

EyeLink® Data Viewer

User's Manual

Document Version 3.2.1

Please report all functionality comments and bugs to:

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1 Introduction

The EyeLink® Data Viewer is a tool that allows users to display, filter, and create output reports from EDF data files recorded with EyeLink eye trackers (EyeLink I, EyeLink II, EyeLink 1000, EyeLink 1000 Plus, EyeLink Portable Duo, etc.). Data Viewer includes the following areas of functionality.

1.1 Data Visualization

Data Viewer supports three viewing modes: Spatial Overlay View, Temporal Graph View, and Animation Playback View. In the first two viewing modes, users can specify which event types to display, including fixations, saccades, blinks, messages, buttons, and inputs, and also to display sample traces. The Animation Playback View plays back the trial and shows where the participants look over time.

Spatial Overlay View allows gaze data to be viewed superimposed on the background image that the participant was looking at while the data was being recorded. This view is ideal for relatively static trial presentations, like reading or visual search paradigms. Fixations can be displayed as either circles or as a scan path. Saccades can be displayed as lines with an arrow specifying the saccade direction. Blinks can be displayed as a line joining the last valid sample position prior to the blink and the first valid sample following the blink. Message, input, and button events can be displayed as a small rectangle, where the position of the event is determined by the position of the nearest sample recorded at the message, input, or button event time.

The Temporal Graph View provides a two dimensional plot of trial data. The X axis represents time, while the Y axis represents the location of the samples or events being plotted. This view is suitable for a wide range of experimental paradigms, including those using dynamic trial displays. The scale of the graph can be changed via zoom in and zoom out operations. This view supports binocular display of sample position, pupil size, velocity, and acceleration traces.

In both Spatial Overlay View and Temporal Graph View, the color of individual events, as well as the global color of a given event type or sample trace, can be changed as desired. There are many preference settings that can be configured by users, saved, and then applied to future loaded data.

The Animation Playback View plays back the participant's gaze data, with a concurrent time code displaying the time from the start of trial recording. If the image or images that were shown during the trial recording are available, they can be loaded as the background for the Animation Playback View. A trackbar control displays the progress of the playback and lets users select a specific position to start playback. The speed of playback can also be adjusted.

Multiple viewing windows can be opened at one time, displaying data from different trials or displaying data of one single trial in the Spatial Overlay View, Temporal Graph View, and Animation Playback View concurrently.

Version 2.3 of EyeLink Data Viewer added support for the Aggregate Mode. This mode allows users to superimpose eye tracking data from multiple participants/trials on the same background image in the Spatial Overlay View, and to play back gaze positions from several trials/participants simultaneously over time in the Animation Playback View. Summary statistics (e.g., average recording duration, event counts, fixation duration, and saccade amplitude) can also be obtained for the entire aggregate trial group. For the ease of data comparison between participants or conditions, different drawing colors can be applied to the events of individual trials or participants.

1.2 Event Selection

EyeLink events can be selected from within either of the static data views (Temporal Graph View or Spatial Overlay View). Detailed properties of the selected event can be examined within an Inspector Window that also provides a list view of all visible events in the selected trial. Properties of a selected event that are editable by users (like the event's color) can be modified directly within the Inspector Window.

1.3 Interest Area Definition

The Spatial Overlay and Animation Playback Views allow the creation of any number of interest areas for the trials. Rectangular, elliptical, and freehand interest area shapes can be created. The position and shape of the Interest Area can be modified after Interest Area creation.

Users can view fixation-based statistics for a selected interest area, including the fixation count and total dwell time for the interest area, as well as the proportion of fixations and dwell time relative to the trial totals.

Interest area templates can be created and applied to multiple trials, speeding the process of defining interest areas for multiple trials / participants.

1.4 Event Filtering

Data Viewer supports data filtering, including deleting, merging, and drift correcting event types. Not all filtering functions are available to all event types. The original EyeLink EDF file is never modified by Data Viewer, so the original recorded data is always available.

Events can be hidden within a viewing session through the definition of some temporal filtering preferences or interest periods. Hiding events allows users to focus on a subset of a trial's data. Hidden events can be made visible again later if required.

Events can also be deleted from within Data Viewer. This is useful, for example, if the researcher inspects a specific fixation or saccade event and determines that the event detection performed by the EyeLink on-line parser did not satisfy their needs. If a fixation or saccade event is deleted, the surrounding saccade or fixation events are automatically merged to keep the event structure consistent.

The position of a fixation event can also be adjusted if required. This is only suggested if it is obvious to the user that improper system setup or calibration has resulted in a trial's fixation data containing significant drift that can be easily corrected manually. Any event that is adjusted in this fashion is flagged so that it is clear which events have been manually altered. Optionally, if the position of a fixation is adjusted, the adjoining saccade end point and start point are also adjusted so that the saccade positions are kept consistent with fixation positions.

