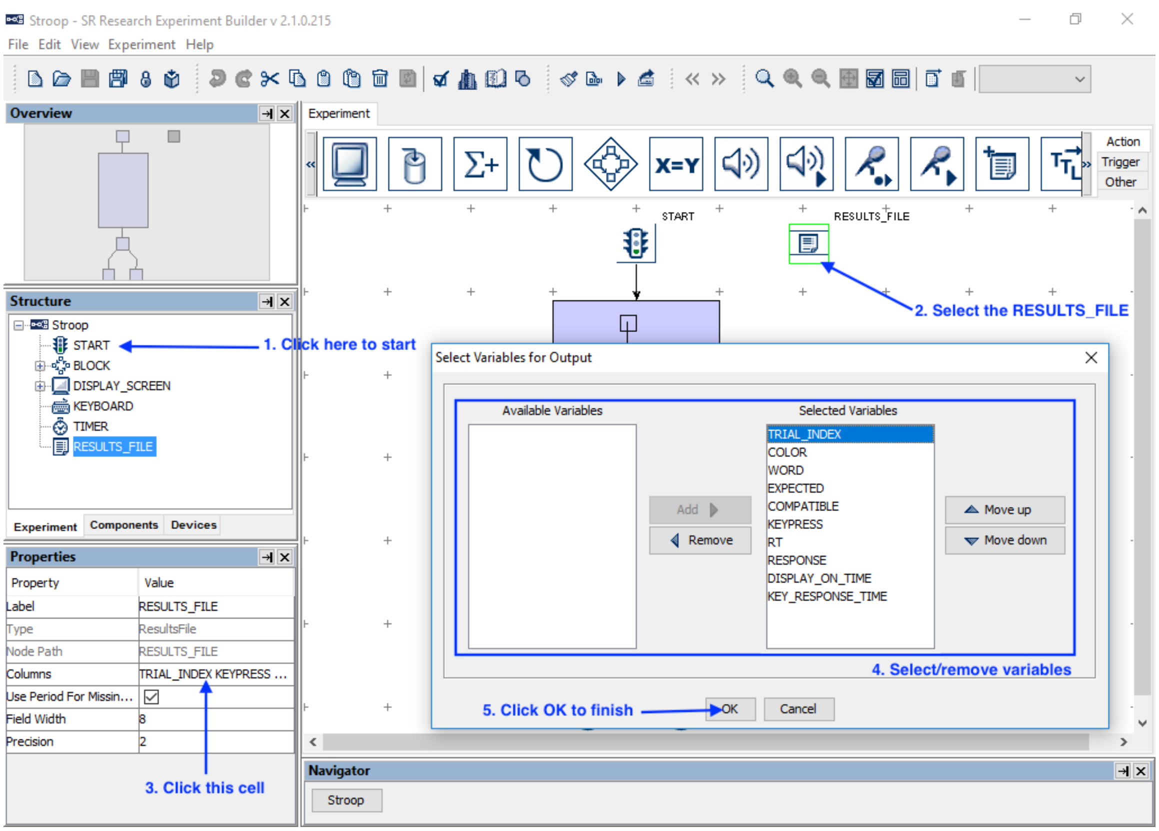


Figure 15-29. Adding Variables to Results File.

1) In the Structure Window, click the first "START" node (just underneath the topmost "Stroop" node) to navigate to the topmost level of the experiment.
2) Select the RESULTS_FILE node.
3) Then click the value field of the "Columns" attribute.
4) In the following dialog box, the "Selected Variables" panel on the right lists all the data source columns and variables currently selected to be written to the

results file as trial variables, and "Available Variables" will show any variables not selected to be written as trial variables. To add or remove items from the Selected Variables, select the item(s) to be moved, then click the "Add" button ( ) or "Remove" button ( ). To configure the order of the variables in the output, select the item(s) to be moved and click the "Move Up" ( ) or "Move Down" ( ) buttons. In this example, make sure all the variables and data source columns are included in the Selected Variables list. Click OK to finish.

5) In the Properties window of the RESULTS_FILE node, set "Field Width" to 8 and "Precision" to 2. To record the missing values as "." in the results file, make sure the "Use Period for Missing Values" box is checked.

15.11 Running the Experiment

Click "Experiment → Build" from the application menu to build the experiment An "Output" tab will be opened in the Graph Editor Window and build information will be displayed. Watch for error messages (displayed in red) and warning messages (in brown) during building. If any error or warning messages appear, double-click on an error or warning message in the output tab to highlight the node or screen resource that produced the error/warning.

Once the project builds successfully, users may test run the experiment by clicking on "Experiment → Test Run" from the application menubar. Please note that the "Test Run" should only be used for testing and debugging experiment code, and not for actual data collection. To collect experiment data, users should first deploy the experiment ("Experiment → Deploy"). The deployed project can be run without relying on the Experiment Builder GUI for better timing performance. Simply double click the executable file Stroop.exe in the deployed directory and then follow the instructions on the screen. The experiment results file will be saved in the "results/{session name}" folder of the experiment.

16 Experiment Builder Project Check List (version 2.3.1)

Users may refer to the following checklist to prevent some common problems in creating and running an Experiment Builder project.

If this is an EyeLink experiment,

1) Is there a recording sequence in your EyeLink Enabled project?
When you check the "Record" property for a sequence in an EyeLink project, Gaze data will be recorded for the duration of that sequence (i.e., a command will be sent to the eye tracker to start recording when the sequence begins and a command will be sent to the eye tracker to stop recording when the sequence ends). This should typically only be enabled for the innermost sequence in the project. Given that recording sequences should only be used to control eye tracker recording and should not be used for looping purposes, the Iteration Count of recording sequences should always be set to 1 and there should never be a Data Source associated with a recording sequence.

2) Does the project use the "hierarchical organization" concept of experiment design?
Employing a hierarchical design helps prevent redundancy and reduces overhead by allowing you to reuse the same trial structures to present multiple trials. For instance, sequences allow you to loop through the same sequence of nodes multiple times, while referencing values in the sequence's Data Source to change the properties of experimental events that need to change one trial to the next (e.g., to change the trials' images or sounds or to change the duration of timers from one trial to the next). Please see the Experiment Builder Video Tutorial Series for detailed instructions on how best to utilize hierarchical organization in your project. As a general rule, your project should have a single data source attached to the trial-level sequence. If your project has multiple data sources, or separate sequences/Data Sources for practice vs experimental trials, then it can make project editing and data analysis more difficult than they need to be.

3) Has the 'Message' property of the critical nodes (e.g., triggers and actions used in the recording sequence) been filled out?
It is absolutely critical that you check through all the nodes in your recording sequence and make sure that all the important action and trigger nodes have appropriate text in the Message properties. Experiment Builder writes these messages to the EDF file to mark when these important events occur. Without these messages it may be impossible to align the gaze data with stimulus events accurately during data analysis or to use some Data Viewer features such as interest periods. It helps to use messages that will be readily interpretable at the analysis stage - e.g. STIMULUS_ONSET for the relevant display screen node, and TRIAL_END for the final display screen node etc. Please see the Experiment Builder examples for illustrations of the kinds of messages to send.

4) Have you checked the Use for Host Display property of one (and only one) display screen node in your recording sequence?
You will not be able to see your stimuli on the Host PC recording unless you check this property for the most important display screen node in your recording sequence and set the "Draw To EyeLink Host" property of your prepare sequence to "image". Keep in mind only a single Display Screen action's contents can be transferred per trial.

[Contents -> Experiment & Graph Components -> Components -> Actions -> Prepare Sequence]

5) Has a Recording Status Message been written to the tracker screen to report progress of experiment testing?
The EyeLink Record Status Message property of a recording sequence allows you to pass a message to the Host PC to provide feedback to the experimenter during data collection. The message will appear in the bottom right of the Record screen on the Host PC, and can be used to provide information about the trial number, trial condition, etc. [Contents -> EyeLink to Data Viewer Integration -> Recording Status message]

6) Has a PREPARE_SEQUENCE action been added before each recording sequence?
The prepare sequence node preloads stimulus resources (images, video, audio) for the upcoming recording sequence, transfers one display screen action's contents to the Host PC for experimenter feedback during the trial, and reinitializes the nodes of the upcoming sequence. It should be placed immediately before the drift correct action that precedes the recording sequence or immediately before the recording sequence if a drift correct is not used. Prepare sequences should not be placed at any higher levels in the experimental structure.

7) Have you prepared interest areas for screen resources which you intended to analyze later?
For certain paradigms such as text based experiments, visual world paradigm experiments, and paradigms where screen resources change position across trials it can be vital that interest areas be defined for the relevant stimuli prior to data collection. Experiment Builder has features to help facilitate this (Runtime word segmentation, Auto Segment, etc...). Data Viewer has features to help with creating and editing interest areas post hoc as well.

8) Have you set the display device settings (resolution, refresh rate, etc...) in the preferences (Edit menu -> Preferences -> Devices -> Display) to values supported by your monitor?

9) Is the trial recording sequence running with "Is Real Time" enabled?
Real Time mode puts the project into a high thread priority to allow the project to use the maximum available resources of your Display PC to ensure proper timing/operation.

10) Does the "Background Color" property of the camera setup and drift correction nodes match that of the display screens used in the experiment?
If the luminance levels of the experimental events are vastly different than the luminance used during calibration/validation/drift correction, then large pupil size changes may occur. These large pupil size changes may disrupt the spatial accuracy of the eye tracker. Please ensure that the background color of the camera setup and drift correct actions matches that of the display screen actions used for the experimental events to prevent such large pupil size changes. If your test displays include full screen images or videos then it may be safest to choose a mid-gray background for camera setup and drift correct nodes.

11) Have you deployed the task on the computer you plan to collect data on?

Deploying a task creates a standalone executable of your project which can be used for data collection. It's important to deploy the task individually on each computer on which you plan to collect data, as the deploy process creates system-specific dependencies which will differ across operating systems.

12) Are you using the proper randomization setting for your experiment?
Please double-check the Randomization Settings in the data source has the appropriate settings for your intended randomization. You can find further details on the randomization features of Experiment Builder in the Randomizing Data Source section of the manual (Contents -> Data Source -> Randomizing the Data Source).

13) Have you taken measures to maximize real-time performance of the Display PC when running the experiment?
In order to achieve optimal timing performance and stability, it is important to ensure that you follow all of the steps in: [Contents -> Installation -> Windows PC System Requirements -> Maximizing real-time performance]

14) Are you making sure to preserve the deployed project structure when importing the EDF files into Data Viewer?
After data collection, it is important to make sure that you do not move your EDF files from their original locations within the Deployed project directory (i.e., do not move the EDF files from their "Results/{Session Name}" directories) and that you do not move only part of the deployed project directory when copying it to a new location or new computer for analysis (i.e., make sure to copy the entire deployed project directory when moving it). It is usually quickest to first zip up the entire {Experiment Name} folder, copy the zip file over to the analysis computer and then unzip it. The EDF files in the project do not contain the project's images and interest area information, so if you only move the EDF files or only move the results folder then you will not be able to see and use the stimuli and interest areas in Data Viewer during data analysis.

If this is a non-EyeLink Experiment, please additional consider

1) If you're using a non-EyeLink enabled project, have you added a Results File to the project? And are you using the Add to Results File action on each trial or as necessary to record data to the results file?
In non-EyeLink experiments there is not an eye tracking data file (EDF file) to which variable values and Data Source column values can be logged. Thus it is important to use an ADD_TO_RESULTS_FILE node at the end of each trial to append data to a RESULTS_FILE.

If this is a reading experiment,

1) Is the drift correction target displayed at the intended location?
While the Drift correction/check routine allows you to assess gaze drift in a project, it can also be used to help orient the participant's gaze to a specific screen location prior to the onset of recording. Thus, you'll want to make sure to adjust the drift check target location appropriately for your task. For instance, in reading research, it is usually sensible to position the drift check target to a location corresponding to that of the first word of the trial's text. This is particularly important for multiline texts to prevent the occurrence of an initial fixation in the middle of the text and subsequent corrective saccade that would need to be filtered out in data analysis. Similarly, if your stimuli are

faces you may want to place the drift check above or below the face, so that the first fixation is not already on part of the face.

2) Have you chosen the appropriate font, style, and size for the text or multiline text resource?
   You may need to use special fonts to display non-ASCII characters. Similarly, for reading research you may want to use fixed width fonts to facilitate certain analyses. (Note: Selecting the appropriate font may be especially important when switching platforms between Windows and Mac, as the two operating systems have different fonts available and use different DPI settings, meaning text will be sized differently between Windows and Mac.)

3) Have you enabled the "Use Runtime Word Segment Interest Area" setting of the text or multiline text resource used in an eye-tracking task?
   This option will automatically generate interest areas for the text or multiline text resource during data collection based on the setting in the preferences (Edit menu -> Preferences -> Screen -> Built-In Interest Area Preference -> WORD_SEGMENT). Interest area segmentation can be done at the word, character, phrase, or custom level, and is highly recommended, as it will facilitate data analysis for text-based experiments.

If this is an experiment using eye-based triggers,

1) Have you checked the location type used in the Screen Builder?
   The location of Screen resources can be based on either the top-left or center coordinate and can be modified in the preferences (Edit menu -> Preferences -> Screen). Please note that regardless of the Screen Location Type chosen for the project, the location of all trigger regions (e.g., invisible boundary trigger, mouse trigger, fixation trigger, saccade trigger, and sample velocity trigger) is always based on the top-left coordinates. Setting the Region Type of these triggers to Interest Area (and associating them with relevant interest areas in Display Screen actions) can often make specifying the triggering region simpler.

2) If running a saccade experiment, which saccade trigger type (saccade trigger vs. sample velocity trigger) should be used?
   If you're using gaze-contingent triggers in your experiment are you using event-based or sample-based triggers? Event-based triggers will have a short delay (e.g., ~20 msec for Saccade triggers) due to the processing time required by event parsing processes on the Host PC. Sample-based triggers use the latest available sample data from the Host PC, which can be accessed with minimal delay. Thus, for experiments requiring fastest access to data (e.g., boundary crossing paradigms), Invisible Boundary triggers are usually optimal. For experiments requiring the precise event data (e.g., paradigms where saccade reaction times may need to be calculated) Saccade triggers are usually optimal. Please make sure you're using the right trigger for your task.

If this is an experiment involving audio playback or recording,

1) Are you using the correct audio driver in Windows?
   Experiment Builder projects can utilize one of two playback methods in Windows, DirectX or ASIO, which have different timing properties. This can be changed in the project preferences (Edit menu -> Preferences -> Devices -> Audio). The DirectX driver will work on any Windows Display PC, but does not provide as precise timing for audio

playback as the ASIO driver and does not allow for audio recording. Please note, the use of the ASIO driver requires the use of a sound card that is compatible with Experiment Builder. A list of supported devices along with installation and configuration instructions can be found in the manual (Contents -> Installation -> Windows PC System Requirement -> ASIO card Installation).
Mac OSX computers have their own audio driver comparable to the ASIO drivers in Windows.

17 Preference Settings

Many aspects of the SR Research Experiment Builder can be configured in the application preference settings, which can be accessed by selecting “Edit → Preferences” (“ExperimentBuilder → Preferences” in macOS) from the application menu bar (see Figure 17-1). These include the EyeLink tracker settings, display setup, screen coordinate type, default values for the experiment components (triggers, actions, and screen resources), graph layout, etc. Once the desired changes have been made, pressing the “Save Properties as Default” button will save the current preferences to be used by default in future experiment projects. If the changes are valid only for the current experiment project, simply press the close () button on the dialog box after making any changes.

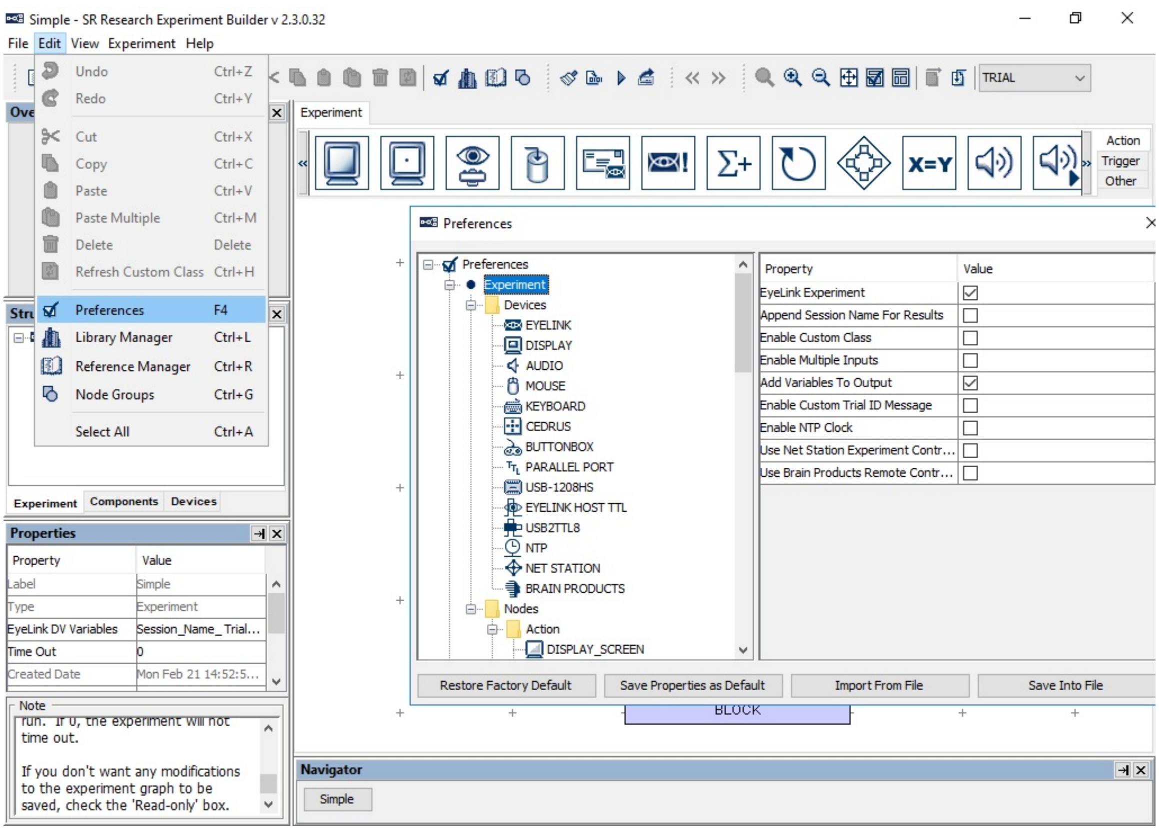
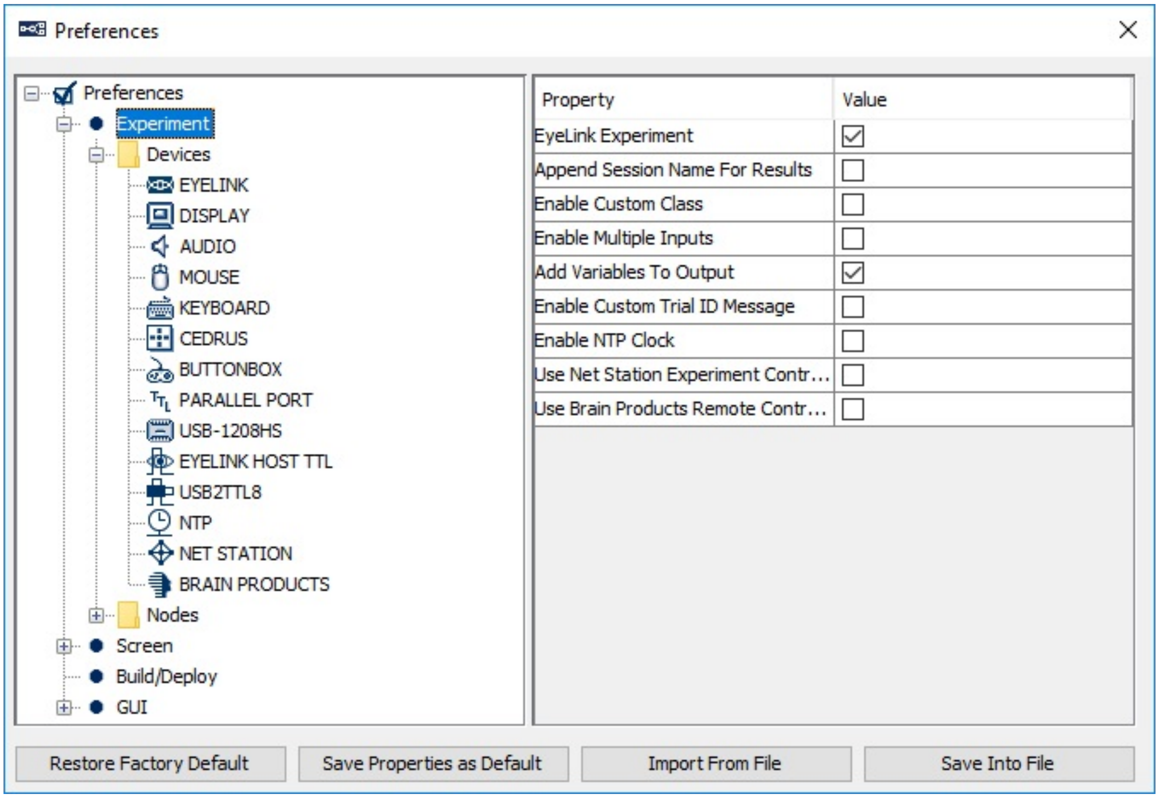


Figure 17-1. Accessing the Experiment Builder Preference Settings.