1.5 Interest Periods and Reaction Time Definition

For each trial, users may selectively view and perform analysis on data within a specific period of time within a trial (Interest Period). Data Viewer allows users to create interest periods based on messages, input, and button events. The created interest periods are added to an interest period list. Users can navigate between different interest periods by selecting the desired interest period from the list. For each interest period, only those events falling within that period are shown in the Spatial Overlay, Temporal Graph Views, and in the event list of the Inspector Window. In addition, only events and data within the selected interest period (custom-defined interest period, or the default "Full Trial Period") are exported to the output file.

One important variant of the interest period is the reaction-time period. Reaction Time Definitions (RTD) can be created and applied to all trials loaded into an EyeLink Data Viewer session. Each RTD can have a set of trial condition variables that must be matched for the RTD to be applied to a given trial. The message event to use as the start time for the reaction time can be defined. Each RTD can have a fixation, saccade, input, button, or message event as the ending event for the reaction time calculation. Depending on the event type selected for the reaction time end event, a set of event properties can be specified to determine which event should be used within each trial. A number of RTDs can be created for a given Data Viewer session, allowing multiple reaction time conditions to be specified. Each trial will only be matched to at most one RTD.

1.6 Data Output and Analysis

Data Viewer can produce a range of output reports.

The Trial Output Report generates one row of data for each trial. A set of output variables can be selected, with each variable output as a column in the report. Variables include the count of each event type visible within the trial, the average fixation duration and saccadic amplitude, as well as the reaction time calculated for the trial based on the reaction time definitions created for the Data Viewer session.

The Fixation Output Report provides information about fixation events; each row of the report represents a fixation event. Fixation report variables include fixation start and end time, duration, average position, interest area identifier, etc. A set of relative variables is also available, including the previous and next fixations' position, angle, distance, and direction.

The Saccade Output Report generates one row for each saccade. Again, a set of output variables can be selected, with each variable output as a column in the report. Saccade output report variables include saccade start and end time, start and end position, amplitude, angle, direction, average and peak velocity, etc. A set of relative variables is also available, including the previous and next saccades' start and end position, etc.

The Interest Area Output Report generates one row for each interest area in every trial. Variables include the interest area identifier, label, fixation index list, number of fixations, summed dwell time, and proportions of fixations and dwell time in the interest area relative to the trial.

The Sample Output Report generates one row of data for each eye sample in a trial. Variables include the index of the sample, time of the sample, gaze position (x, y), velocity, acceleration, and pupil data of the current sample. If appropriate target position messages are read from the EDF file, the position, velocity, and acceleration data of (up to two) targets can also be provided.

The Message Output Report provides information concerning the messages written in each trial. Variables include the index, label, text, and time of the messages. The message report also provides the eye movement event data (fixation, saccade, blink) and sample position at the time when a message was recorded to the EDF file.

Data Viewer can also output group-level summary statistics. The Aggregate Event Statistics provide an event summary report for each trial group. Variables include blink, button, fixation, saccade, input, fixation run, and sample count averaged across trials, as well as the mean and median fixation duration and saccade amplitude for the entire trial group. The Aggregate Interest Area Report provides information about each interest area in each trial group. Variables include dwell time, fixation count, first fixation time/duration, and run count, as well as the percent of trials visited/revisited.

In addition, users can also save the Spatial Overlay and Temporal Graph views into image files, save the playback of the trial into a movie file, or create a "landscape" view (i.e., fixation or heat map) for a trial or for a group of trials with the same background

image.

1.7 Experiment Integration

Data Viewer can respond to specific commands that are written directly into the .EDF file by the experimental software, allowing very high levels of integration. These commands are interpreted by Data Viewer when the data file is loaded and can automate several areas of functionality.

By using a set of predefined viewer commands, the programmer of an experiment can inform Data Viewer regarding:

- a) The image(s) to load for each trial's Spatial Overlay View.
- b) The Interest Areas to load for each trial.
- c) The Reaction Time Definitions to apply to the Data Viewing session.
- d) The trial condition variables and values to use for each trial.
- e) The position of the target in a dynamic display.

If you use SR Research Experiment Builder software, please make sure you use the Experiment Builder Project Checklist to check the experiment project before data collection. Following the steps in the list will ensure optimal integration with Data Viewer. The checklist is contained in the Experiment Builder User Manual (or from this link <https://www.sr-support.com/forums/showthread.php?t=1012>).

1.8 Citing EyeLink Data Viewer

Please use the following to cite the Data Viewer software in your manuscript:
EyeLink Data Viewer 3.2.1 [Computer software]. (2018). Mississauga, Ontario, Canada: SR Research Ltd.

2 Installation

2.1 System Requirements

Operating System: Windows XP, Vista, 7, 8, or 10, Mac OS X (10.10-10.13), Linux (Ubuntu x86 and x64, 14.04 LTS or later)

Processor: Pentium 4 1.4 GHz or higher (avoid computers with atom CPU)

RAM: Minimum 1GB MB RAM (2GB or higher recommended)

Disk Space: 240 MB free disk space for application plus space required for EyeLink data files and saved viewing sessions.

Graphics Card: video card with OpenGL 2.0 support and with at least 128 MB RAM; a recent video card with OpenGL3.0 support is required for dynamic heat map presentation.

Monitor Resolution: 1024x768 or better resolution

Other: Free USB port required

2.2 Installation on Windows

The latest version of the Data Viewer installer can be downloaded from <https://www.srsupport.com/showthread.php?4434>. If you have a previous version of EyeLink Data Viewer installed on the computer, please choose the “Clean Install” option when running the DV installer or uninstall it through Windows© Control Panel before installing the newer version. By default, the EyeLink Data Viewer software will be installed at " {Windows Drive} :\Program Files (x86)\SR Research\DataViewer".

Important: A USB license key provided by SR Research is required to run this application and must remain connected to the PC while the application is running. If a USB license key is not detected by the program, the application will run in a DEMO mode supporting limited data loading.

2.2.1 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 EyeLink Data Viewer software. Double click on the EyeLinkDV_3.*.exe installer, keeping the default settings.
2. Install the standalone HASP key driver (if this is the first time that the USB license key has been used on the display PC). You may install the driver by clicking "Start -> All Programs -> SR Research -> Install Hasp Driver" from your computer desktop, or by double clicking on "hdd32.exe" in "C:\Program Files (x86)\SR Research\Common" folder.
3. Insert the license key into the display computer. Click on the License Manager utility (Start -> All Programs -> SR Research -> License Manager) to check for the licensing status for the Data Viewer software.
4. From the computer desktop, click "Start -> All Programs -> SR Research -> EyeLink -> DataViewer -> DataViewer" to run the application.

2.2.2 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 EyeLink Data Viewer at the same time) for the Data Viewer software.

1. Install the Data Viewer software. Double click on the EyeLinkDV_3.*.exe installer, keeping the default settings on InstallShield Wizard screens except for the following two:
 - On the "Setup Type" dialog box, select "Custom".
 - On the "Select Feature" screen, make sure that both "HASP4" and "HASPHL" driver options are selected.
2. Install the network HASP key driver. You may install the driver by clicking "Start -> All Programs -> SR Research -> HASP HL Driver" from your computer desktop or double clicking on "HaspUserSetup.exe" in "C:\Program Files (x86)\SR Research\Common" folder.
3. Install network HASP License Manager. You may install the tool by clicking "Start -> All Programs -> SR Research -> Networked HASP License Manager" from your computer desktop or double clicking on "lmsetup.exe" in "C:\Program Files (x86)\SR Research\Common" folder. Failing to install this will report a "NO HASP Key Found" error in the SR License Manager dialog box.
 - When installing the license manager, set the "Installation Type" to Service (nhsrvce.exe).
 - On the "HASP License Manager" dialog box, check either Yes or No to continue.
4. If this is the server computer, you may install optional Aladdin Monitor software by clicking "Start -> All Programs -> SR Research-> Aladdin Monitor" from your computer desktop or double clicking on "Aksmon32.exe" in "C:\Program Files\SR Research\Common" folder.
5. Test license status.
 - Please make sure that the server and client computers are running and visible to each other in the same network group (check this out from "My Network

Places -> View Network computers"). Contact your system administrator if the computers cannot see each other in the same network group.

- Please make sure that the network license key is plugged into the server computer (remove all other HASP license keys) and drivers are already installed.
- Now, click "Start -> All Programs -> SR Research -> License Manager" to check the licensing status of each of the client computers in the network.

2.3 Installation on Mac OS X

The latest version of the Data Viewer installer can be downloaded from <https://www.srsupport.com/forums/showthread.php?t=4434>. If you have a previous version of EyeLink Data Viewer installed on the computer, please uninstall it first by removing the "/Applications/EyeLink Data Viewer" folder to Trash. Now double click on the EyeLinkDV_3.*.dmg installer. Select the "EyeLink DataViewer 3.*" folder in the package, and drag and drop it into the "Applications" folder. The software is now installed at "/Applications/EyeLink Data Viewer 3.*". Click on "DataViewer.app" to run the software.

To run Data Viewer in a fully licensed mode, users need to purchase a license key for the software and have the key attached to the computer on which the Data Viewer 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 key. The driver installer can be found in the folder after unpacking the DataViewer installer program. Double click on the "Sentinel_HASP_RTE_Installer.dmg" file and then run the "Install HASP SRM Runtime Environment" application with default settings. The license key will glow if the driver installation is successful.

2.4 Installation on Linux (Ubuntu x86 and x64)

For installation on Ubuntu x86 and x64, please use the PDF document that can be found at the Data Viewer download page - <https://www.srsupport.com/attachment.php?attachmentid=4171>. If you have not yet done so, please follow the instructions to first set up our software repository at its new URL address, and then Section 1.5 of that PDF document related to installing Data Viewer and its dependency packages.

3 Working with Files

Data Viewer can import EyeLink EDF files. The software loads each data file into a Data Viewing Session (DVS). A DVS can consist of many EyeLink data files. Only one DVS can be open within Data Viewer at a time (although in Windows multiple copies of Data Viewer can be run simultaneously).