17.1 Experiment

This section lists preference settings related to the Experiment Builder devices and nodes (actions, triggers, etc.).



EyeLink Experiment: If checked, the experiment will be designed for use with an EyeLink eye tracker. All eye-tracking related triggers (saccade, fixation, sample velocity, and invisible boundary triggers, and EyeLink button, triggers) and actions (sending EyeLink message, sending EyeLink command, camera setup, and drift-correction actions) will be available for experiment creation. If this field is unchecked, all of the abovementioned actions and triggers will be removed from the components toolbox and experiment graph.

Append Session Name For Results: If checked, Experiment Builder will concatenate the current session name with the output files (warning.log, messages.txt, etc.) in the "results\{session name}" directory.

Enable Custom Class: If checked, additional features (Custom class instance, execute method, Custom class library, callback attribute of sequences, etc.) will be available for programming an experiment using custom class. Please note that custom class-related features use advanced Experiment Builder functionality that requires knowledge of the Python programming language.

Enable Multiple Inputs: If checked, multiple display keyboards and mice can be used in the same experiment; responses on the different input devices can be handled differently. The number of distinct keyboards and mice can be set in the keyboard and mouse device settings. If unchecked, responses from all keyboards and mice connected to the computer are treated the same (as if the response is made to a single keyboard or mouse).

Key Press Used to Identify Keyboard(s): If multiple keyboards are used and the "Enable Multiple Inputs" option is checked, Experiment Builder will prompt the user when the experiment starts to identify each keyboard by pressing a particular key. This option specifies which key is used.

Add Variables To Output: If checked, new variables and data source column labels will be added automatically to the "EyeLink DV Variable" list of the topmost experiment node (see section 7.6 "Experiment Node") and to the "Columns" field of the RESULTS_FILE node (see section "7.11.2 Result File"). Users need to manage the output variables to Data Viewer or results file manually if this option is not enabled.

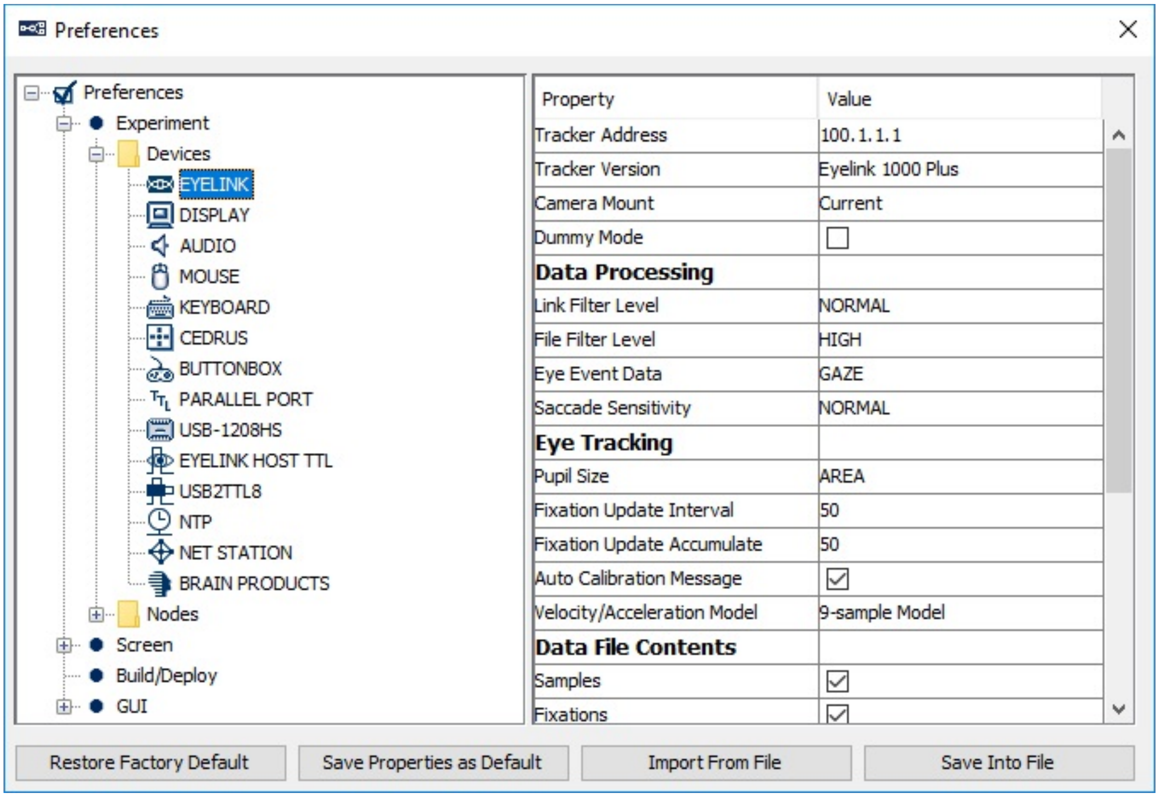
Enable Custom Trial ID Messages: By default this option is not enabled so that Experiment Builder automatically sends a "TRIALID n" message to the EDF file, with n being the trial index in the session starting from 0. If this option is enabled, this default Trial ID message will not be written. Instead, user will find a "Custom Trial ID Message" property in the Recording sequence, from which a customized Trial ID message can be sent.

Enable NTP Clock: If enabled, attributes are added to all of the nodes to report the NTP time of the action or trigger data. The NTP clock is enabled automatically if the "Use Net Station Experiment Control Interface" option is enabled.

Use Net Station Experiment Control Interface: If true, this enables the "Net Station" device and adds the "Net Station Control" action to the Component Toolbox. It will also enable the NTP time option for all of the triggers and actions.

Use Brain Products Remote Control Interface: If true, this enables the "Brain Products" device and the "Brain Products Control" action in the Component Toolbox.

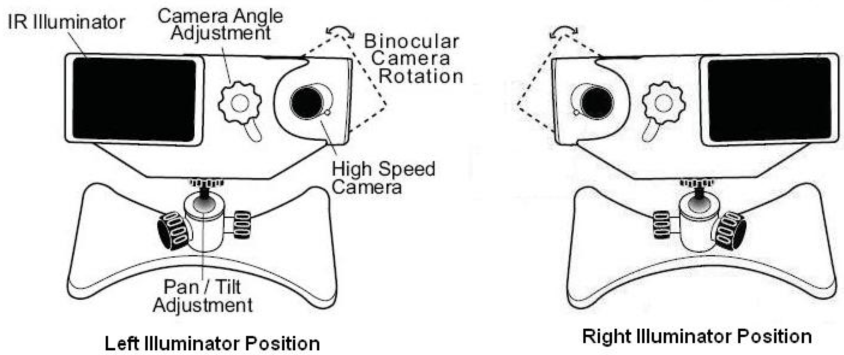
17.1.1 EyeLink



Tracker Address (.trackerAddress): The IP address of the Host PC. This must be the same as the "host_address" setting in the eyenet.ini file on the Host PC (typically under \eyelink2\exe directory for an EyeLink II tracker, \EyeLink\exe directory for an EyeLink I tracker, and \elcl\exe directory for an EyeLink 1000, EyeLink 1000 Plus, or EyeLink Portable Duo eye tracker).

Tracker Version (.trackerVersion): The version of the EyeLink eye tracker being used: EyeLink I , EyeLink II, EyeLink 1000 (previously EyeLink CL), EyeLink 1000 Plus, EyeLink Portable Duo, or Current. When "Current" is selected, Experiment Builder will connect to any EyeLink tracker and not modify the tracker settings on the host side.

Camera Mount (.mount): The mount type (e.g., Tower, Desktop, Arm, Long Range) if the Tracker version is EyeLink 1000, 1000 Plus, or Portable Duo. If the option “Current” is selected, Experiment Builder will not attempt to change the camera mount setting on the host side.



Desktop Version (.desktopVersion): The version of EyeLink 1000 Desktop Mount (Illuminator on Left vs. Illuminator on Right). This option is only available if the "Tracker Version" is EyeLink 1000 and the "Camera Mount" type is set to Desktop. This option requires version 4.20 or later of the EyeLink 1000 host software.

Mount Usage (.mountUsage): This option is only available when the "Camera Mount" is set to "Desktop", "Arm", or "Tripod/Laptop". If the Desktop Mount is used, possible options are "Monocular - Stabilized Head", "Binoc / Monoc - Stabilized Head", "Monocular - Remote", or "Binoc / Monoc - Remote". If the Arm Mount is used, users can choose the "Monocular - Stabilized Head" or "Monocular - Remote" options.

Dummy Mode (.dummyMode): If checked, the experiment can be run without attempting to connect to the EyeLink tracker. This can be used to simulate EyeLink link connection for early development work, or when an EyeLink tracker is not available.

Data Processing

Link Filter Level (.linkFilterLevel): Each increase in the filter level reduces noise by a factor of 2 to 3 but introduces a 1-sample delay to the link sample feed. This setting is only available for EyeLink II, 1000, 1000 Plus, and Portable Duo eye trackers.

File Filter Level (.fileFilterLevel): Selects the file sample filter for data in the EDF file. Each increase in the filter level reduces noise by a factor of 2 to 3. **Note:** By changing the file sample filter from high to another value this will affect EyeLink Data Viewer and other analysis tool calculations. SR Research Ltd recommends leaving this value set to High. This setting is only available for EyeLink II, 1000, 1000 Plus, and Portable Duo eye trackers.

Heuristic Filter (.heuristicFilter): Sets level of filtering on the link output, analog output, and file data. This setting is only available for EyeLink I tracker.

Eye Event Data (.eyeEventData): Sets how velocity information for saccade detection is to be computed. This setting is almost always left to GAZE.

Saccade Sensitivity (.saccadeSensitivity): Defines the sensitivity of the EyeLink II, EyeLink 1000, EyeLink 1000 Plus, or EyeLink Portable Duo parser for saccade event generation. Normal is intended for cognitive tasks like reading; while High is intended for psychophysical tasks where small saccades must be detected (Not available for EyeLink I). Version 2.1.512 or later of the software logs the requested parser setting to the EDF file.

Eye Tracking

Eye-tracking Mode (.eyeTrackingMode): Sets the tracking mode for recording. EyeLink II runs either under the pupil-CR (corneal reflection) mode or pupil-only mode. EyeLink I only runs under the pupil-only mode. EyeLink 1000, 1000 Plus, and Portable Duo almost always run under the pupil-CR mode.

Eye-tracking High Speed (.eyeTrackingHighSpeed): Sets sampling rate in combination with the Eye-tracking mode setting for EyeLink II trackers. If set to true, it will be 500 Hz in a pupil-only recording and 250 Hz in a pupil-CR mode. This setting is only available for EyeLink II tracker.

Pupil Detection (.pupilDetection): Algorithm used to detect the pupil center position (centroid algorithm vs. ellipse fitting algorithm). This option is only applicable to EyeLink 1000, EyeLink 1000 Plus, and EyeLink Portable trackers when operating in a head-supported mode.

Eye-tracking Sampling Rate (.eyeTrackingSamplingRate): Sets sampling rate for EyeLink 1000, 1000 Plus, and Portable Duo. The available options are: 2000, 1000, 500, and 250. The default sampling rate depends on the tracker version and operating mode. Availability of some sampling rates depends on having the appropriate hardware and camera programming.

Eyes To Track (.eyesToTrack): Select the eye(s) to track during recording. For EyeLink I and II, the default is "BOTH." For EyeLink 1000, EyeLink 1000 Plus, and EyeLink Portable Duo, the default is "EITHER."

Pupil Size (.pupilSize): Whether to record the pupil size by area or diameter (in arbitrary units).

Fixation Update Interval (.fixationUpdateInterval): During fixation, send updates every (m) msec, integrated over (n) msec (max=m, min = 4 msec), where the Fixation Update Interval is (m). These can be used for gaze-controlled software or for pursuit tracking. Intervals of 50 or 100 msec are suggested. Set to 0 to disable the fixation update through the link.

Fixation Update Accumulate (.fixationUpdateAccumulate): During fixation, send updates every (m) msec, integrated over (n) msec (max=m, min = 4 msec), where the Fixation Update Accumulate is (n). Set to 50 or 100 msec to produce updates for gaze-controlled interface applications. Set to 4 to collect single sample rather than average position. Set to 0 to disable the fixation update through the link.

Auto Calibration Message (.autoCalibrationMessage): If True, the calibration messages will be included in the EDF file.

Velocity/Acceleration Model (.velocityAccelerationModel): EyeLink 1000, EyeLink 1000 Plus, and EyeLink Portable Duo only. Allows the user to choose the model (5-sample, 9-sample, 17-sample, or EL1000 Tracker) used to calculate velocity and acceleration data. For 5-, 9-, and 17-samples, the calculation of instantaneous velocity and acceleration is based on 5, 9, or 17 samples. If EyeLink 1000 eye tracker models are used, 5, 9, 19, and 39 samples will be used for the calculation under 250, 500, 1000, and 2000 hz respectively. In general, the more samples used in the calcuation, the less noisy velocity/acceleration estimates will be (and the longer delay in the sample velocity trigger firing as well).

Current Time# (.currentTime): Returns the current tracker time in milliseconds. The tracker clock starts at 0 when the EyeLink host program was started.

Sample Rate # (.sampleRate): Returns the actual sample rate running in the experiment. This may differ from the value set in the "Eye-tracking Sampling Rate" property, e.g., if the setting is changed in the Camera Setup screen.

CR Mode # (.CRMode): Returns the actual mode ("PUPIL_CR" or "PUPIL_ONLY" string) running on the Host PC. This may differ from the value set at the above "Eye-tracking Mode" property.

File Filter # (.fileFilter): Returns the actual file filter level ("OFF", "NORMAL", or "HIGH") used in the experiment. This may differ from the value set at the above "File Filter Level" property.

Link Filter # (.linkFilter): Returns the actual link filter level ("OFF", "NORMAL", or "HIGH") used in the experiment. This may differ from the value set at the above "Link Filter Level" property.

Eye Used # (.eyeUsed): Returns the actual eye(s) used ("LEFT", "RIGHT", or "BOTH") in the experiment. This may differ from the value set at the above "Eyes To Track" property.

Pupil Detection Model # (.pupilDetectionModel): Returns the actual algorithm used to detect the pupil center position (centroid algorithm vs. ellipse fitting algorithm). This option is only applicable to EyeLink 1000, 1000 Plus, and Portable Duo trackers.

Last Sample #: Possible data that can be retrieved from the last eye sample (see the table below for details).

Data File Contents
Important: SR Research Ltd. does not recommend changing the following default settings as this may have negative impacts on the data file integrity and your data analysis.

Samples: If checked, samples will be recorded in the EDF file.

Fixations: If checked, fixations will be recorded in the EDF file.

Saccades: If checked, saccades will be recorded in the EDF file.

Blinks: If checked, blinks will be recorded in the EDF file.

Buttons: If checked, presses and releases of the EyeLink button box will be recorded in the EDF file.

Inputs: If checked, input data will be recorded in the EDF file.

Remote Warnings
Note: The following options are only available for EyeLink Remote eye trackers. The remote warning may not work on some older, single-core processor computers running under real-time mode. If so, please check the BIOS setting of the Display PC so that hyperthreading or multithreading is enabled.

Enable Remote Warning (.enableRemoteWarning): Whether a warning beep should be given when the eye or target is missing when the eye tracker is operating in the remote mode.

Minimum Eye Missing Duration (.eyeMissingThreshold): Minimum amount of time (in milliseconds) the eye data is missing before a warning beep will be given.

Eye Missing Beep (.eyeMissingBeep): The audio clip to be played when the eye is missing. A different audio clip may be used if it has already been loaded into the Library Manager ("Edit → Library Manager", select the "Sound" tab). Messages ("REMOTE_WARNING_AUDIO_ON" and "REMOTE_WARNING_AUDIO_OFF") are recorded to the EDF file to mark the time of the onset and offset of the audio.

Minimum Target Missing Duration (.targetMissingThreshold): Minimum amount of time (in milliseconds) the target is missing before a warning beep will be given.

Target Missing Beep (.targetMissingBeep): The audio clip to be played when the target is missing. A different audio clip may be used if that clip has already been loaded into the library manager ("Edit → Library Manager", select the "Sound" tab).

Event/ Sample Queue Sizes:

Experiment Builder maintains separate event queues for the eye-based triggers. The following sets the size of the event queue and reports the current event count in each queue.

Force Enable Link Data (.forceEnableLinkData): Enabling this option will send eye tracker link samples and events so that they can be accessed in the custom class code.

Fixation Queue Size (.fixationQueueSize): Sets the maximum number of fixation events (FIXUPDATE, STARTFIX, or ENDFIX) that can be cached in the fixation event queue.

Saccade Queue Size (.saccadeQueueSize): Sets the maximum number of saccade events that can be cached in the saccade event queue.

Blink Queue Size (.blinkQueueSize): Sets the maximum number of blink events (STARTBLINK or ENDBLINK) that can be cached in the blink event queue.

Button Queue Size (.buttonQueueSize): Sets the maximum number of button events that can be cached in the button event queue.

Sample Queue Size (.sampleQueueSize): Sets the maximum number of samples that can be cached in the link sample queue.

Fixation Event Count # (.fixationEventCount): The number of fixation events (FIXUPDATE, STARTFIX, or ENDFIX) cached in the fixation event queue.

Saccade Event Count # (.saccadeEventCount): The number of saccade events cached in the saccade event queue.

Blink Event Count # (.blinkEventCount): The number of blink events (STARTBLINK, or ENDBLINK) cached in the blink event queue.

Button Event Count # (.buttonEventCount): The number of button press/released events cached in the button event queue.

Use Keyboard (.useKeyboard): In a project with multiple-input support, this specifies the display keyboard(s) that can be used to control the camera setup, calibration, and drift correction process.

Use Mouse (.useMouse): In a project with multiple-input support, this specifies the display mouse/mice that can be used in the camera setup process.