Once a DVS has been created and EyeLink data files have been imported into it, the DVS file can be saved and then reloaded at a later date for future analysis. It is *much* quicker to open a saved DVS than to reimport the original EDF files.

All changes made during a viewing session only affect the DVS data; the original EDF files are never altered.

3.1 Creating a Data Viewing Session (DVS)

From the menu, choose:

File → New

Tip: A new viewing session can also be created by clicking the Create New Data Viewing Session tool  on the standard toolbar, or press Ctrl N on Windows or ⌘ N on Mac OS X.

Tip: To find out the meaning of a tool on the standard toolbar, simply hover the mouse over the tool.

3.2 Saving a Viewing Session

From the menus, choose:

File → Save

Tip: The viewing session can also be saved by clicking the Save Data Viewing Session tool  on the standard toolbar, or press Ctrl S on Windows or ⌘ S on Mac OS X.

When a new viewing session is saved, Data Viewer will create a {session name}.evs file as well as a {session name}.res folder - both of these are contained within a folder that has the viewing session name and both of them are required for a proper re-opening of the viewing session later on.

Note: For Experiment Builder projects, it is sensible to save the viewing session in the “results” or “myfiles” subfolder of the deployed project so that everything stays together.

3.3 Opening an Existing Viewing Session

To open an existing viewing session

- 1) From the menus, choose:
File → Open ...
- 2) In the Open dialog box, browse to the location of the file and select it.
- 3) Click Open

Tip: A saved viewing session can also be opened by clicking the **Open Existing Data Viewing Session** tool  on the standard toolbar, or press **Ctrl + O** on Windows or **⌘ + O** on Mac OS X. The viewing session can also be opened by double clicking on the **{session name}.evs** file. Please make sure that the **{session}.res** folder is available; otherwise the viewing session cannot be properly opened.

Note: Viewing sessions saved with an earlier version of Data Viewer can be opened with later versions of the software. However, earlier versions of Data Viewer will not be able to open a viewing session saved by later versions of the software.

Note: If a viewing session cannot be opened with a “Cannot open the active session” error, please check whether the current viewing session is already open. This error can also arise because of an unhandled .lock file from a crashed viewing session – removing this file will fix the issue.

3.4 Saving an Existing Viewing Session to a Different File

To save a viewing session to a file

- 1) From the menus, choose:
File → Save As...
- 2) In the Save As dialog box, browse to the directory in which you want to save the document.
- 3) In the File Name text box, type in the name for the document.
- 4) Click OK.

Tip: The viewing session can also be saved by clicking the **Save Data Viewing Session As ...** tool  on the standard toolbar.

3.5 Importing EyeLink Data Files

EyeLink EDF files can be imported into an already opened Viewing session or, if no Viewing session is open, a new one will be created for you when the data files are imported.

To import a single .EDF file,

- 1) From the menus, choose:
File → Import Data ... → EyeLink Data File ...
- 2) In the Open dialog box, browse to the location of the EDF file that you want to import and select it.
- 3) Click Load.

Tip: EyeLink data can also be imported by clicking the Import EyeLink Data File button  on the standard toolbar,

Multiple EDF files can be imported through “File → Import Data ... → Multiple EyeLink Data Files ...”, or Press Ctrl I on Windows or ⌘ I on Mac OS X. This can also be done by clicking on the  icon in the application toolbar. In the “Import EyeLink Data File” dialog box, browse to the intended “Location”. A list of EDF files will be displayed. If the "Include Sub-directories" option is checked (default option), the target directory and its subdirectories are searched; otherwise, only the location selected will be searched. Select the intended files and then click “Import”.

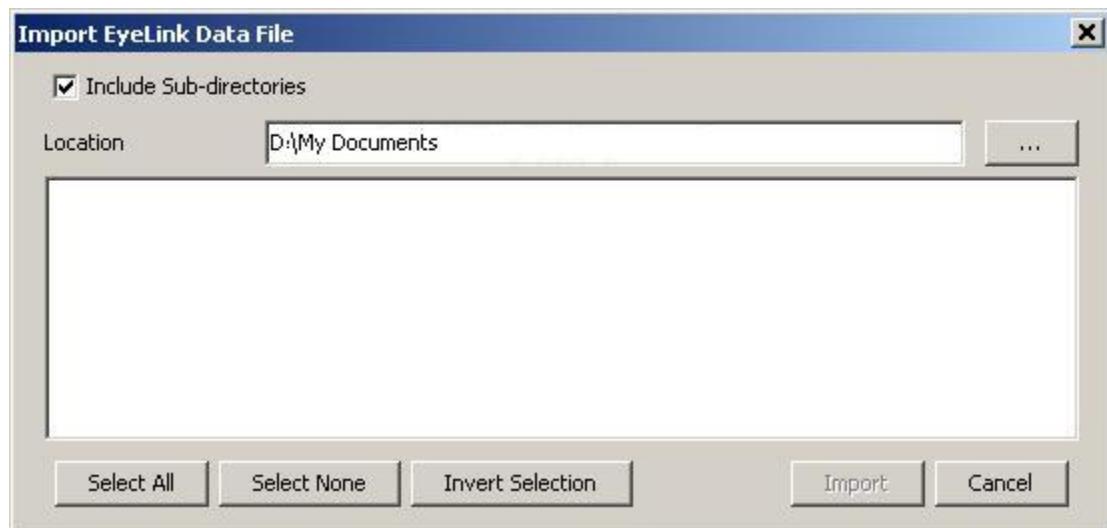


Figure 3-1. Import Multiple EDF Files

Some earlier versions of the software didn't load samples by default for performance considerations. To make sample data available to a viewing session, you will need to first change the data loading preferences and then reload the EDF file.

1. Before loading any EDF files, please close the current viewing session and click "File -> New" to create a new session.
2. Click the "Preferences" tab in the Inspector Window and go to "Data Loading" preferences. Check the "Load Samples" option. If you want this change to be persistent over future viewing sessions, you may consider saving this as a default

- setting. This can be done by selecting any preference tree node, clicking the right mouse button and selecting "Save Properties as Defaults".
3. Now start loading in the EDF files.

Note: To load data files using the SceneLink gaze mapping, please make sure to enable the "Enable SceneLink Gaze Mapping" and "Generate SceneLink Frame Messages" in the "Data Loading" preferences settings before you import the data files. Make sure that you have already created the lookup tables for the trials in SceneLink.

Note: The time it takes to load the data files will depend on their size and particularly on whether or not you are loading samples from the data file. Data Viewer will take a few minutes to initially parse a 60-minute binocular 500 Hz recording if loading all events and samples. Once you have saved the viewing session, reloading the session takes a fraction of the time because the data is in a format optimized for the Data Viewer.

3.6 Packaging a Viewing Session

For the ease of transferring a data viewing session from one computer to another, or from one folder to another, users can create a single packaged file of the current data viewing session by clicking "File -> Package ..." from the application File menu. This will zip up the current viewing session and save the packaged file at a location selected by the user. The packaged viewing session, still preserving the necessary image and interest area integration, can be unpacked by double clicking on the file on a computer with version 2.2.1 or later of Data Viewer installed. **Important! The package file only contains necessary files for reconstructing the data viewing session at another location or computer; it is not a complete backup of the original experiment data and does not contain the original .EDF files. Users are strongly recommended to make a backup copy of the original experiment data.**

Tip: The Data Viewing session can also be packaged up by clicking the "Package Existing Data Viewing Session" button () on the application tool bar or pressing F5 on Windows.

3.7 Unpacking a Packaged Viewing Session

A packaged viewing session can be unpacked by double clicking on the .dvz file on a computer with a recent version of Data Viewer installed, or by clicking "File -> Unpack ..." from the application File menu. In the following dialog box, users can specify the source file to be unpacked and the directory where the session should be unpacked.

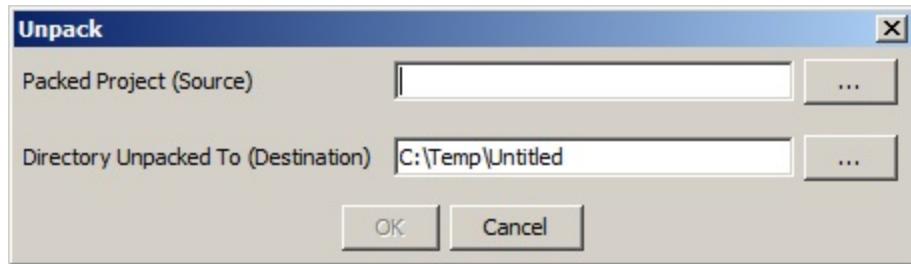


Figure 3-2. Unpack a Packaged Viewing Session

Tip: The Unpack Viewing Session dialog box can be started by clicking the "Unpack Data Viewing Session" button (ZIP icon) on the application tool bar or pressing F3 on Windows.

3.8 *Merging Viewing Sessions*

Data Viewer allows users to import EyeLink data from multiple participants so that the analysis and report output can be performed within a single session. If users have already saved individual viewing sessions for each of the EDF files, Data Viewer provides an option to merge the individual viewing sessions into the current active session. Click “File -> Merge Viewing Session ...” from the application file menu bar, browse to the folder where the individual .evs file is located, select the file, and click Open in the dialog box. Upon merging, all of the data adjustments (e.g., fixation cleaning, moving, merging) and interest area and image/video integration in the viewing session that is being merged will be preserved. However, its session preferences, selection of report variables, and interest period configuration will be dropped – the settings from the currently active viewing session will be used instead. Please also note that settings from the old viewing sessions can be exported and imported into the current active session if desired.