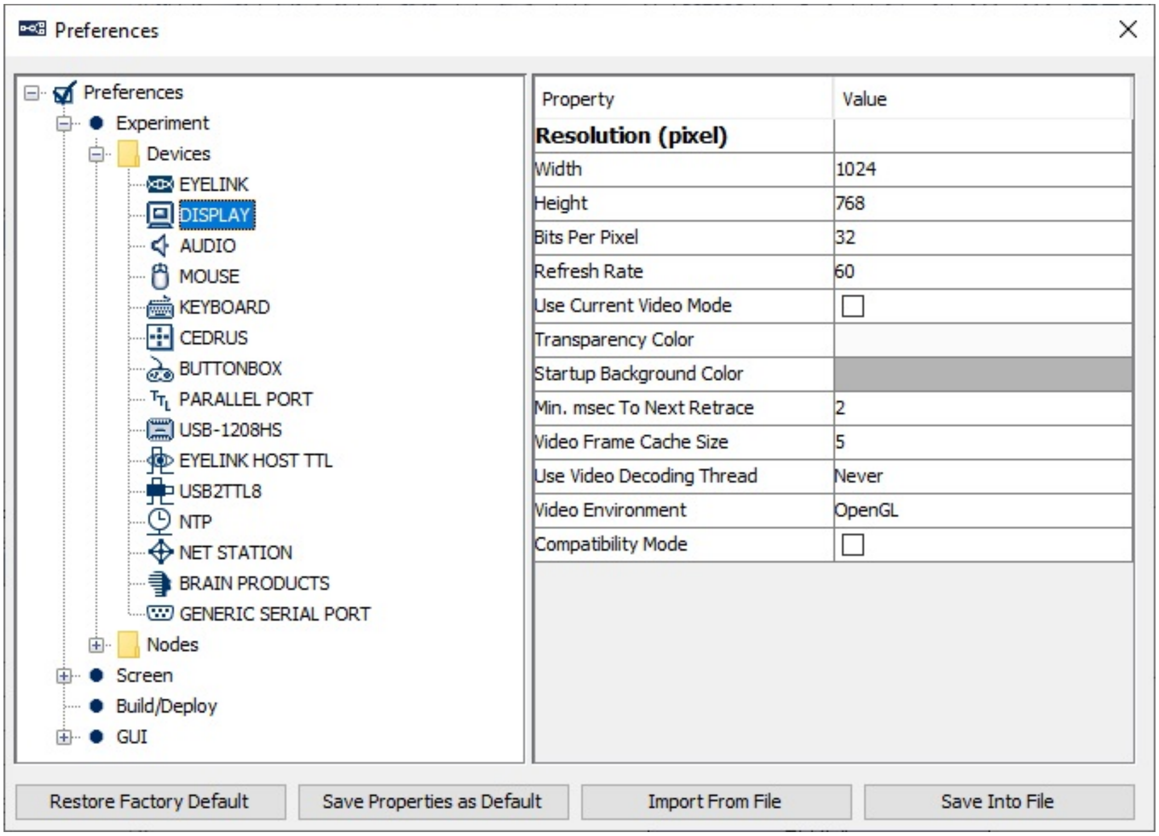
The following table lists possible data that can be retrieved from the last eye sample:

Reference	Attribute	Type	Content
Time	.time	Integer	Display computer time (in milliseconds from the start of the experiment) when the last sample occurs.

EDF Time	.EDFTime	Integer	EDF time of the last sample.
Eyes Available	.eyesAvailable	Integer	Eyes available in recording (0 for left eye; 1 for right eye; 2 for both eyes).
PPD X, PPD Y	.PPDX, .PPDY	Float	Angular resolution at the current gaze position (in screen pixels per visual degree) along the x-, or y-axis.
Left Gaze X, Right Gaze X, Average Gaze X	.leftGazeX, .right GazeX, .average GazeX [1]	Float	Gaze position of the last sample along the x-axis for the left eye, right eye and an average between the two.
Left Gaze Y, Right Gaze Y, Average Gaze Y	.leftGazeY, .right GazeY, .average GazeY [1]	Float	Gaze position of the last sample along the y-axis for the left eye, right eye and an average between the two.
Left Pupil Size, Right Pupil Size, Average Pupil Size	.leftPupilSize, .ri ghtPupilSize, .averagePupilSize [1]	Float	Left eye, right eye, or average pupil size (in arbitrary units, either area or diameter as selected in the EyeLink device settings).
Target Distance	.targetDistance	Integer	Distance between the target and camera (10 times the measurement in millimeters). This option is available only when the eye tracker is operating in the remote mode. Returns "MISSING_DATA" (-32768) if target is missing or if the tracker is operating in a head-supported mode.
Target X, Target Y	.targetX, .targetY	Integer	X, Y position of the target in camera coordinates. This option is available only when the eye tracker is operating in the remote mode. Returns "MISSING_DATA" (-32768) if target is missing or if the tracker is operating in a head-supported mode.
Target Flags	.targetFlags	Integer	Flags used to indicate target tracking status (0 if target tracking is ok; otherwise error code). This option is available only when the eye tracker is operating in the remote mode. Returns "MISSING_DATA" (-32768) if target is missing or if the tracker is operating in a head-supported mode.

Note:
[1] Returns "MISSING_DATA" (-32768) for the untracked eye.

17.1.2 Display



Width (.width): The width of the display screen in pixels. If using macOS and have "Antialias Drawing" enabled (Preferences -> Screen), make sure the resolution is set to the native resolution of the built-in screen or external monitor to achieve the best anti-aliasing results.

Height (.height): The height of the display screen in pixels.

Bits Per Pixel (.bitsPerPixel): The number of bits used to represent the luminance and chroma information contained in each pixel.

Refresh Rate (.refreshRate): Sets the refresh rate (Hz) of the monitor.

Use Current Video Mode (.useCurrentVideoMode): If enabled, Experiment Builder will ignore the specified "Width", "Height", "Bits Per Pixel", and "Refresh Rate" values and initialize the experiment graphics based on the current desktop resolution and refresh rate. The actual display settings will be reported in the output tab.

Transparency Color (.transparencyColor): When the DirectDraw Video Environment is being used, defines the color value to be used as transparency. Any pixels in image resources that match the specified transparency color will be treated as transparent and will not be drawn.

Startup Background Color (.startupBackgroundColor): The background color used when experiment starts up.

Minimum msec To Next Retrace (.flipRemainThreshold): The minimum amount of time (in milliseconds) remaining in a retrace before the next flip can be scheduled. During experiment runtime, if the remaining time in a retrace to perform a flip is less than the specified amount of time, the flip will be scheduled to the retrace after to ensure that the flip is done properly.

Video Frame Cache Size (.cacheFrameThreshold): Sets the number of video frames that are decoded and cached in advance when playing back a video resource. Min should be 5, max should be 60.

Use Video Decoding Thread (.useVideoDecodingThread):Whether to use a video decoding thread for video playback. If used, a buffer is created so that a decoding thread continually fills this buffer while video playing thread consumes it.

Current Time # (.currentTime): Reads the millisecond clock running on the display computer; the clock starts at 0 when the EyeLink library is initialized.

Software To Hardware Blit Time # (.softwareToHardwareBlitTime): Time required to perform a software-based copying of resource from system memory to the display surface.

Hardware To Hardware Blit Time # (.hardwareToHardwareBlitTime): Time required to blit resource from the video card memory to the display surface.

Video Memory Size # (.hardwareMemorySize): The total amount of memory found in a video card.

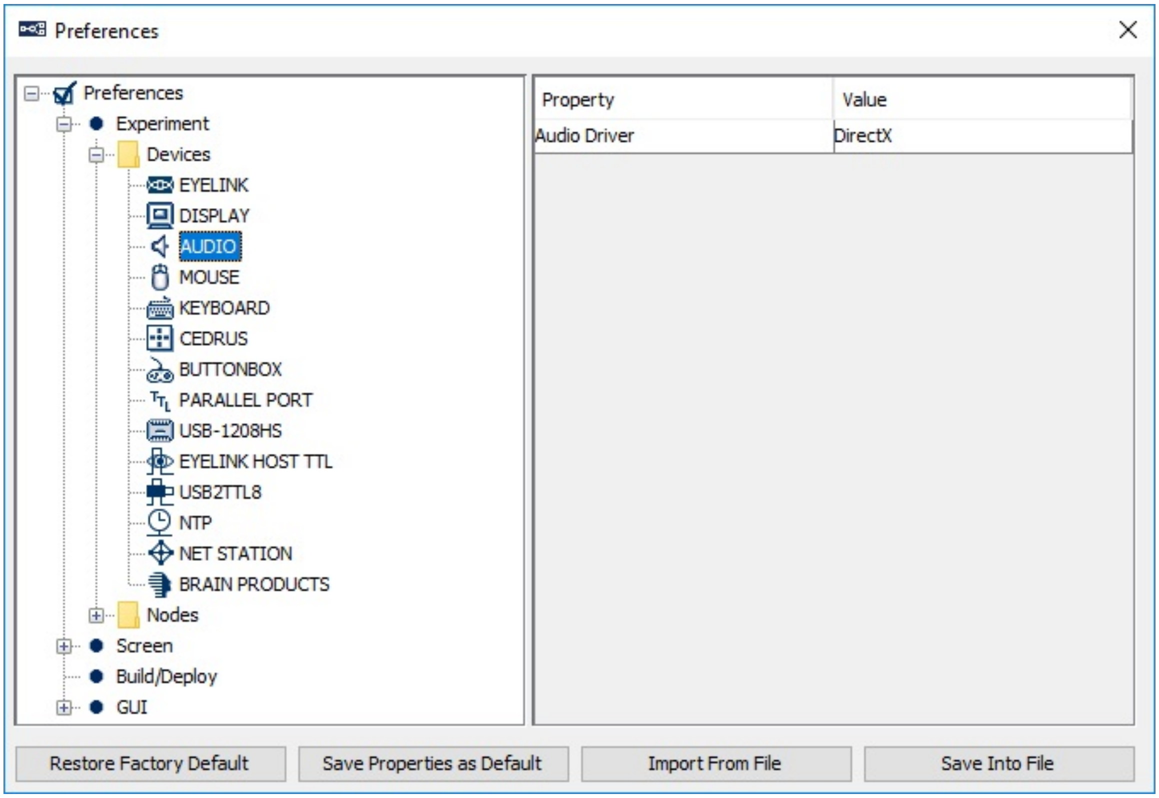
Video Memory Available # (.hardwareMemoryAvailable): The amount of memory in a video card available for graphics operation (e.g., stores images before they are sent to the display monitor).

Retrace Interval # (.retraceInterval): The duration of one refresh cycle of the monitor, calculated as 1000000/refresh rate.

Video Environment: Whether OpenGL or DirectDraw graphics should be used to support visual stimulus presentation in the current experiment project. Version 1.x of Experiment Builder used DirectDraw graphics on Windows and OpenGL graphics on macOS. OpenGL is recommended for experiment projects running on Windows 8 and 10.

Compatibility Mode: This option is only applicable when the OpenGL graphics is used (i.e., macOS or Windows when the "Video Environment" is set to OpenGL). This mode is necessary when the display graphics are done through Custom Class drawing and require some Pygame function calls to support the drawing operations. This option should be turned off for typical experiments that don't use Custom Class graphics.

17.1.3 Audio



Audio Driver (.driver): The driver used to play audio clips. Two audio drivers are available on Windows: DirectX or ASIO. If using the ASIO driver, an ASIO-compatible sound card should be installed on the computer with the proper sound card driver installed. On macOS, this is always set to "OS X".

Properties applicable to ASIO Driver:

- **Output Interval #** (.outputInterval): The interval (in milliseconds) between ASIO buffer swaps, which determines how often new sounds can be output.

- **ASIO Audio Driver #** (.driverName): The name of the ASIO driver.

- **Minimum Output Latency #** (.minimumOutputLatency): The minimum output latency of the ASIO driver (delay from buffer switch to first sample output).

Properties applicable to OS X Audio Driver (Mac OSX)

- **Minimum Scheduling Latency #** (.minimumSchedulingLatency): The minimum amount of delay (in milliseconds) required for the audio to be played at the intended/scheduled time.

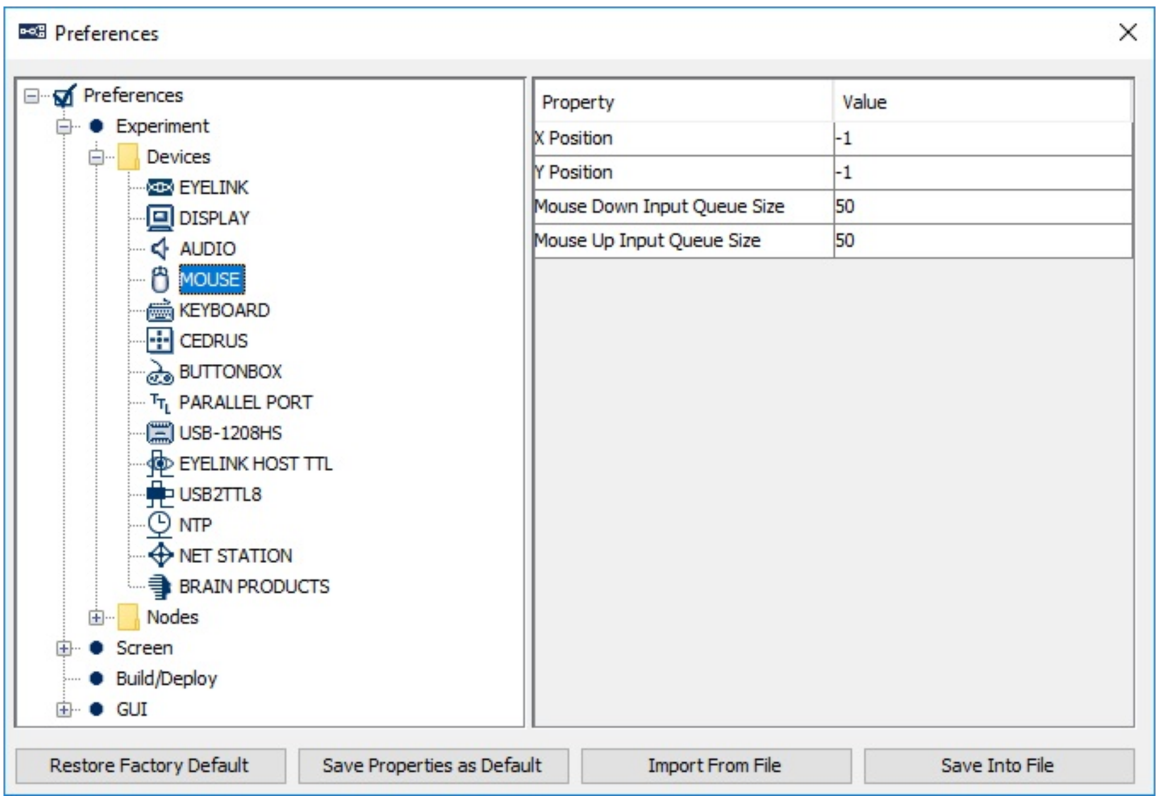
Properties applicable to ASIO driver or OS X Audio Driver

- **VoiceKey Queue Size** (.voiceKeyQueueSize): Sets the maximum number of voice key events that can be cached in the voicekey event queue.

- **VoiceKey Event Count #** (.voiceKeyEventCount): Returns total number of voice key events cached in the event queue.

  VoiceKey Threshold (.voiceKeyThreshold): Value from 0.0 to 1.0 to set voice key trigger level, with 1.0 being the maximum audio level. The threshold should be set high enough to reject noise and prevent false triggering, but low enough to trigger quickly on speech. A threshold of 0.05 to 0.10 is typical.

17.1.4 Mouse



Number of Mice (.numberOfMouses): Sets how many distinct mice are used in the experiment. This option is only available if "Enable Multiple Input" option is enabled.

Mouse One Label (.mouseOneLabel): Supplies a label for the first mouse detected by the experiment. This option is only available if "Enable Multiple Input" option is enabled.

X Position (.xPosition): Default X position of the mouse (or the first mouse if multiple inputs are supported).

Y Position (.yPosition): Default Y position of the mouse (or the first mouse if multiple inputs are supported).

Mouse Down Input Queue Size (.mouseDownInputQueueSize): Sets the maximum number of press events that can be cached in the press event queue for the mouse (or the first mouse if multiple inputs are supported).

Mouse Up Input Queue Size (.mouseUpInputQueueSize): Sets the maximum number of release events that can be cached in the release event queue for the mouse (or the first mouse if multiple inputs are supported).

Mouse Down Event Count # (.mouseDownEventCount): Total number of press events cached in the press event queue for the mouse (or the first mouse if multiple inputs are supported).

Mouse Up Event Count # (.mouseUpEventCount): Total number of release events cached in the release event queue for the mouse (or the first mouse if multiple inputs are supported).

Mouse Two Label, Mouse Three Label, ... (.mouseTwoLabel, .mouseThreeLabel, ...): Supplies a label for the second, third, ..., mouse detected by the experiment. This option is only available if "Enable Multiple Input" option is enabled.

Mouse Two X Position, Mouse Three X Position, ...
(.mouseTwoXPosition, .mouseThreeXPosition, ...): Default X position of the second, third, ... mouse.

Mouse Two Y Position, Mouse Three Y Position, ...
(.mouseTwoYPosition, .mouseThreeYPosition, ...): Default Y position of the second, third, ... mouse.

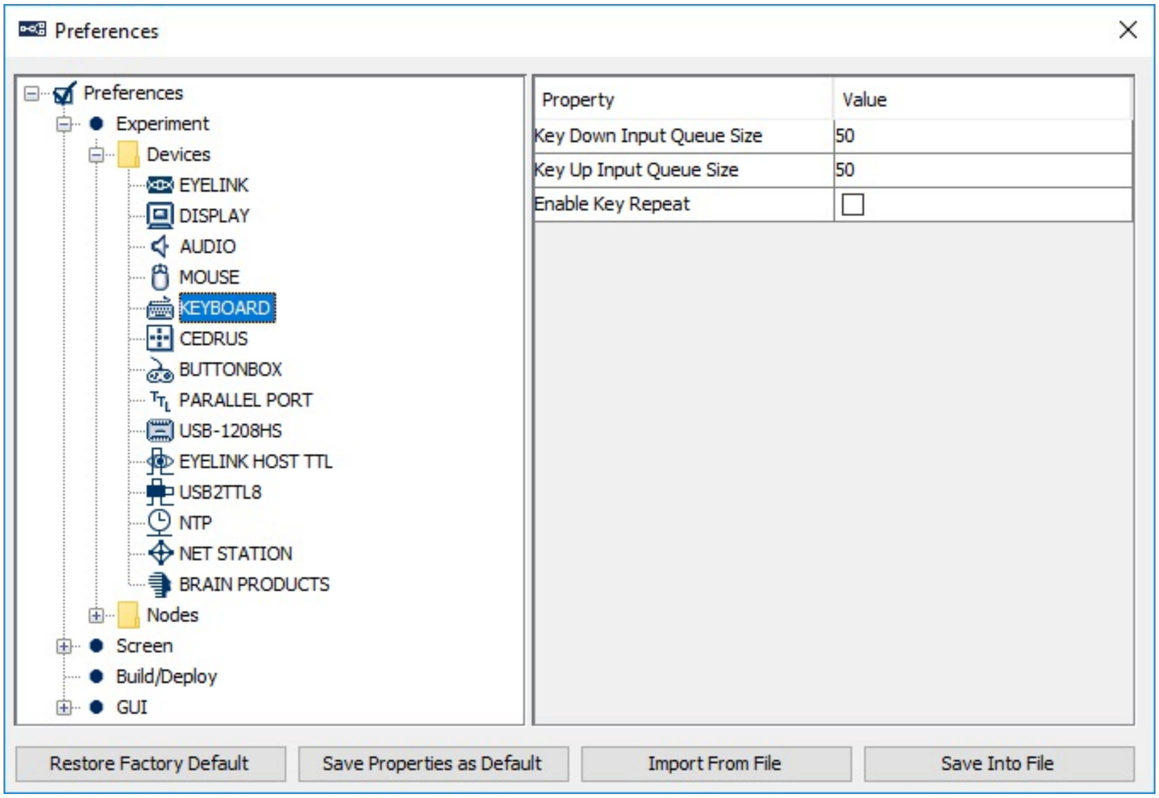
Mouse Two Button Down Input Queue size, Mouse Three Button Down Input Queue size, ...
(.mouseTwoDownInputQueueSize, .mouseThreeDownInputQueueSize, ...): Sets the maximum number of press events that can be cached in the press event queue for the second, third, ... mouse.