4 Data Viewer Windows

Data Viewer uses a desktop framework that contains all windows of the Viewer application. Once a Data Viewing Session (DVS) is opened and EyeLink data is loaded, two windows will appear: the Inspector Window on the left and the Trial View Window on the right. The Inspector Window allows users to choose data to be viewed, to review statistical summaries, and to configure default application settings. The Trial View Window allows a graphic examination of the data for the selected trial. Both windows can be minimized and maximized within the Application desktop when running Data Viewer on Microsoft Windows whereas the Inspector Window is built into the main Application desktop and cannot be maximized/minimized on Mac OS X. The figure below shows the viewer desktop after loading one example file.

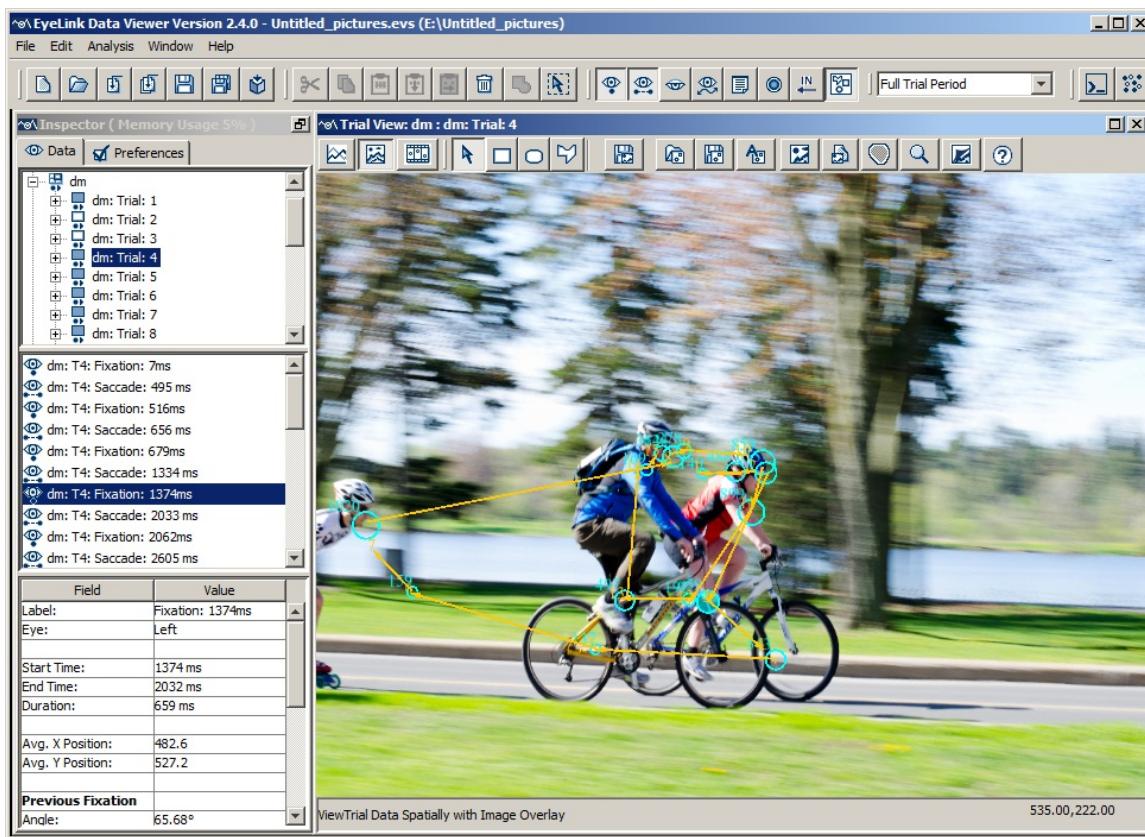


Figure 4-1. Viewer Display after Loading an Example Recording File

4.1 Inspector Window

The Inspector Window consists of 2 tabs, the Data Tab and the Preferences Tab (see Figure 4-2).

4.1.1 Data Tab

The Data Tab consists of 3 panels (Figure 4-2, left Panel). The top panel provides a tree view of the viewing session. The first level of the tree view contains trial-grouping nodes (⊕). EyeLink Data Viewer lists trials within a viewing session either by data file or by experimental conditions. When expanded, each trial-grouping node has a set of tree leaves representing the trials (⊖) that are contained within that node. Users may navigate through the tree view by clicking on nodes with the mouse or by using the up and down arrow keys on the keyboard. To open a closed trial group node, double-click on the node or press the right arrow key. To close an opened trial group, double-click on the trial group node or press the left arrow key.