Mouse Two Button Up Input Queue Size, Mouse Three Button Up Input Queue Size, ... (.mouseTwoUpInputQueueSize, .mouseThreeUpInputQueueSize, ...): Sets the maximum number of release events that can be cached in the release event queue for the second, third, ... mouse.

Mouse Two Button Down Event Count #, Mouse Three Button Down Event Count #, ... (.mouseTwoDownEventCount, .mouseThreeDownEventCount, ...): Total number of press events cached in the press event queue for the second, third, ... mouse.

Mouse Two Button Up Event Count #, Mouse Three Button Up Event Count #, ... (.mouseTwoUpEventCount, .mouseThreeUpEventCount, ...): Total number of release events cached in the release event queue for the second, third, ... mouse.

17.1.5 Keyboard



Number of Keyboards (.numberOfKeyboards): Sets how many distinct keyboards are used in the experiment. This option is only available if "Enable Multiple Input" option is enabled.

Keyboard One Label (.keyboardOneLabel): Supplies a label for the first keyboard detected by the experiment. This option is only available if "Enable Multiple Input" option is enabled.

Key Down Input Queue Size (.keyDownInputQueueSize): Sets the maximum number of press events that can be cached in the press event queue for the keyboard (or the first keyboard if multiple inputs are supported).

Key Up Input Queue Size (.keyUpInputQueueSize): Sets the maximum number of release events that can be cached in the release event queue for the keyboard (or the first keyboard if multiple inputs are supported).

Key Down Event Count # (.keyDownEventCount): Total number of press events cached in the press event queue for the keyboard (or the first keyboard if multiple inputs are supported).

Key Up Event Count # (.keyUpEventCount): Total number of release events cached in the release event queue for the keyboard (or the first keyboard if multiple inputs are supported).

Enable Key Repeat (NR): If enabled, supports repeated key inputs when you hold down a key. This option is only available if "Enable Multiple Input" option is NOT enabled.

Repeat Delay (.repeatDelay): Adjusts the amount of time that elapses before characters repeat when you hold down a key. This option is only available if "Enable Multiple Input" option is NOT enabled.

Repeat Interval (.repeatInterval): Adjusts how quickly characters repeat when you hold down a key. This option is only available if "Enable Multiple Input" option is NOT enabled.

Keyboard Two Label, Keyboard Three Label, ... (.keyboardTwoLabel, .keyboardThreeLabel, ...): Supplies a label for the second, third, ... keyboard detected by the experiment. This option is only available if "Enable Multiple Input" option is enabled.

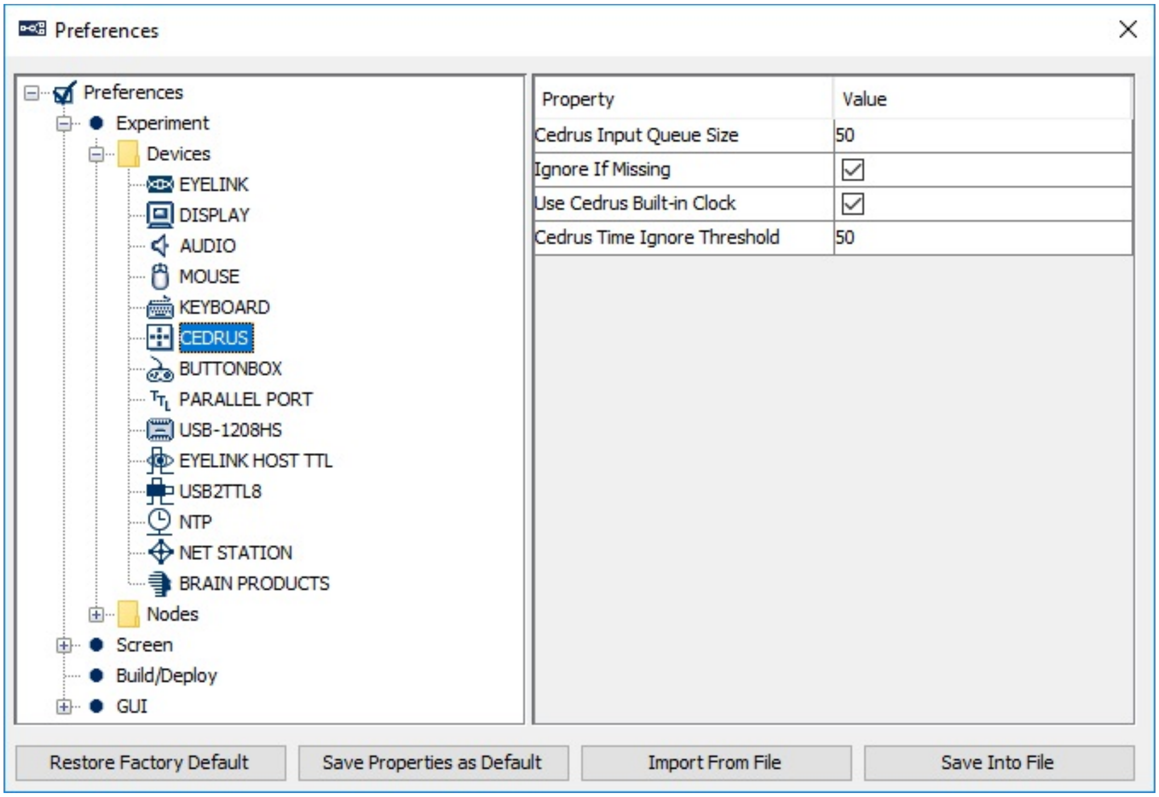
Keyboard Two Key Down Input Queue Size, Keyboard Three Key Down Input Queue Size, ... (.keyboardTwoKeyDownInputQueueSize, .keyboardThreeKeyDownInputQueueSize, ...): Sets the maximum number of press events that can be cached in the press event queue for the second, third, ... keyboard.

Keyboard Two Key Up Input Queue Size, Keyboard Three Key Up Input Queue Size, ... (.keyboardTwoKeyUpInputQueueSize, .keyboardThreeKeyUpInputQueueSize, ...): Sets the maximum number of release events that can be cached in the release event queue for the second, third, ... keyboard.

Keyboard Two Key Down Event Count #, Keyboard Three Key Down Event Count #, ... (.keyboardTwoKeyDownEventCount, .keyboardThreeKeyDownEventCount, ...): Total number of press events cached in the press event queue for the second, third, ... keyboard.

Keyboard Two Key Up Event Count #, Keyboard Three Key Up Event Count #, ... (.keyboardTwoKeyUpEventCount, .keyboardThreeKeyUpEventCount, ...): Total number of release events cached in the release event queue for the second, third, ... keyboard.

17.1.6 Cedrus



Cedrus Input Queue Size (.cedrusInputQueueSize): Sets the maximum number of Cedrus device input events that can be cached in the Cedrus device event queue.

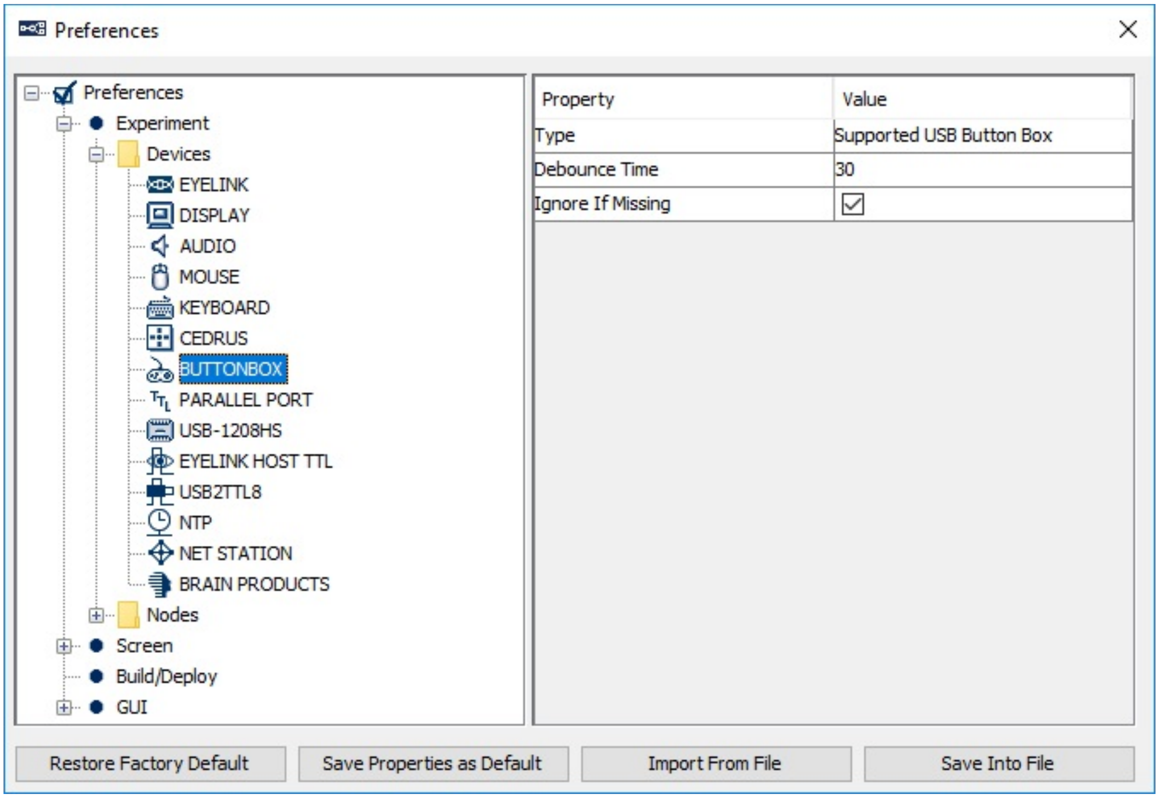
Cedrus Event Count # (.cedrusEventCount): Total number of Cedrus device input events cached in the event queue.

Ignore if Missing (.ignoreIfMissing). If unchecked, experiment will not run if no Cedrus button box is detected. If checked, the experiment will still run even if the device is not detected (however the Cedrus Input trigger itself will not be functional).

Use Cedrus Built-in Clock (.useCedrusBuiltinClock): Cedrus button box has a built-in clock on the hardware which can be used to report the event time directly from the button box. Users have an option to either report the built-in clock time from the button box, or use the current display PC time when the button response is detected by the box. By default, the software reports the time from the Cedrus hardware; however, the display computer time is used if the clock difference between the display computer and the Cedrus hardware exceeds a threshold value.

Cedrus Time Ignore Threshold (.cedrusTimeIgnoreThreshold): Experiment Builder monitors the clock times from the Cedrus button box and the display computer. If the difference between the two clocks exceeds a threshold value, the current display computer clock time will be used.

17.1.7 EyeLink Button Box Device



Type (.type): Identifies the type of button box plugged into the host computer. This can be the “Current Button Box”, "Supported USB Button Box" (plugged into a USB port), "SR Research Gamepad" (plugged into a parallel port), or "ResponsePixx Button Box" (plugged into a parallel port). Button presses on the response box will be processed by the EyeLink button trigger.

Debounce Time (.debounceTime): Sets the button debounce time in milliseconds. Typically, button responds immediately to first change; any change following this is ignored for the amount of time set in the debounce time.

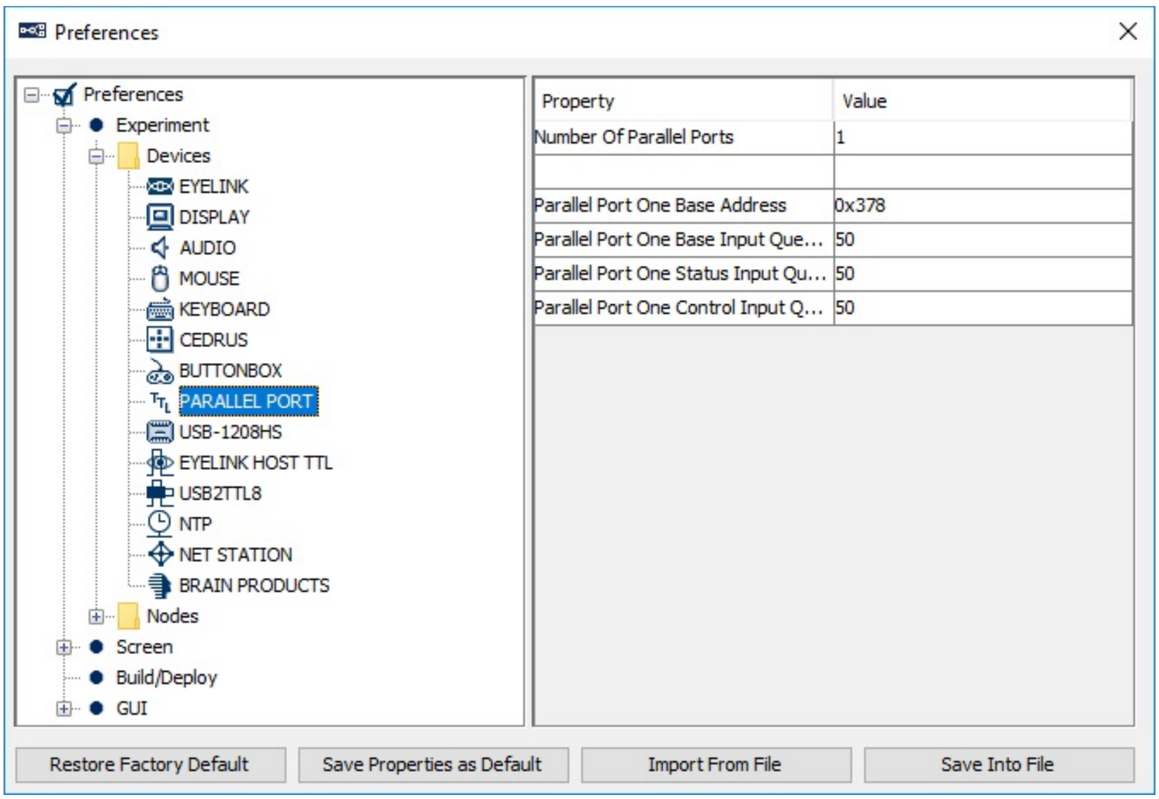
Model (.model): Different model options (5-button handheld, 4-button dual-handheld, and 5-button desktop) if a "ResponsePixx Button Box" is used.

Parallel Port (.parallelPort): The parallel port to which the gamepad is plugged if the "SR Research Gamepad" or "ResponsePixx Button Box" is chosen. This can be the parallel port on the motherboard, or the PCI-express adapter card (LF811) installed on the host computer. The "Card" option is only supported with version 4.50 or later of the EyeLink 1000 host software or 2.30 or later of the EyeLink II host software. If using an EyeLink 1000 Plus, should be set to “Card” as this system only uses an add-on card. A "Parallel port expansion card not supported in this version of host software" error will be reported if an earlier version of software is running on the host computer. If this property is set to "Card" while the physical card (LF811) is not installed on the host computer, a "No parallel port card detected by the tracker" error message will be displayed.

Digital In/Output Address (.digitalAddress). The base address of the parallel port device to which the button box is connected. The default is 0x8 if using an add-on parallel port on the Host PC, or 0x378 if using the parallel port on the motherboard..

Ignore if Missing (.ignoreIfMissing). If unchecked, the experiment will not run if no EyeLink button box is detected. If checked, the experiment will still run even if the button box is not detected, though any node that uses the device will not be functional.

17.1.8 Parallel Port



Number of Parallel Ports (.numberOfParallelPorts): Sets how many distinct parallel ports are used in the experiment.

Parallel Port One Label, Parallel Port Two Label, ... (.portOneLabel, .portTwoLabel, ...): Supplies a label for the first, second, ... parallel port device used in the experiment.

Parallel Port One Base Address, Parallel Port Two Base Address, ... (.portOnebaseAddress, .portTwobaseAddress, ...): The address of data port or data register for outputting data on the first, second, ... parallel port's data lines. LPT1 on a motherboard is normally assigned a base address of 0x378, while parallel port cards may have addresses within a wide range. If set to 0, the software will do an auto detection of the parallel port address. This field expects a hexadecimal number, so users should enter values like "0x378" (without quotes) instead of "378".

Parallel Port One Base Input Queue Size, Parallel Port Two Base Input Queue Size, ... (.portOneBaseInputQueueSize, .portTwoBaseInputQueueSize, ...): Sets the maximum number of input events at the base register of the first, second, ... parallel port that can be cached in the event queue.

Parallel Port One Status Input Queue Size, Parallel Port Two Status Input Queue Size, ... (.portOneStatusInputQueueSize, .portTwoStatusInputQueueSize, ...): Sets the maximum number of input events at the status register of the first, second, ... parallel port that can be cached in the event queue.

Parallel Port One Control Input Queue Size, Parallel Port Two Control Input Queue Size, ... (.portOneControlInputQueueSize, .portTwoControlInputQueueSize, ...): Sets the maximum number of input events at the control register of the first, second, ... parallel port that can be cached in the event queue.

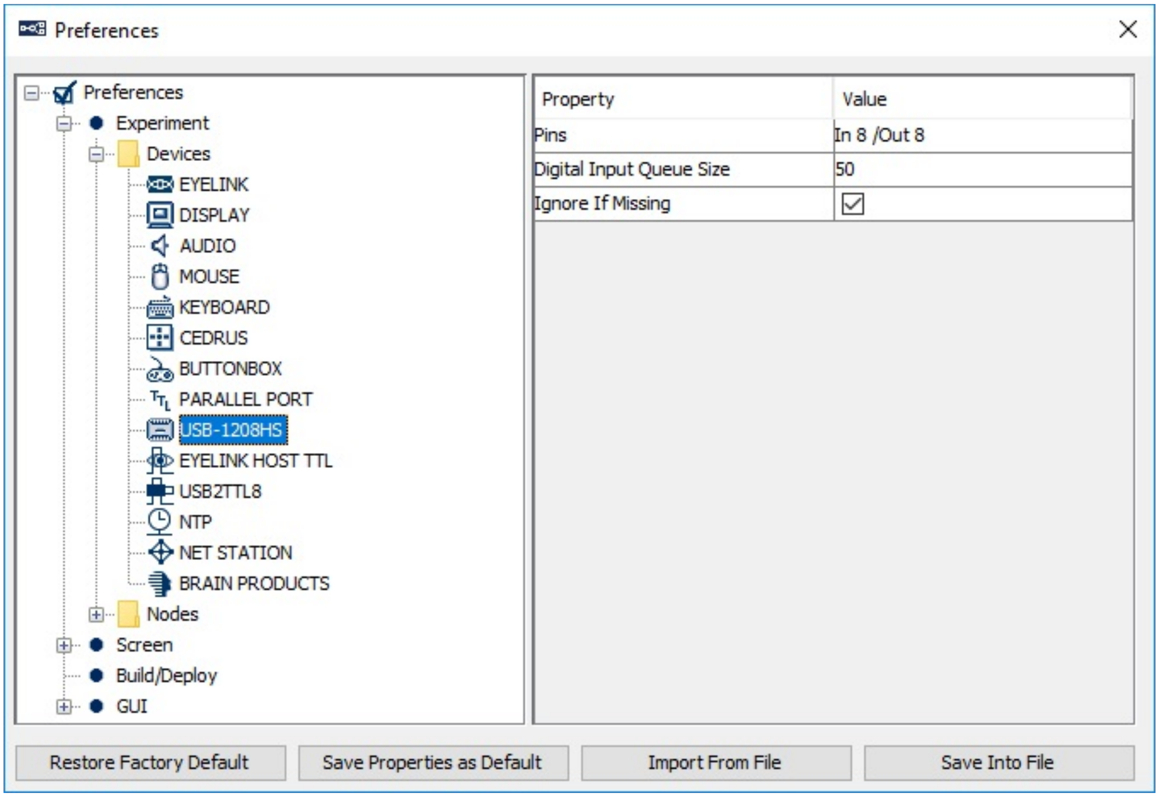
Parallel Port One Base Event Count, Parallel Port Two Base Event Count, ... # (.portOneBaseEventCount, .portTwoBaseEventCount, ...): Total number of input events at the base register of the first, second, ... parallel port cached in the event queue.