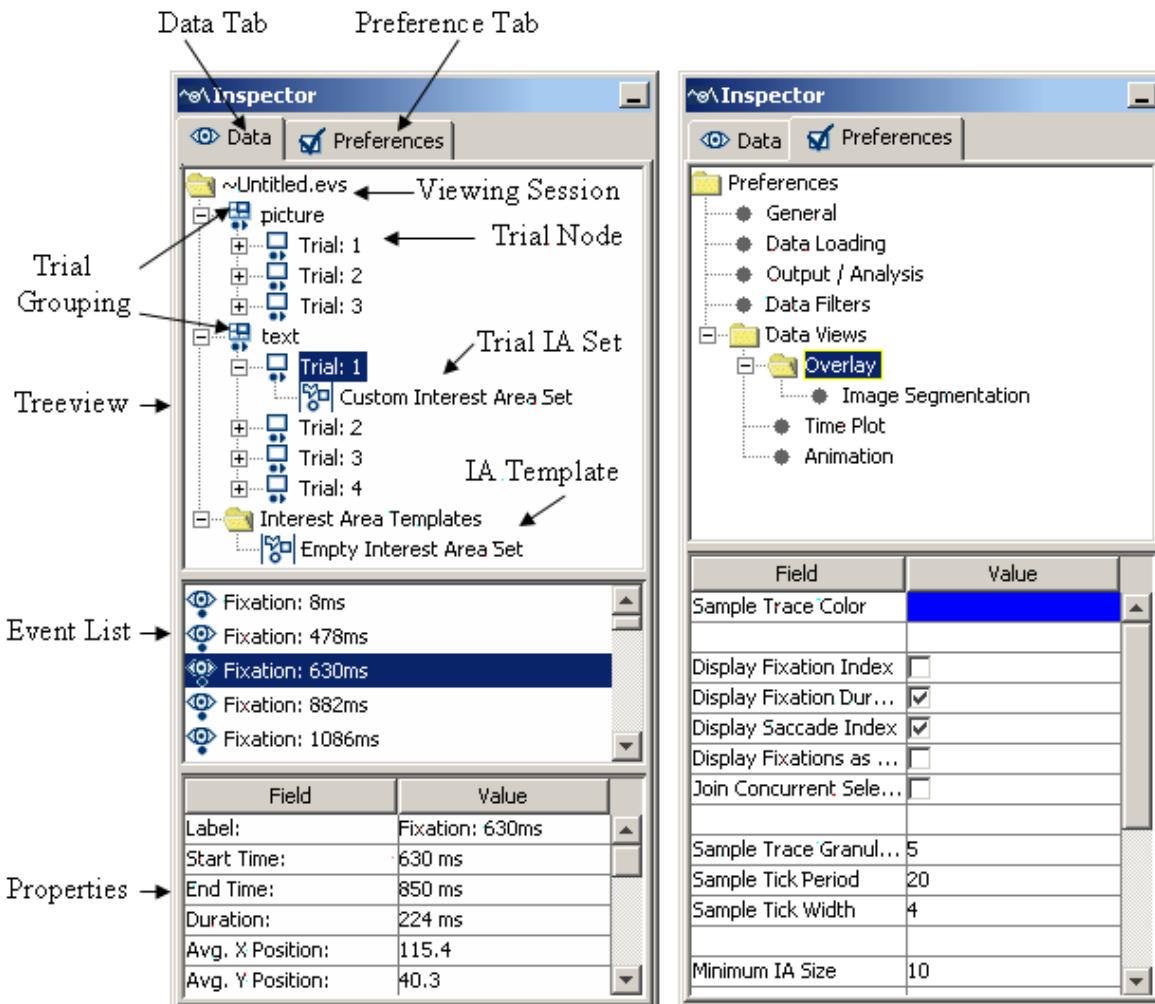


Figure 4-2. Components of the Inspector Window (Left: Data Tab; Right: Preference Tab)

The middle panel represents a list of components within the selected node of the analysis session tree. If a trial is selected in the session tree, a list of visible events is displayed. If an Interest Area Set is selected, a list of interest areas that make up the set is displayed.

The bottom panel is a table representing the properties of the selected tree node or selected list component. For example, if a fixation is selected, all properties of the fixation are listed in the properties table. Some properties, like color, can be edited by clicking on the property value with the mouse.

4.1.1.1 Data Tree Hierarchy

When a data file is loaded, the tree view panel lists the possible analysis levels in a hierarchical order. Users can view information on the trial groups and individual trials. Within each trial, statistics on all events (fixations, saccades, blinks, button presses, and messages) and interest areas can also be retrieved.

4.1.1.2 Trial Groups

By clicking on a trial-grouping node ()¹, information on this trial group can be viewed in the bottom panel of the Inspector Window. This information includes the label of the group, the number of trials within the group, and the interest area set for trials within the group, allowing users to easily configure interest areas across trials. By default, trials in a viewing session are grouped by EyeLink Data File, but this can be easily changed by clicking “Edit -> Trial Grouping”. See section 6.1.3 for more information on defining trial groupings.

Version 2.3 of EyeLink Data Viewer introduced Aggregate Mode ()², which allows users to visualize eye-tracking data from multiple participants and/or trials, and provides summary statistics (e.g., average recording duration, event counts, fixation duration, saccade amplitude) for the entire trial group. A warning dialog box will be displayed when the Aggregate Mode button is clicked for the first time in the viewing session. Please note that data visualization in the Aggregate Mode requires trial data to be loaded into memory. For performance consideration, Data Viewer will only load trials from the current trial group into memory; if you are analyzing a large dataset not all trials may be loaded into memory. You can determine the number of loaded trials in the current trial group by clicking on the group node and checking the "Loaded Trial Count" property in the Inspector Window. The icon in the tree view next to each trial indicates whether the trial is loaded into memory—filled icons () indicate a loaded trial, whereas open icons () indicate an unloaded trial.