Parallel Port One Status Event Count, Parallel Port Two Status Event Count, ... # (.portOneStatusEventCount, .portTwoStatusEventCount, ...): Total number of input events at the status register of the first, second, ... parallel port cached in the event queue.

Parallel Port One Control Event Count, Parallel Port Two Control Event Count, ... # (.portOneControlEventCount, .portTwoControlEventCount, ...): Total number of input events at the control register of the first, second, ... parallel port cached in the event queue.

Parallel Port One Current Value, Parallel Port Two Current Value, ... # (.portOneCurrentValue, .portTwoCurrentValue, ...): Current value of the first, second, ... parallel port in the format of (data register value, status register value, control register value).

17.1.9 USB-1208HS Box



Pins (.pins): Sets the digital pins used for sending or receiving signals through the USB-1208HS box. Clicking on the "Value" field will bring up a USB-1208HS configuration dialog box. The arrows indicate the directions of the data flow that each pin is configured for: if the arrow points towards the box, the pin is used to receive signals; if the arrow points away from the box, the pin is used to send signals.

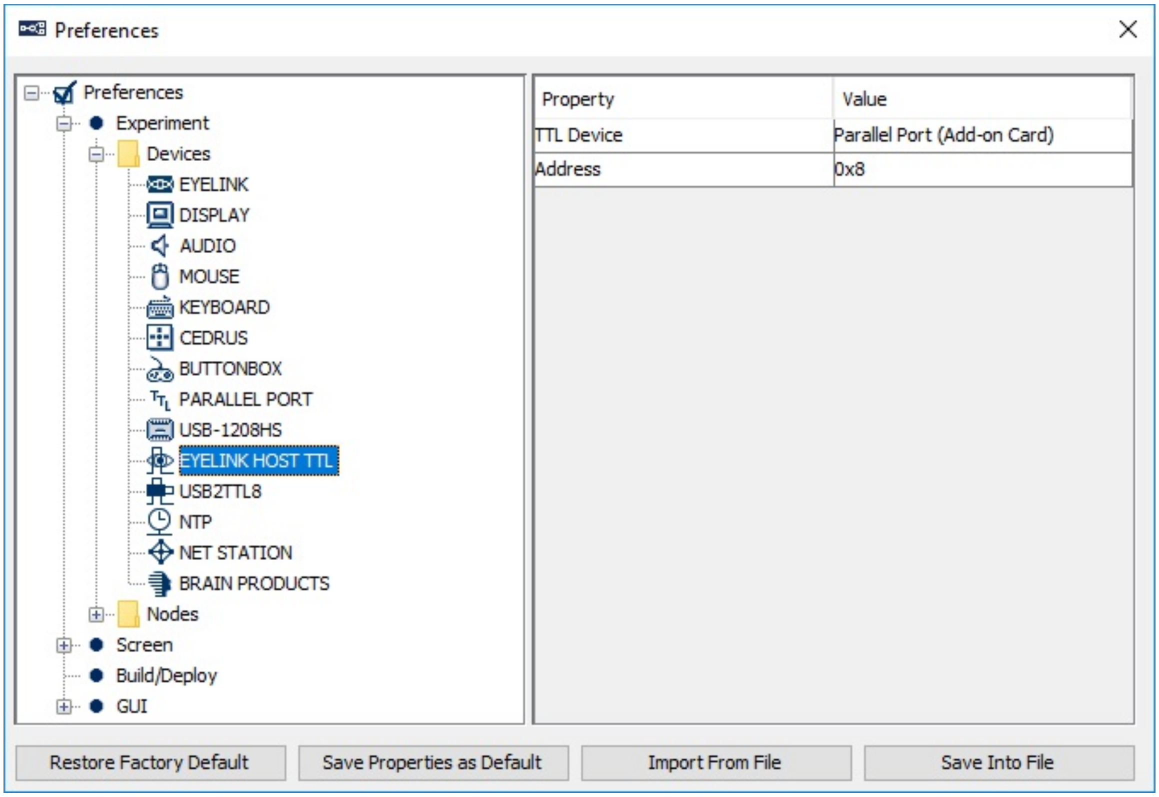
Digital Input Queue Size (.digitalInputQueueSize): Sets the maximum number of TTL input events from the USB-1208 HS box that can be cached in the event queue.

Digital Event Count # (.digitalEventCount): Total number of TTL input events from the USB-1208 HS box that are cached in the event queue.

Current Value # (.currentValue): The current TTL value across all 16 pins.

Ignore if Missing (.ignoreIfMissing). If unchecked, the experiment will not run if the USB-1208HS is not detected. If checked, the experiment will still run even if the device is not detected, though any node that uses the device will not be functional.

17.1.10 EyeLink Host TTL



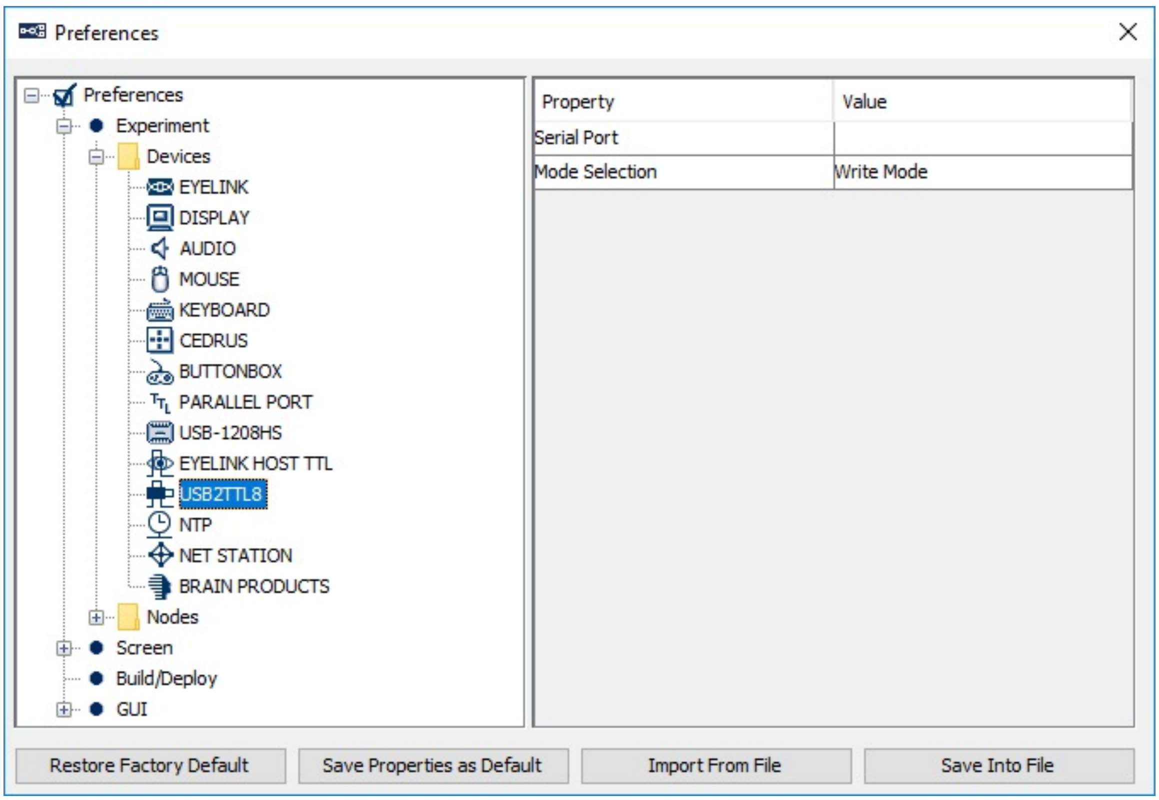
TTL Device (.TTLDevice): Specifies the digital I/O device on the EyeLink Host computer that is used to send TTL signals (through the Biometric TTL action or the Brain Products Control action). The supported TTL Devices include parallel port (onboard or add-on card), USB-1208HS, and the digital ports on a supported analog card. When a device is selected, the address will be automatically assigned based on the default EyeLink Host PC configuration.

Address (.address): The address of the selected TTL device on the EyeLink Host computer that is used to send TTL signals. This field expects a hexadecimal value, so users should enter a value like "0x378" (without quotes) instead of "378".

17.1.11 USB2TTL8

The USB2TTL8 by Labhackers (http://www.labhackers.com/usb2ttl8.html) is a USB Serial interface allowing sending and receiving of TTL signals. The USB2TTL8 is plug-and-play in Windows 10 and macOS. If using it on Windows 7, please install the required USB Serial driver from www.labhackers.com/downloads.html. The USB2TTL8 device can be set to either “Read Mode” or “Write Mode”, and can be switched as needed during an experiment by using an Update Attribute node to set the Mode Selection property. Make sure the device is in the “Write Mode” before sending TTL signals through a SET_TTL or BIOMETRIC_TTL action, and in the “Read Mode” before receiving TTL signals through the TTL Input trigger. A run-time warning will be given if the mode selection of the device is not consistent with the direction of data flow.

When a single USB2TTL8 is used, Experiment Builder will automatically find the device as long as the "Enable Auto Detect" property is enabled. If multiple USB2TTL8 devices are used, however (or if the USB2TTL8 is used with another conflicting serial device such as a Cedrus response pad), the "Enable Auto Detect" property should be disabled and the address should be specified manually. For the latter, start the Windows Device Manager, go to the "Ports (COM & LPT)" section and search for the entry "USB Serial Port (COMx)". In the dropdown list of the "USB2TTL8 X Serial Port" property, select the COM port number identified by the Windows device manager. On macOS, the COM Port will appear in the format of "/dev/cu.usbmodem***".



Number of USB2TTL8 Devices (.numberOfSerialPorts): Total number of USB2TTL8 USB interface devices used in the current experiment.

Ignore if Missing (.ignoreIfMissing): If unchecked, the experiment will not run if the USB2TTL8 USB interface is not detected. If checked, the experiment will still run even if the device is not detected, although any node that uses the device will not be functional.

USB2TTL8 One/Two/Three/Four Label (.UTOne/Two/Three/FourLabel): If multiple USB2TTL8s are used in the experiment, each device is given a unique label so users can easily select the desired TTL Device in the SET_TTL, BIOMETRIC_TTL, and TTL_INPUT nodes.

USB2TTL8 One/Two/Three/Four Serial Port (.UTOne/Two/Three/FourSerialPorts): Specifies the COM port of the USB2TTL8 interface—the COM port is assigned by the operating system when a device is connected. Experiment Builder will auto-detect the COM port on both Windows and Mac, and display possible COM ports in green in the dropdown list. If the "CUSTOM" option is selected, users will be further provided with a "USB2TTL8 Custom Port Value" property.

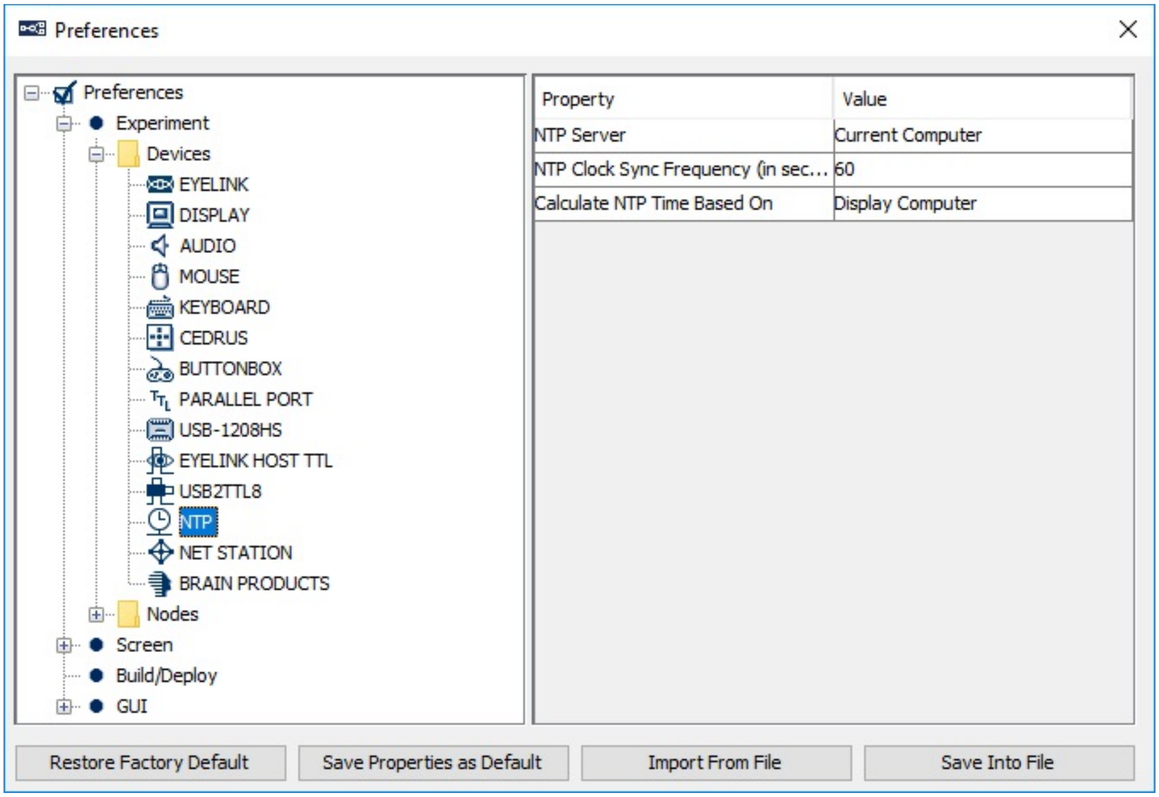
USB2TTL8 One/Two/Three/Four Custom Port Value (.UTOne/Two/Three/FourCustomPortValue): If automatic detection of the serial port is not enabled and the "CUSTOM" option is selected in the "USB2TTL8 Serial Port" property, users can enter the proper COM port value here.

USB2TTL8 One/Two/Three/Four Time Out (.UTOne/Two/Three/FourTimeOut): The timeout duration set for the serial port when in the read mode (typically a low value to ensure getting a reply from the port).

USB2TTL8 One/Two/Three/Four Mode Selection (.UTOne/Two/Three/FourModeSelection): Whether the USB2TTL8 should operate in a Read Mode or a Write Mode. In Write Mode, the device can be used to send TTL signals using the SET_TTL, BIOMETRIC_TTL, or BRAIN_PRODUCTS_CONTROL action. In Read Mode, the device can be used to read incoming signals with the TTL_INPUT trigger.

Enable Auto Detect (.enableAutoDetect): If enabled, Experiment Builder will automatically assign the COM port to the USB2TTL8 USB interface. This is only possible if the "Number of Serial Ports" is one.

17.1.12 NTP



NTP Server (.NTPServer): Determines which computer is used as the server computer. If "Use Net Station Experiment Control Interface" is enabled, the Amplifier will be the NTP server.

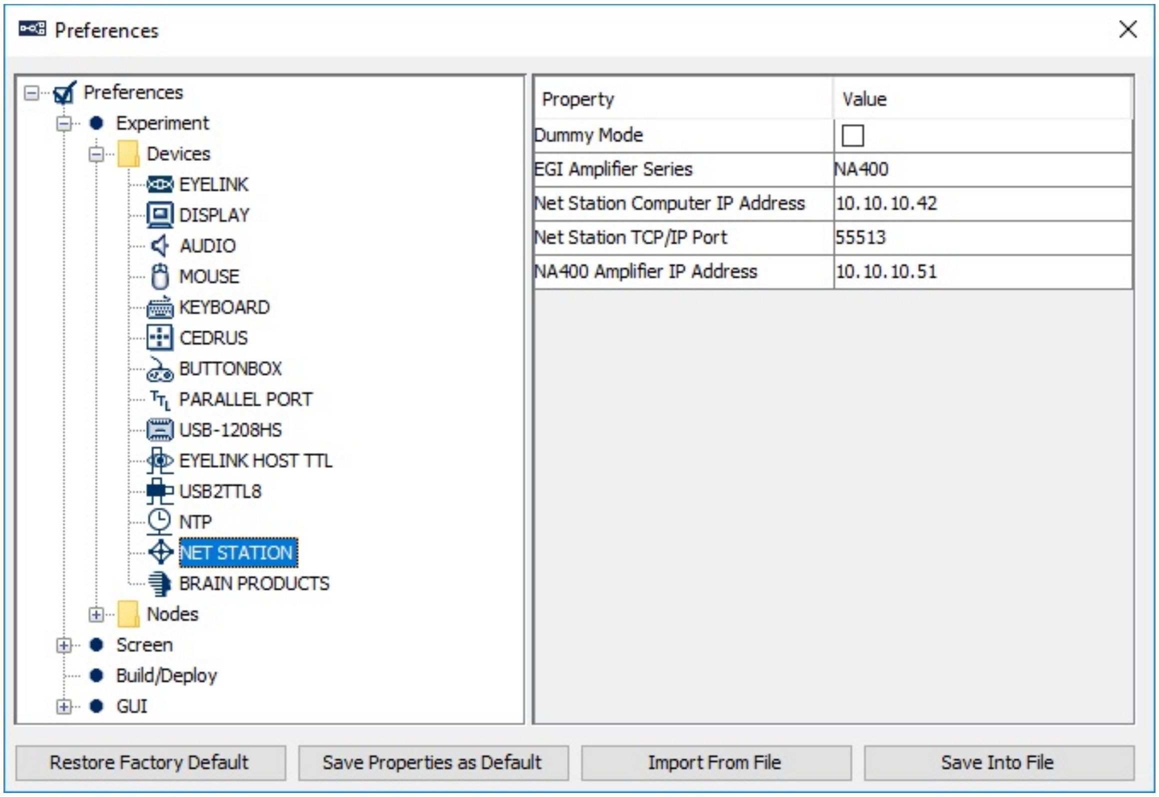
NTP Server IP Address (.NTPServerIPAddress): The IP address of the NTP Server. If "Use Net Station Experiment Control Interface" is enabled, the Amplifier will be the NTP server, and the IP address is set through the Net Station device.

NTP Clock Sync Frequency (in seconds) (.NTPClockSyncFrequency): Determines how often the clocks between systems will be synchronized. When interfacing with the Net Station, at each synchronization Experiment Builder will read the current Display PC clock, EyeLink Host PC clock, and Net Station Amplifier clock, and send a "NTP_CLOCK_SYNC" message to the EDF file and Net Station.

Current NTP Time (.currentNTPTime): This returns the current estimation of the server NTP time.

Net Station Initial Sync Times (.netStationInitialSyncTimes): This returns the Display PC clock, EyeLink Host PC clock, and Net Station Amplifier clock when the initial synchronization is made. This option is available only if the "Use Net Station Experiment Control Interface" in the Experiment preferences is enabled.

17.1.13 Net Station



Dummy Mode (.dummyMode): Enable this to test the project without connecting to the EGI Net Station. If the dummy mode is turned on, the communication through the Net Station Experiment Control Interface is turned off; all of the Net Station related nodes will be skipped.

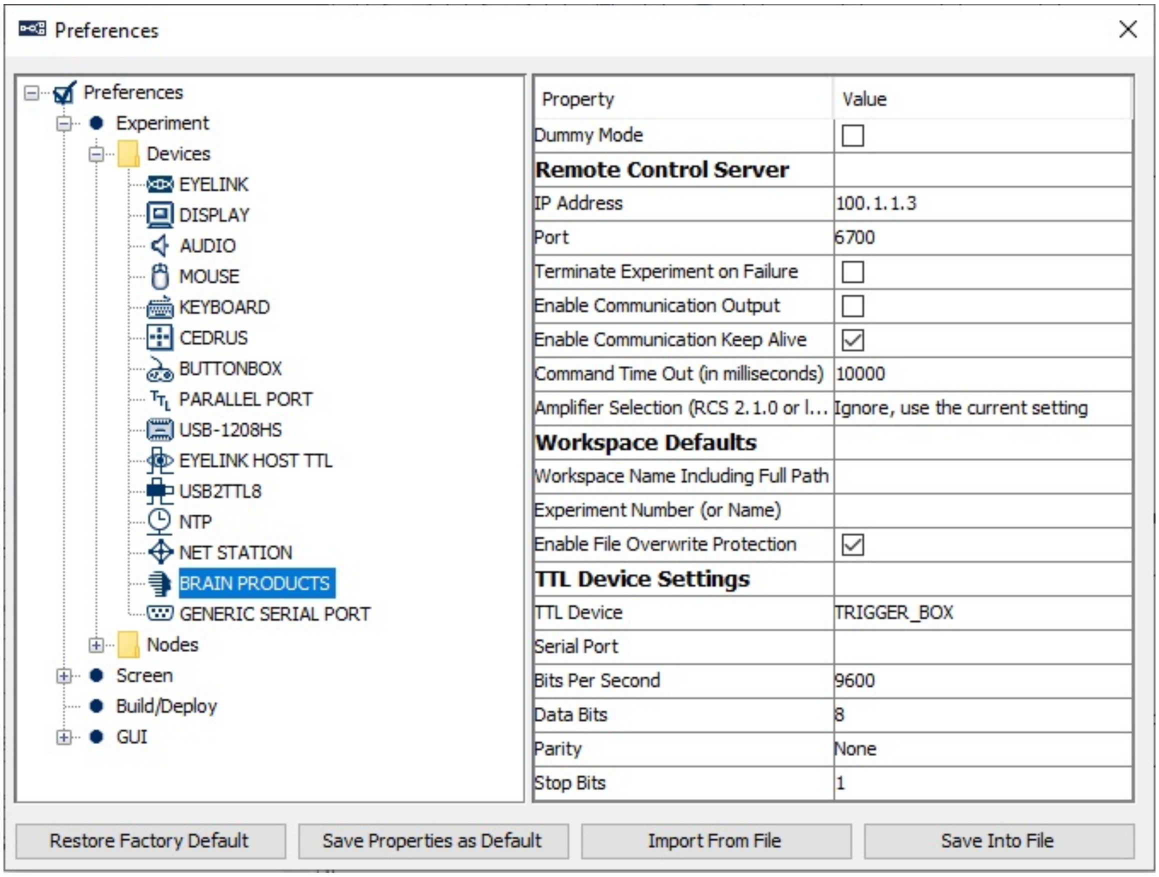
EGI Amplifier series (.EGIAmplifierSeries): This informs the software which version of EGI Amplifier (NA400 series or NA300 series) is used.

Net Station Computer IP Address (.IPAddress): The IP address of the Net Station Computer (default 10.10.10.42).

Net Station TCP/IP Port (.port): The port (default: 55513) used by the Net Station Experiment Control Interface for TCP/IP communication.

NA400 Amplifier IP Address (.NA400AmplifierIPAddress): IP address of the NA400 series amplifier (default 10.10.10.51).

17.1.14 Brain Products



Dummy Mode (.dummyMode): Enable this to test the project without connecting to the BrainVision Remote Control Server.

Remote Control Server

IP Address (.brainIPAddress): The IP address of the computer that runs the Remote Control Server 2.0 (RCS 2.0). Please make sure the RCS Server PC, the Display PC running Experiment Builder, and the EyeLink Host PC are placed in the same network and that the communication is not blocked by a firewall. If running Experiment Builder and RCS 2.0 on the same machine (this is not recommended for actual data collection!), set this to 127.0.0.1.

Port (.brainPort): The port (default: 6700) used by the Remote Control Server for TCP/IP communication.

Terminate Experiment on Failure (.terminateOnFail): If enabled, Experiment Builder will terminate the experiment if there are errors in controlling the BrainVision Recorder (e.g., failed to set the recorder to the proper mode).

Enable Communication Output (.communicationOutput): If enabled, debugging text is printed in the output to report the communication between Experiment Builder and the Remote Control Sever.

Enable Communication Keep Alive (.communicationKeepAlive): When enabled, Experiment Builder will explicitly send an "AP" status command every 5 seconds to the Brain Products device to detect connection status during runtime. It does this by writing data to the TCP socket: if any type of disconnection occurrs, it will detect it and terminate the experiment. If using the "Send Raw Command" operation, it may be best to disable this option, as it may provide misleading results for the "Send Raw Command" return value (the result from the "AP" status command can be combined with the result of the Send Raw Command).

Command Time Out (in Milliseconds) (.pauseTime): Sets the maximum time allowed for commands to return a result.

Amplifier Selection (RCS 2.1.0 or later) (.AmplifierSelection): Enter Amplifier selection to connect to Brain Products Amplifier. This feature requires RCS version 2.1.0 or later.

Brain State (.brainState): This read-only property will return the current states of the BrainVision application, Recorder, and acquisition, as well as the last acquisition error (if any).

Workspace Defaults

Workspace Name Including Full Path (.pathToWorkspace): A workspace is a collection of settings used in BrainVision Recorder for a given experiment. This setting allows users to load the required workspace that can be found under the "Path to Workspace". If left empty, the current workspace in BrainVision Recorder will be used. Users should enter the intended workspace here (e.g., "C:\Vision\Workfiles\actiCHamp.rwksp").

Experiment Number (or Name) (.experimentNumber): This is used to set the experiment name or experiment number so that the saved ".eeg" file is named correctly according to RCS 2.0 conventions. If left empty, the name of the current Experiment Builder project will be used. Experiment Builder uses the current session name as the test subject number for RCS 2.0 file naming scheme (i.e., ExperimentNumber_SubjectID.eeg).

Enable File Overwrite Protection (.fileOverridingOptions): This option sets the overwrite protection on the Recorder. If you enable the File Overwrite Protection, RCS will append incrementing integers, already starting with the first one (e.g. "_1") to the name of the saved file.

Brain Configuration (.brainConfig): This read-only property reports the configuration settings on BrainVision Recorder and RCS2.0 (version of the messaging protocol and Remote Control Server, work space name, experiment name, etc.)

TTL Device Setting

TTL Device (.TTLDevice): The device used to send TTL signals from the Brain products Control action (Parallel Port, EyeLink Host TTL, USB2TTL8, USB-1208HS, or TriggerBox). Note that the parallel port and TriggerBox are only supported in Windows, and the EyeLink Host TTL is only supported in an EyeLink experiment. The following serial port configuration properties will only be applicable when the TriggerBox (https://www.brainproducts.com/productdetails.php?id=55) is selected.

Serial Port (.serialPorts): Specifies the COM port the TriggerBox should use. The COM port number can be found in the "Ports (COM & LPT)" section of the Windows Device Manager. Look for the entry "TriggerBox Virtual Serial Port (COMx)".

Custom Port Value (COM10 to COM255) (.customPortValue): If the COM port is not in the range of COM1-COM9, users can enter the proper one here.

Bits Per Second (.bitsPerSecond): Specifies the data rate to be used when sending data. Default: 9600.

Data Bits (.dataBits): The number of data bits in each character. Default: 8.

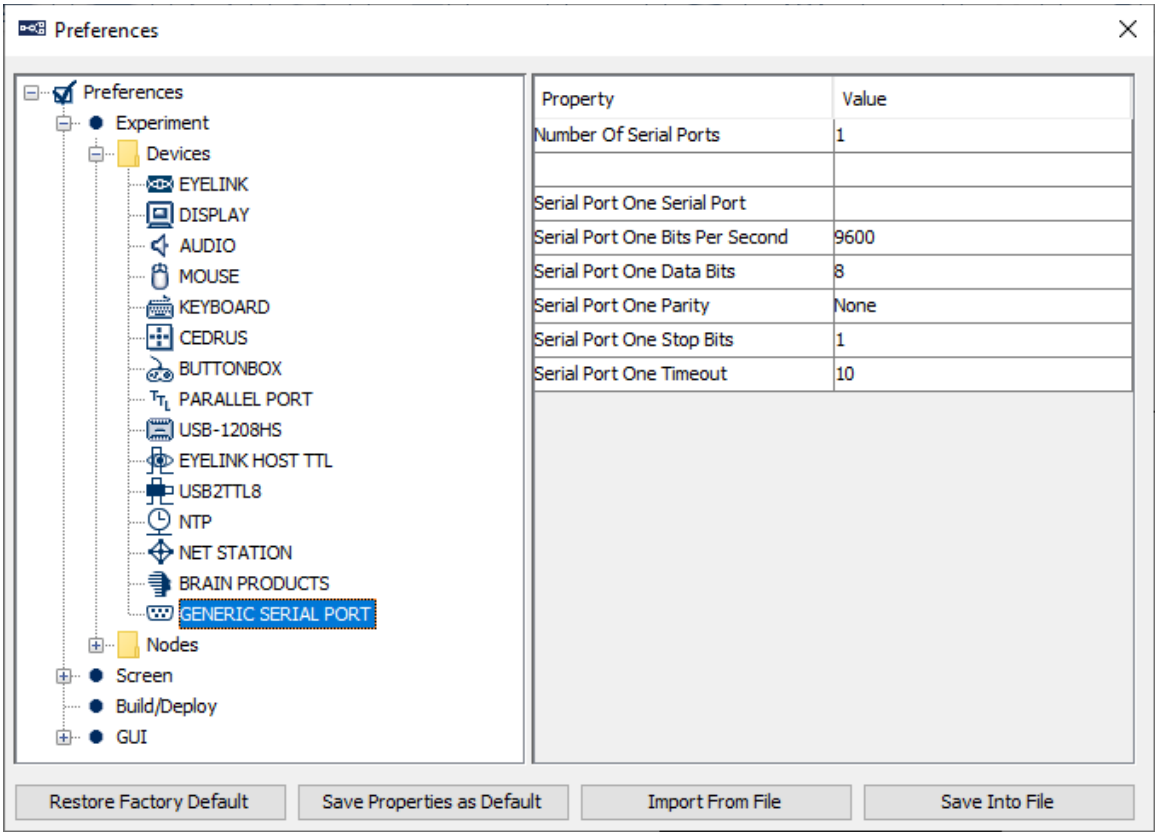
Parity (.parity): Specifies whether error-detection should be used. Default: None.

Stop Bits (.stopBits): Number of bits needed to resynchronize receiving hardware (stop bits sent at the end of every character allow the receiving signal hardware to detect the end of a character and to resynchronize with the character stream). Default 1.

17.1.15 Generic Serial Port

When the Recipient Biometric Device in a Biometric TTL node is set to Biosemi, the Biosemi USB trigger interface (https://www.biosemi.com/faq/USB%20Trigger%20interface%20cable.htm) may be used as the TTL Device. The Generic Serial Port device can be used to configure the serial port properties of the interface. Start the Windows Device Manager, go to the "Ports (COM & LPT)" section and search for the entry "USB Serial Port (COMx)". In the dropdown list of the "Serial Port X Serial Port" property, select the COM port number identified by the Windows device manager. On macOS, the COM Port will appear in the format of "/dev/tty.usbserial-***".

Presently the Biosemi USB interface is the only hardware supported by the Generic Serial Port device.



Number of Serial Ports (.numberOfSerialPorts): Total number of serial port device (or virtual serial port device) used in the current experiment.

Serial Port One/Two/Three/Four Label (.serialPortOne/Two/Three/FourLabel): If multiple (virtual) serial port devices are used in the experiment, each device is given a unique label so users can easily select the desired TTL Device in the BIOMETRIC_TTL node.

Serial Port One/Two/Three/Four Serial Port (.serialPortOne/Two/Three/FourSerialPorts): Specifies the COM port of the serial port device—the COM port is assigned by the operating system when a device is connected. Experiment Builder will auto-detect the COM port on both Windows and Mac, and display possible COM ports in green in the dropdown list. If the "CUSTOM" option is selected, users will be further provided with a "Serial Port X Custom Port Value" property to manually enter the COM port value.

Serial Port One/Two/Three/Four Custom Port Value (.serialPortOne/Two/Three/FourCustomPortValue): If the "CUSTOM" option is selected in the "Serial Port X Serial Port" property, users can enter the proper COM port here.

Serial Port One/Two/Three/Four Bits per Second (.serialPortOne/Two/Three/FourBitsPerSecond): Specifies the data rate to be used when sending data. This needs to be set to 115200 for the Biosemi USB trigger interface to work properly.

Serial Port One/Two/Three/Four Data Bits (.serialPortOne/Two/Three/FourDataBits): The number of data bits in each character. Default: 8.

Serial Port One/Two/Three/Four Parity (.serialPortOne/Two/Three/FourParity): Specifies whether error-detection should be used. Default: None.

Serial Port One/Two/Three/Four Stop Bits (.serialPortOne/Two/Three/FourStopBits): Number of bits needed to resynchronize receiving hardware (stop bits sent at the end of every character allow the receiving signal hardware to detect the end of a character and to resynchronize with the character stream). Default 1.

Serial Port One/Two/Three/Four Timeout (.serialPortOne/Two/Three/FourTimeout): The timeout duration set for the serial port when in the read mode (typically a low value to ensure getting a reply from the port).

17.1.16 Timer

See section 7.10.1 “Timer Trigger”.

17.1.17 Invisible Boundary

See section 7.10.2 “Invisible Boundary Trigger”.

17.1.18 Conditional

See section 7.10.3 “Conditional Trigger”.

17.1.19 EyeLink Button

See section 7.10.4 “EyeLink Button Trigger”.

17.1.20 Cedrus Input

See section 7.10.5 “Cedrus Button Trigger”.

17.1.21 Keyboard

See section 7.10.6 “Keyboard Trigger”.

17.1.22 Mouse

See section 7.10.7 “Mouse Trigger”.

17.1.23 TTL Trigger

See section 7.10.8 “TTL Trigger”.

17.1.24 Fixation

See section 7.10.9 “Fixation Trigger”.

17.1.25 Saccade

See section 7.10.10 “Saccade Trigger”.

17.1.26 Blink

See section 7.10.11 “Blink Trigger”.

17.1.27 Sample Velocity

See section 7.10.12 “Sample Velocity Trigger”.

17.1.28 Voice Key

See section 7.10.13 “ASIO Voice Key Trigger”.

17.1.29 Display Screen

See section 7.9.1 “Display Screen”.

17.1.30 Drift Correct

See section 7.9.2 “Performing Drift Correction”.

17.1.31 Camera Setup

See section 7.9.3 “Performing Camera Setup and Calibration”.

17.1.32 Send EyeLink Message

See section 7.9.4 “Sending EyeLink Message”.

17.1.33 Send Command

See section 7.9.5 “Sending EyeLink Command”.

17.1.34 Set TTL

See section 7.9.6 “Sending TTL Signals”.

17.1.35 Add to Experiment Log

See section 7.9.7 “Adding to Experiment Log”.

17.1.36 Update Attribute

See section 7.9.8 “Update Attribute”.

17.1.37 Add to Accumulator

See section 7.9.9 “Adding to Accumulator”.

17.1.38 Add to Results File

See section 7.9.10 “Add to Results File”.

17.1.39 Prepare Sequence

See section 7.9.11 “Preparing Sequence”.

17.1.40 Sequence
See section 7.7 “Sequence”.

17.1.41 Reset Node
See section 7.9.12 “Reset Node”.

17.1.42 Play Sound
See section 7.9.13 “Playing Sound”.

17.1.43 Play Sound Control
See section 7.9.14 “Play Sound Control”.

17.1.44 Record Sound
See section 7.9.15 “Record Sound”.

17.1.45 Record Sound Control
See section 7.9.16 “Record Sound Control”.

17.1.46 Terminate Experiment
See section 7.9.17 “Terminating an Experiment”.

17.1.47 Recycle Data Line
See section 7.9.18 “Recycle Data Line”.

17.1.48 Execute
See section 7.9.19 “Execute Action”.

17.1.49 Null Action
See section 7.9.20 “Null Action”.

17.1.50 ResponsePixx LED Control
See section 7.9.21 “ResponsePixx LED Control”.

17.1.51 Biometric TTL Control
See section 7.9.22 “Biometric TTL Control”.

17.1.52 Net Station Control
See section 7.9.23 “Net Station Control”.

17.1.53 Brain Products Control
See section 7.9.24 “Brain Products Control”.

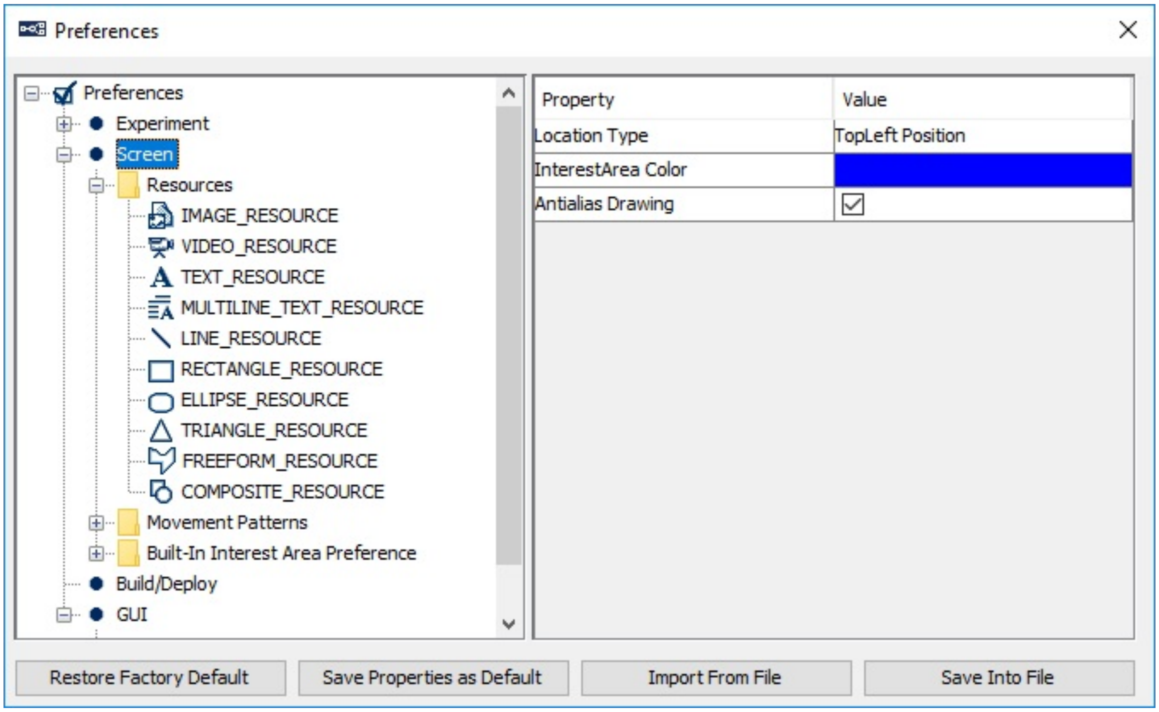
17.1.54 Accumulator
See section 7.11.3 “Accumulator”.

17.1.55 Results File

See section 7.11.2 "Results File".

17.2 Screen

17.2.1 Screen



Location Type: For all resources on the Screen Builder, whether the "Location" refers to the top-left corner or the center of the resource.

InterestArea Color: Color used to draw the border of interest areas.

Antialias Drawing: Anti-aliasing is the process of blurring sharp edges in text or line drawings to get rid of the jagged edges on lines. If this preference is set to true, anti-aliasing is applied to resources to make screen drawings appear smoother. If using macOS, make sure the resolution (Preferences -> Experiment -> Devices -> Display -> "Width" and "Height") is set to the native resolution of the built-in screen or external monitor to achieve the best anti-aliasing results. When using the DirectDraw Video Environment, make sure the transparency color (Preferences -> Experiment -> Devices -> Display -> "Transparency Color") is set close to, but not identical to, the background color of the display (Preferences -> Experiment -> Nodes -> Action -> Display Screen -> "Background Color").

17.2.2 Image Resource

See section 8.1.1 "Image Resource".

17.2.3 Video Resource

See section 8.1.2 “Video Resource”.

17.2.4 Text Resource

See section 8.1.3 “Text Resource”.

17.2.5 Multiline Text Resource

See section 8.1.4 “Multiline Text Resource”.

17.2.6 Line Resource

See section 8.1.5 “Line Resource”.

17.2.7 Rectangle Resource

See section 8.1.6 “Rectangle Resource”.

17.2.8 Ellipse Resource

See section 8.1.7 “Ellipse Resource”.

17.2.9 Triangle Resource

See section 8.1.8 “Triangle Resource”.

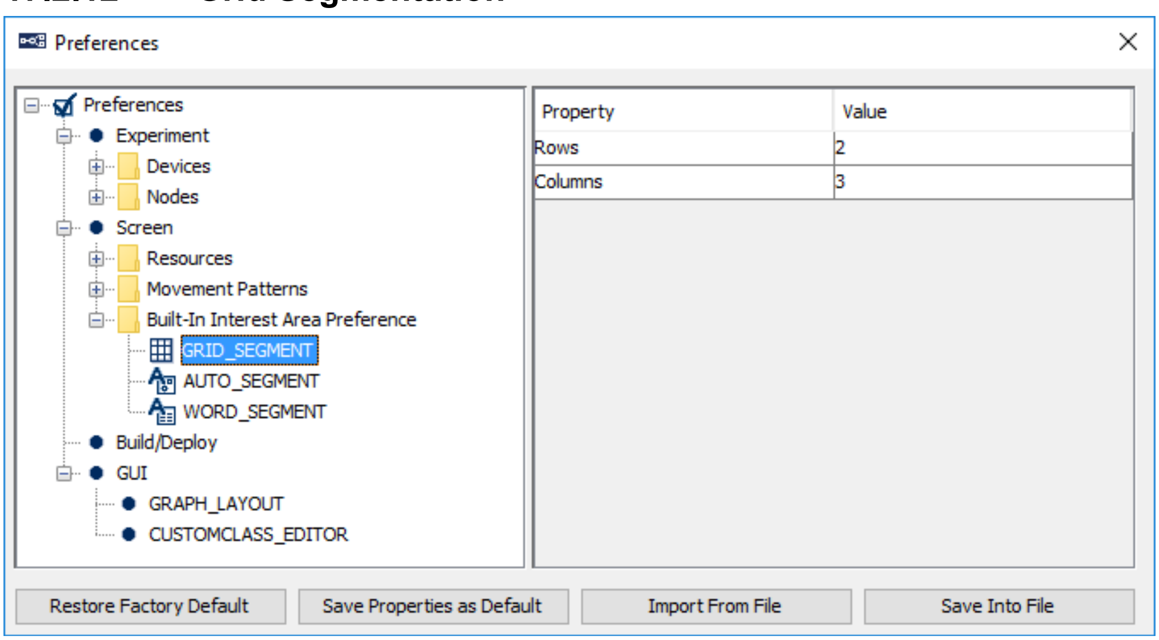
17.2.10 Freeform Resource

See section 8.1.9 “Freeform Resource”.

17.2.11 Sine Pattern

See section 8.2.1 “Sinusoidal Movement Pattern”.

17.2.12 Grid Segmentation

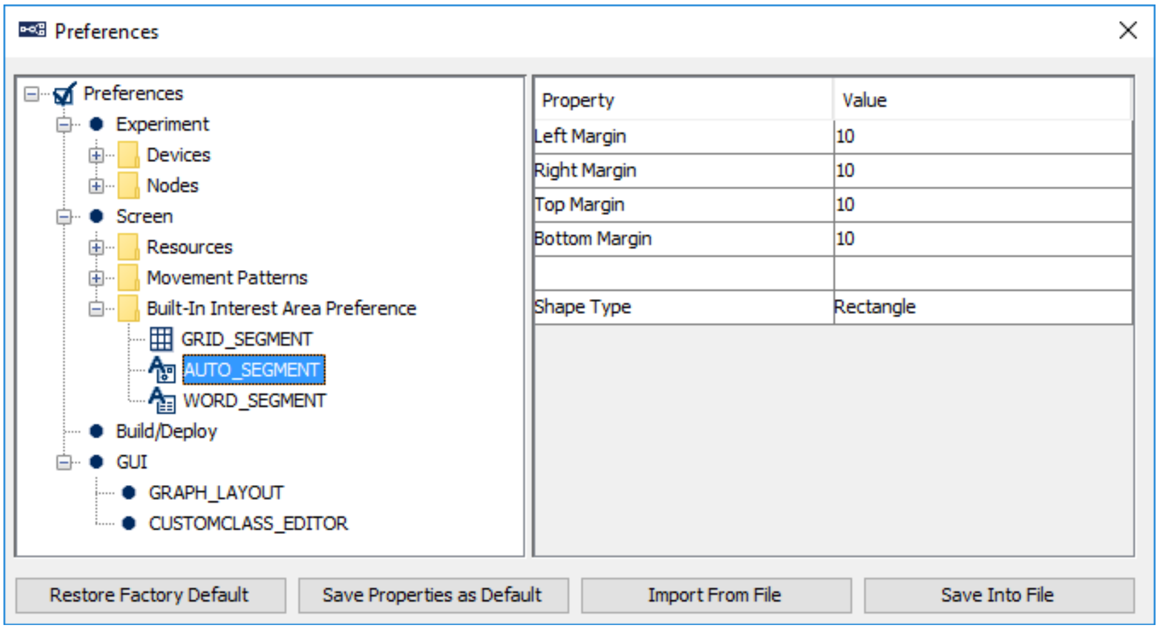


Grid segmentation will divide the entire screen into evenly spaced [Rows] × [Columns] interest areas.

Rows: Number of rows used to create grid segment.

Columns: Number of columns used to create grid segment.

17.2.13 Auto Segmentation

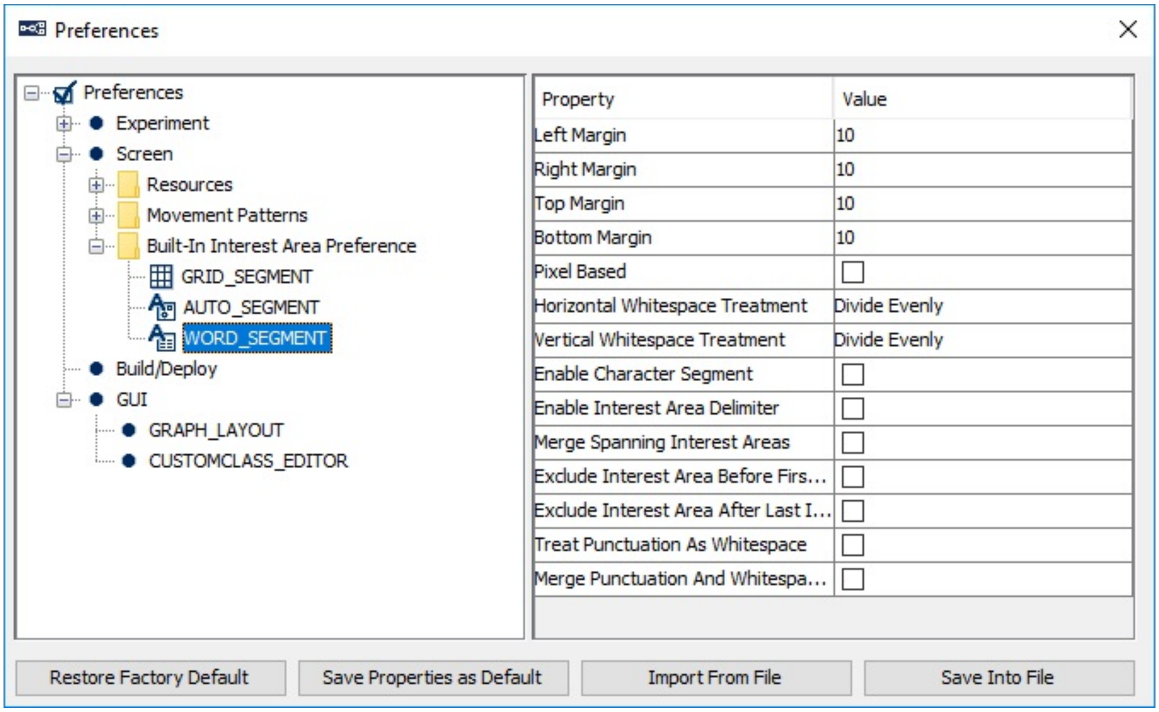


Auto segmentation will create a rectangular or elliptic interest area for the selected resources on the display screen based on the minimum bounding rectangle.

Left Margin, Right Margin, Top Margin, and Bottom Margin: Number of pixels added to the left, top, right, and bottom of the interest area that bounds the resource.

Shape Type: The type of interest area to be created (either rectangular or elliptic).

17.2.14 Word Segmentation



Word segmentation will create a rectangular interest area to contain each of the words in a text or multiline text resource.

Left Margin, Right Margin, Top Margin, and Bottom Margin: Number of pixels added to the left, top, right, and bottom of the interest area.

Pixel Based: This option is intended for interest area segmentation for the right-to-left texts (e.g., Arabic, Hebrew). If this option is enabled, interest areas are created based on the image analysis of the text created. Essentially, it will look for a cluster of dark/bright pixels in one or multiple lines and use "Segmentation Spacing Threshold" to decide where the boundary of an interest area should be. Note, for this feature to work properly, please make sure the "Text Orientation" property of the multiline text resource is set to "Right to Left".

Segmentation Spacing Threshold: Number of consecutive pixels below threshold before segment end is identified.

Fill Gap Between: If checked, gaps between consecutive interest areas will be filled by expanding the size of each interest area.

Horizontal Whitespace Treatment: This specifies how the whitespace between words is treated in the interest area segmentation. The following options are supported:

- Divide Evenly – Divides the space evenly so half of the whitespace goes to the interest area containing the previous word, and the other half goes to the next interest area. This is the existing and default segmentation behavior. For example: Whitespace | Treatment.

- Include with Previous Word – Includes the space with the lower-numbered interest area, which will usually contain the word earlier in the direction of reading. For example, Whitespace |Treatment.
- Include with Next Word – Includes the space with the higher-numbered interest area, which will usually be later in the direction of reading. For example, Whitespace| Treatment.
- Exclude – Excludes the space from being included in any interest areas. Whitespace| |Treatment. Note that for this example only two interest areas are created and they don't contain any part of the interword space.
- Extend Left and Right Margins of Words – Extends the left and right margins of the interest areas by the amount specified by the "Left Margin" and "Right Margin" options specified above. For example, Whitespace | | Treatment. Note, extra pixels specified by the "Right Margin" are added to the previous word "Whitespace". Similarly, extra pixels specified by the "Left Margin" are added to the next word "Treatment".
- Create IA for Whitespace – Creates a separate interest area for the whitespace, and for punctuations as well if the "Treat Punctuation as Whitespace" preference is checked (see below). For example, Whitespace| |Treatment. Note, unlike all of the above options, this will create three interest areas instead of two.

Vertical Whitespace Treatment: Specifies how the space between lines of texts is treated in the interest area segmentation. The following options are supported:

- Divide Evenly – Divides the space evenly between the lines of text, and has part of the line space included in the interest areas above and below the space. This is the existing and default segmentation behavior.
- Include with Previous Line – Groups the line space with the previous line of text.
- Include with Next Line – Groups the line space with the following line of text.
- Exclude – Excludes the line space from being included in any interest areas.
- Extend Top and Bottom Margins of Words - Extends interest areas for the text above the line space by extra pixels specified by the Bottom Margin option. Similarly, interest areas for the text below the space are extended by extra pixels specified by the Top Margin option.
- Create IA for Whitespace – Creates a separate interest area for the line space.

Enable Character Segment: If checked, an interest area will be created for each letter/character of the text. This is useful for interest area segmentation, e.g., with some languages such as Chinese, or for letter-by-letter segmentation in English text. While this option previously applied only to the multiline text resource, version 2.3 of the software supports character-based segmentation in the single-line text resource as well.

Enable Interest Area Delimiter: Whether a special delimiter character should be used to mark the boundary between segments. If False, the space character will be used as the delimiter.

Delete Delimiter: If enabled, the delimiter character will be removed from the text without replacement. This option also toggles off the "Enable Interest Area Delimiter Replacement" option.

Delimiter Character: Specifies the delimiter character(s) used to separate segments. Version 2.0 of Experiment Builder allows one or more delimiter characters to be used. Simply type all of the delimiters characters into the editor box. (Note: any space or comma entered will be interpreted as one of the delimiter characters-enter only the desired delimiter character(s), and Experiment Builder will parse this into a list of characters separated by commas.)

Enable Interest Area Delimiter Replacement: Whether the delimiter character should be replaced by another character. The delimiter characters are used to separate string tokens and will not be displayed in the text or multiline text resource. Therefore, if using space as the delimiter character, the delimiter replacement option should be enabled, and space should be set as the replacement character. Please note that enabling this option will toggle off the "Delete Delimiter" option if it is enabled.

Delimiter Replacement Character: A list of characters that are used to replace the delimiter characters. Version 2.0 of Experiment Builder allows one or more delimiter characters to be used. This property should be set to either one character, to apply the same replacement character to all delimiter characters, or to the same number of characters as in the "Delimiter Character" list, for a 1-to-1 mapping between the Delimiter Characters and the Delimiter Replacement Characters.

Merge Spanning Interest Areas: Sometimes interest areas can span across multiple lines (e.g., when you are trying to create a phrase-, sentence-, or paragraph- based interest area segmentation). Enabling this option will merge interest areas across lines and create a single (freehand) interest area.

Exclude Interest Area Before First Instance of Delimiter Character, Exclude Interest Area After Last Instance of Delimiter Character: If the option is checked, no interest area will be created before the first, or after the last instance of the delimiter characters.

Treat Punctuation As Whitespace: If checked, punctuation marks such as , . ! - will be treated as if they were a space; segmentation options “Horizontal Whitespace Treatment” and “Vertical Whitespace Treatment” will be similarly applied to the punctuation characters. The list of applicable punctuation marks can be specified through the “Punctuation” option below.

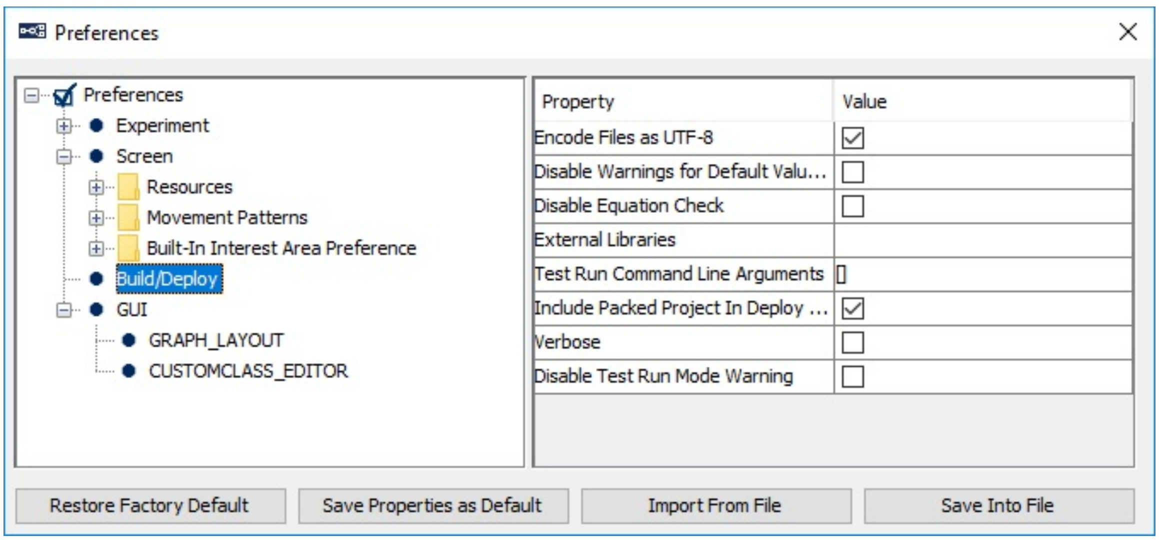
Punctuation: Specifies a list of applicable punctuation marks to be treated as whitespace if the "Treat Punctuation as Whitespace" option is enabled.

Segmentation Direction: Direction ("Left to Right, Top to Bottom", "Left to Right, Bottom to Top", "Right to Left, Top to Bottom", and "Right to Left, Bottom to Top") in which the text is segmented. Interest areas are numbered consecutively based on the order they are created. This option is only available if the Pixel Based option is enabled.

Merge Punctuation And Whitespace Interest Areas: If the "Horizontal Whitespace Treatment" option is set to "Create IA for Whitespace" and the "Treat Punctuation as Whitespace" option is enabled, this preference allows to create separate interest areas for the punctuation and neighboring whitespace, or to merge them.

17.3 Build/Deploy

This section lists preference settings related to the build and deploy processes.



Encode Files as UTF-8: If enabled, the generated experiment code and dataset files are written using UTF-8 encoded files (http://en.wikipedia.org/wiki/UTF-8). This must be enabled if the user is using any characters not included in the ASCII encoding range (1-127), i.e., any characters with diacritics (e.g., à, è, ù, ç), or from non-European languages, curved quotes, etc.

Disable Warnings for Default Value Use: If unchecked, this will raise a warning in the Output tab of the Graph Editor Window for some particular properties if the default value is used for the property (for instance, if the default value of 4000 msec is used for the Duration of a Timer trigger). If checked, these warnings are not displayed in the Output tab.

Disable Equation Check: A warning message will be given if the value and attribute of an equation are of different data types. Check this option to hide the type mismatch warning.

External Libraries: Put directory paths here if you will need to use other Python packages in custom class code.

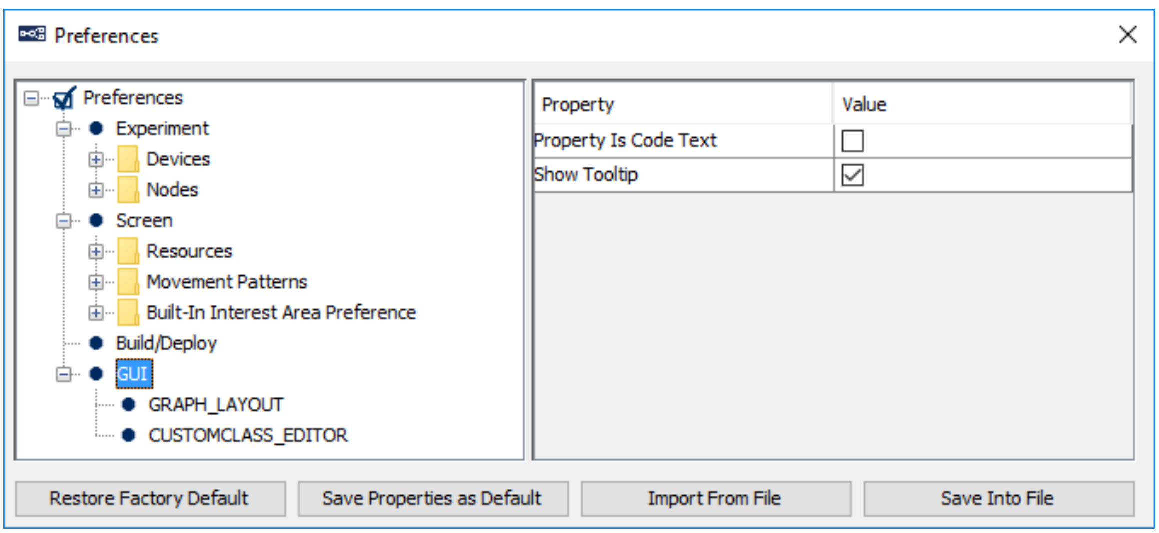
Test Run Command Line Arguments: If the deployed experiment runs from the command prompt, additional parameters can be passed to the program. The parameter can be retrieved as ".cmdargs" of the topmost experiment node. Users can add parameters to this field for test run purposes.

Include Packed Project in Deploy Directory: If checked, a copy of the packed experiment project will be included in the "source" folder of the deployed directory; otherwise, only the graph.ebd and preferences.properties files will be included for reconstructing the original project if necessary. (**Note:** Version 2.0 or later of the Experiment Builder software includes the packed project in the deploy directory by default.)

Verbose: If checked, a detailed printout will be shown in the EB output tab when deploying a project for debugging purposes.

Disable Test Run Mode Warning: If checked, the software will not display the "Warning! You are running your experiment in Test Run mode" message when test running an experiment.

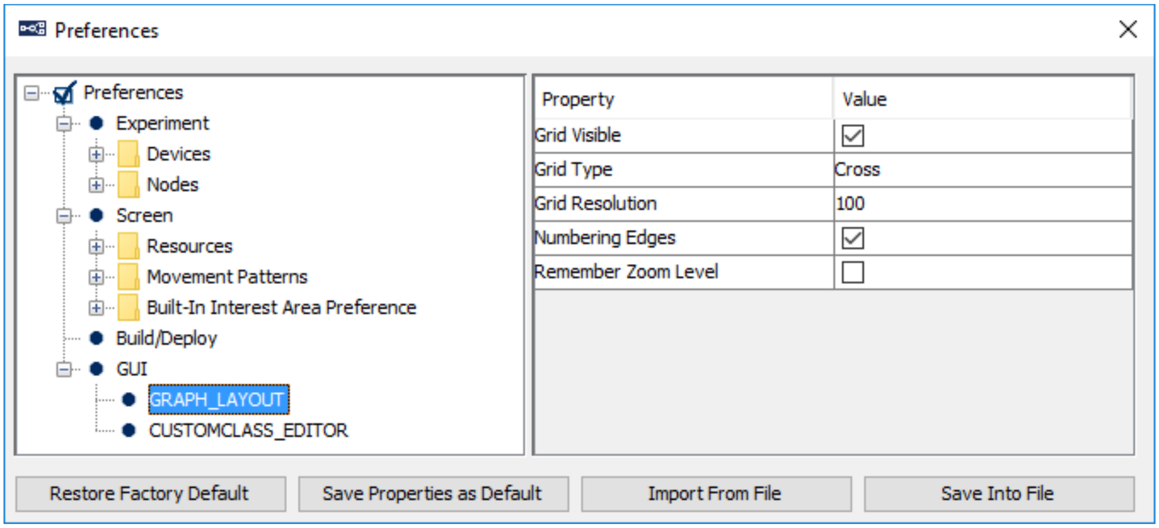
17.4 GUI



Property is Code Text: Sets the format of labels in the property table. If unchecked (the default setting), the label of the properties will be formatted and/or translated (for internationalization) to be understood easily. If enabled, an internal label will be displayed (for ease of references) and no internationalization or formatting will be done.

Show Tooltip: If enabled, a description text will appear beside the item on which the mouse cursor is placed.

17.4.1 Graph_Layout



Grid Visible: Whether the grids should be visible in the workspace outside of the Screen Builder.

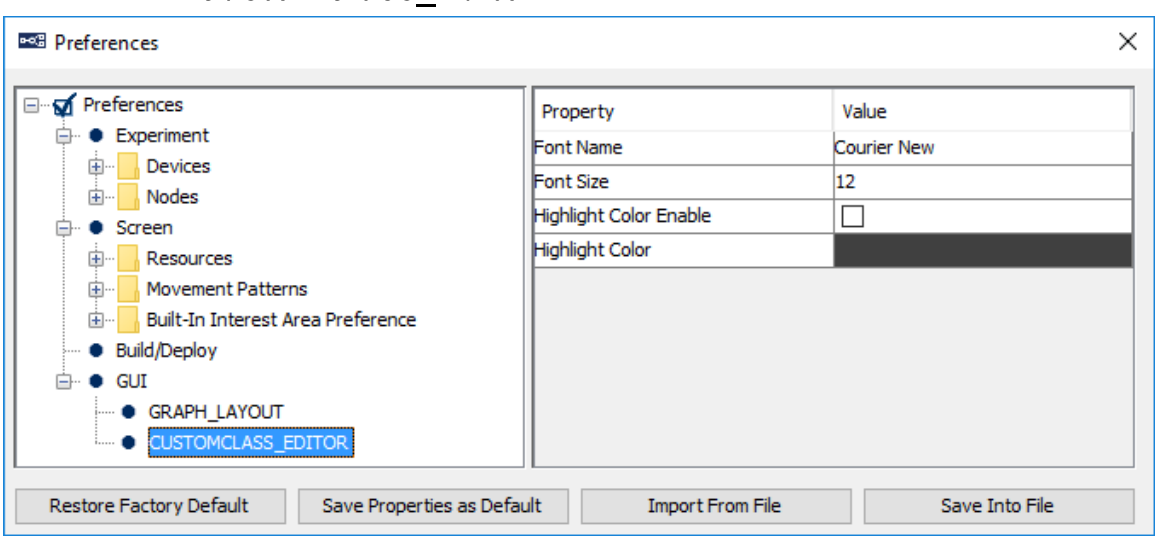
Grid Type: Determines whether the grid should be drawn as lines, crosses, or points.

Grid Resolution: Determines the distance between grid lines in pixels.

Numbering Edges: If checked, adds a number to each of the connections between a node and multiple triggers that connect from the node to indicate evaluation priority among the triggers.

Remember Zoom Level: If checked, the current zoom level will be saved and remembered when the project is re-opened later.

17.4.2 CustomClass_Editor



Font Name: Name of the font that the custom class editor uses to show custom class code.

Font Size: Size of the font that the custom class editor uses to show code.

Highlight Color Enable: If enabled, the current editing line will be highlighted.

Highlight Color: Color used to highlight the current editing line.

18 Revision History

Version 2.3.1

- This is a full release of Experiment Builder that runs on 32-bit and 64-bit Windows (7, 8, and 10) and macOS Sierra (version 10.12), High Sierra (version 10.13), Mojave (version 10.14), and Catalina (version 10.15).
- Added “Use Current Video Mode” option to the Display Device
- Allowed saving screen captures directly from Display Screen actions during experiment runtime
- Allowed reporting of multiple trigger regions for Invisible Boundary, Mouse, Fixation, Saccade, and Sample Velocity Triggers
- Added a reset threshold option to the Blink trigger if not using parsed blink event
- Added support for mouse- or gaze-contingency for Multiline Text Resource when not in the full-screen mode
- Added “Force Enable Link Data” option in the EyeLink device so that link samples and events from the eye tracker can be accessed in the custom class code
- Updated “ExperimentBuilder Examples”

Version 2.2.299

- Fixed video playing bug on Windows 7

Version 2.2.245

- Updated the License Manager and HASP driver
- Supported software-based license keys
- Added "Amp Selection" property to the Brain Products device

Version 2.2.1

- Provided various bug fixes and documentation updates for the 2.1 build
- Added support for USB2TTL8 USB Interface from Labhackers
- Added “EEG Integration Examples” in the “ExperimentBuilder Examples” folder
- Added support for Neuroscan (running on the Curry software) and Biosemi EEG systems
- Added support for the Biosemi USB trigger interface
- Added Generic Serial Port device

Version 2.2.0.507

- Added integration with Brain Products EEG using Remote Control Interface (RCS2.0)
- Added Brain Products Control action
- Added Brain Products device
- Added TriggerBox support from Brain Products
- Added Biometric TTL action
- Added EyeLink Host TTL device

Version 2.2.0.298

- Added Net Station device for integration with EGI's NA400 amplifier using Experiment Control Interface
- Added NTP device
- Added NTP time for the triggers and actions
- Added Net Station Control action
- Added Blink trigger

Version 2.1.512

- Provided various bug fixes and documentation updates for the 2.1 build
- Added "Enable Outer Boundary (Screen Bound)" and "Fire on Missing Data" properties to the INVISIBLE_BOUNDARY trigger
- Added three built-in variables: SESSION_NAME_, TRIAL_INDEX_, and TRIAL_RECYCLED_
- Added "Apply Correction" property to the DRIFT_CORRECT action
- Improved the Multiline Text Resource Editor for text/reference selection and formatting
- Added "Background Transparent" and "Background Color" properties to the Multiline Text Resource
- Improved HTML text support using Multiline Text resource
- Added "Convert Line Break (Return) to New Line Character" and "Line Break Replacement" properties to RESULTS_FILE
- Added "Key Press Used to Identify Keyboard(s)" option when multiple input support is enabled (through the "Experiment" preferences)
- Added "Disable Test Run Mode Warning" in the Build/Deploy preferences
- Added the "Use Cedrus Built-in Clock" and "Cedrus Time Ignore Threshold" options to the Cedrus Device
- Disabled the "warning:2003 The IO node is used in realtime Sequence RECORDING" warning for CEDRUS_INPUT, KEYBOARD, and MOUSE triggers
- Improved the Split AVI and video playback performance

Version 2.1.140

- Provided various bug fixes and documentation updates for the 2.1 build
- Supported automatic interest area segmentation for right-to-left texts
- Added "Apply Transparency" option to CAMERA_SETUP and DRIFT_CORRECT when animation targets are used

Version 2.1.1

- This is a full release of Experiment Builder that runs on 32-bit and 64-bit Windows (XP, Vista, 7, 8, and 10) and macOS (version 10.6 or later).
- Added Multiple Input Support for keyboard and mouse on Windows 10.
- Added support for playing .mov, and mp4 files directly.
- Added "Video Loader" option for video resources.
- Added support for EyeLink Portable Duo in the EyeLink Device

- Added 2000 Hz head-fixed tracking and 1000 Hz remote tracking for EyeLink 1000 Plus in the EyeLink Device
- Improvements to the Custom Class Editor
- Added Split AVI tool in the Mac build
- Added Set Restore Point and Restore option for project version control
- Added “Enable Custom Trial ID Message” option in the “Experiment” Preferences
- Added “Custom Trial ID Messages” to the EyeLink recording sequence.

Version 2.0.0.0

- This is a beta release of Experiment Builder that runs on 32-bit and 64-bit Windows (XP, Vista, 7, 8, and 10).
- Added OpenGL graphics for Windows 10 (configured through "Devices → DISPLAY → Video Environment")
- Added "Contingency deadband" and "Gaze-contingent Eye" options to all screen resources
- Added "Lock Aspect Ratio", "Use Fixed Pixel Area", and "Total Image Pixel" to the Image Resources. Added "Background colour", "Source Factor", "Destination Factor", "Use Color Key", "Color Key", and "Ignore Alpha" to the image resources when in the OpenGL mode.
- Added "Is Completed" and "Is Paused" options to the video resources
- Added "Supports html" and "Full Screen", and "Text Orientation" options to the Multiline Text Resource properties. Multiline text resources are no longer a full-screen resource.
- Added "Superscript", "Subscript", "Strikethrough", "Background colour", "Justify", "Vertical Alignment options", "Width", "Height", "Text Orientation", "Preview", "Show margins in the Editor" options to the Multiline Text Resource Editor
- Added "Multiple Resource Alignment" options when multiple screen resources are selected
- Added "Add Column", "Add Row", "Import Data", "Randomizer settings", "Find / Replacement" buttons to the Data Source editor. Added "Delimiter option" in the Import Data editor
- Added workspace to view/edit context of data cell in the screen editor.
- Added more blocking levels to the randomizer. Relaxed the maximum run-length restriction to 1.
- Added "Export node", "Import node" buttons and Data Source selector to the application toolbar.
- Supported more word segmentation options (Preferences → Screen → IA → Word Segment): Horizontal whitespace treatment, Vertical whitespace treatment, Enable character Segment, Merge Spanning Interest Areas, Exclude IA before first instance, Exclude IA after last instance, Treat punctuations as whitespace, Merge punctuations and white space, Support multiple delimiter character.
- Added "Loop" and "Iteration" properties to Custom Movement pattern
- Added automatic experiment message logging

- Added multiple instances of EB sessions on Mac
- Nodes are now sorted by experiment flow, instead of order of adding
- Supported pause/unpause video plyaback
- Allowed to pause current ASIO playback
- Allowed to stop ASIO sound if played through DISPLAY_SCREEN action
- Provided a standalone EB Asio configuration tool
- Supported automatically adding data source columns and variables to the EyeLink DV Variables property
- Provided project template for new project creation
- Enhancement to project unpacking
- Voicekey support on Mac OSX

Version 1.10.1939

- Adds a "Current" option in the EyeLink Device to support newer EyeLink eye trackers.
- Fixes the deploy error when running Experiment Builder on Windows 10.

Version 1.10.1630

- Adds support for playing animation target during calibration and drift correction on macOS.
- New variables and data source columns will now be automatically added to the "EyeLink DV Variable" list.

Version 1.10.1385

- Adds support for macOS Yosemite (version 10.10).

Version 1.10.1241

- Adds support for the Binocular Tower Mount, Binocular Remote, and "Current" option for EyeLink 1000 Plus eye tracker in the EyeLink devices.
- Supports loading dynamic interest area files in the library manager.

Version 1.10.968

- Adds support for EyeLink 1000 Plus eye tracker in the EyeLink devices.
- Supports the parallel port auto detection by setting the port address to 0.
- Bug fix in the video handler.
- Bug fix for exception in running projects using sinusoidal movement pattern.
- Bug fix for word segmentation involving Chinese text.
- Updates in camera image display and file transfer.

Version 1.10.165

- Bug fix for automatic interest area creation for multiline text resources.

- Bug fix for performing internal randomization with data sources attached to multiple sequences;
- Bug fix for ResponsePixx LED Control action;
- Bug fix for TTL_INPUT trigger not firing properly;
- Bug fix for improper reporting of composite resources in Data Viewer;
- Bug fix for file transfer issues (aborted file transfers, corrupted EDF files, or false alarms).

Version 1.10.1

- This is a full release of Experiment Builder that runs on 32-bit and 64-bit Windows (2000, XP, Vista, and 7). This is also a beta release of Experiment Builder that also supports running on macOS (Intel CPU, OS v10.6 or later). Experiment projects saved on the Windows operating systems can be opened with the same version or a newer version of the software on macOS and vice versa, with some exceptions on the transferability. Known limitations when designing/running the experiment on macOS with this release:
    - Voicekey is not supported.
    - Only Xvid video clips are supported through the video resources; animation video clips are not supported in Camera Setup and Drift Correction actions.
    - Sending or receiving TTL signals is only supported through USB-1208HS box.
    - Calibration control through external device is not supported.
- Adds support for ASIO driver for sound playing, sound recording, and voice key on 64-bit Windows 7.
- Adds support for USB-1208HS box through SET_TTL action and TTL_INPUT trigger.
- Adds "Ignore if Missing" option to the EyeLink Button Box device so that the project can still be run if button box is missing from EyeLink II and 1000. Also fixes EyeLink I button box issue.
- Adds a "Lock Project/Unlock Project" icon to the application toolbar and file menu.
- Adds support for using multiple parallel port devices and for reading the current data/status/control register values of the parallel port device.
- fix for automatic interest area creation for the multi-line text resource when delimiter characters are used.
- Bug fix for "Error: 2031: Equation parse error..." when running projects with non-ASCII characters in the multi-line text resource.
- Bug fix for collecting response from button 8 of Cedrus RB-830 and RB-834 response pads.

Version 1.6.121

- This release supports using multiple display keyboards and mice in the same experiment; responses on the different input devices can be handled differently.

- Supports the keyboard trigger to detect a release event.
- Adds options for different types of EyeLink button boxes (Microsoft SideWinder Plug & Play Gamepad as well as button boxes plugged to the parallel port).
- Adds RESPONSEPixx_LED_CONTROL action to allow set the LED lighting on a ResponsePixx button box.
- Allows to cancel the "Clean", "Build", "Test", and "Deploy" processes before they start.
- This release provides an I/O port driver for both 32-bit and 64-bit Windows. You will need to manually install the I/O driver if you are running Windows 2000.
- Cedrus Input trigger now works on 32-bit Windows XP, Vista, Windows 7, and 64-bit versions of Windows Vista and Windows 7.
- SplitAVI and Xvid codec runs fine with both 32-bit and 64-bit versions of Windows.
- Bug fix for the custom movement pattern when the first resource point doesn't start from time 0.
- Bug fix for the mouse movement range in screen resolutions higher than 1024 × 768.
- Bug fix for uncleared EyeLink Button trigger used in the non-recording sequence.
- Bug fix for gaze-contingent moving window manipulations with a variable size across trials.
- Bug fix for size error when the location of a triangle resource is modified by a reference.

Version 1.6.1

- This release runs fully on 32-bit versions of Windows 2000, XP, Vista, and Windows 7. Known limitations on 64-bit of Windows 7:
  - ~~TTL driver is not supported~~
  - ~~Cedrus Input Trigger is not supported~~
  - ~~ASIO audio driver is not supported.~~
  - ~~Cannot install xvid driver; Split AVI tool will not be able to convert the files to .xvd file format.~~
- Updated the "ASIO Sound Card Installation" section of this document. Existing users of the following sound cards should re-check the installation steps to select the "Audio Creation Mode" and enable "Bit-Matched Playback" option, even if you have already had the sound card working with the software.
  - Creative Labs Soundblaster X-Fi XtremeGamer
  - Creative Labs Soundblaster X-Fi XtremeMusic
  - Creative Labs Soundblaster X-Fi Titanium PCI Express

- Bug fix for resource drawing when the offset value is not (0,0).
- Added more options for line spacing in multiline text resource.
- Bug fix for displaying non-ASCII (Chinese, Hebrew, Thai, etc.) characters in English versions of Windows.
- Split AVI converter now supports multiple input files.

- Added "Clear Target At Exit" option for drift correction action.
- Touch screens are now supported (as a variant of the mouse trigger) in 32-bit Windows 2000, XP, Vista, and Windows 7.

Version 1.5.201

- For MEG/MRI applications, adds supports for camera setup, calibration/validation, drift correction through an external control device (e.g., a Cedrus Lumina fMRI Response Pad). These can be done through the Camera Setup action and Drift Correction action.
- Several improvements have been introduced to the calibration procedure thorough the Camera Setup action.
  - o For horizontal only (H3) calibration type, now users can specify the intended vertical position using the "Horizontal Target Y Position" option.
  - o Now support using a customized calibration background image.
  - o Users can now specify customized calibration/validation point list.
  - o Some calibration related EyeLink device settings are now moved to the Camera Setup screen.
  - o Bug fix for using non-English keyboards while in the calibration mode.
- Bug fix for the duration calculation of the fixation trigger and saccade trigger.
- The packed project now includes files contained in the "myfiles" folder of the project.

Version 1.5.58

- Bug fix for the default directory of the "ExperimentBuilder Examples".

Version 1.5.1

- This release runs on 32-bit versions of Windows 2000, XP, and Vista. Known issues with Windows Vista:
  - o Touch screens are not supported;
  - o Driver for the Cedrus button box needs to be installed twice before the device is fully functional;
- Bug fix for the "Prepare Next Display Screen Action" of the Display Screen action.

Version 1.4.624

- Bug fix for automatic interest area creation for multiline text resources.
- Bug fix for resetting the position of mouse cursor.

Version 1.4.562

- Touch screens are now supported (as a variant of the mouse trigger).
- More options ("Camera Mount", "Desktop Version" and "Mount Usage") are added to the EyeLink Device.

Version 1.4.402

- EyeLink Remote: EyeLink Device can now be set to use EyeLink Remote system
- Invisible Boundary Trigger Updated: Trigger now supports specification of a minimum duration that the eye needs to be in the boundary before the trigger will fire. Also added "EDF Start Time" and "Start Time" to the TriggeredData.
- Animation Target: Now supports calibration and drift correction with an animation target.