The following table lists the group properties if trials are grouped by data file. Fields that are editable in the viewer are marked with an asterisk. Please note that if not all the trials in the group load because of the memory limit, the summary statistics displayed in the property table will be based on the loaded trials the complete statistics based on the entire trial group can be obtained from the Aggregate Event Statistics report.

Field	Contents
Label *	Label of the trial group.
File	File name of the recording, including path information. This property is only visible when the default trial grouping (by recording data) is used.
EyeLink Version	Tracker version of the EyeLink system. This property is only visible when the default trial grouping (by recording data) is used.
Recorded By	Name of the application running on the display side that produced the current EDF file. This property is only visible when the default trial grouping (by recording data) is used.
Number Trials	Total number of trials in the trial group.
Loaded Trial Count	Total number of trials loaded into memory for aggregated data analysis (if all trials are loaded, this should be equal to the total number of trials in the trial group).
Loaded Trial Indices	A list containing the indices of all the trials in the trial group that are loaded into memory for aggregated data analysis.
Default Interest Area Set *	Shows the default interest area set (chosen from the interest area templates) used for this group of trials. If none, then displays "Empty Interest Area Set".
Display Width, Display Height	Horizontal and vertical resolution of the eye tracker recording (in screen pixels).
Display Left, Display Top	X and Y coordinate (in screen pixels) for the top-left corner of the recording.
Exclude from Reports *	If checked, the entire data file (if default trial grouping is used) or grouping node (if trial grouping is applied) will be excluded from the reports.
Apply Coloring to Visible Events *	Data Viewer provides default drawing colors for events in the Trial View Window for all trials/participants. Users can change the color of the currently visible (visibility toggled on) events through this property so that a distinct color can be applied to all events in a trial, or in all trials of a trial group. Please make sure the "Apply Coloring to Events" box is checked before choosing the intended color.
Color *	If the "Apply Coloring to Events" box is checked, users can customize the colors of currently visible (i.e., events with

	visibility toggled on) events in the Trial View Window so that the selected color can be applied to all events in a trial or in all trials of a trial group (or participant).
Average Recording Duration	Average duration (in milliseconds) of trial recording (between the START event and the END event) across all trials in the trial group. This property will only be visible when the Aggregate Mode is turned on.
Average Number of Samples	Average number of samples in a trial, calculated as the total number of samples in the trial group divided by the number of trials in the group. This property will only be visible when the Aggregate Mode is turned on.
Average Number of Fixations	Average number of fixations in a trial, calculated as the total number of fixations in the trial group divided by the number of trials in the group. This property will only be visible when the Aggregate Mode is turned on.
Average Number of Saccades	Average number of saccades in a trial, calculated as the total number of saccades in the trial group divided by the number of trials in the group. This property will only be visible when the Aggregate Mode is turned on.
Average Number of Blinks	Average number of blinks in a trial, calculated as the total number of blinks in the trial group divided by the number of trials in the group. This property will only be visible when the Aggregate Mode is turned on.
Average Number of Buttons	Average number of button presses in a trial, calculated as the total number of button presses in the trial group divided by the number of trials in the group. This property will only be visible when the Aggregate Mode is turned on.
Average Number of Messages	Average number of messages in a trial, calculated as the total number of messages in the trial group divided by the number of trials in the group. This property will only be visible when the Aggregate Mode is turned on.
Average Number of Inputs	Average number of input events that occur during the trial, calculated as the total number of input events in the trial group divided by the number of trials in the group. This property will only be visible when the Aggregate Mode is turned on.
Average Number of IAs	Average number of interest areas, calculated as the total number of interest areas across all trials in the trial group divided by the number of trials. This property will only be visible when the Aggregate Mode is turned on.
Average Number of Run Counts	Average number of fixation runs (two consecutive fixations in the same interest area belong to the same run) of in a trial. In

	the Aggregate Mode, this is calculated as the average run count across all trials in the trial group. This property will only be visible when the Aggregate Mode is turned on.
Average Number of IAs Visited	Average number of unique interest areas visited in the trial (calculated as the average count across all trials in the group). This property will only be visible when the Aggregate Mode is turned on.
Average Fixation Duration	Average duration (in milliseconds) of all fixations in the trial group. This is calculated by summing up the duration of all fixations in the trial group divided by the total number of fixations in the group. This property will only be visible when the Aggregate Mode is turned on.
Average Pupil Size	Average pupil size (in arbitrary units) across all non-blink samples in the trial group. This property will only be visible when the Aggregate Mode is turned on.
Average Saccade Amplitude	Average size (in degrees of visual angle) of all saccades in the trial group. This is calculated by summing up the amplitude of all saccades in the trial group divided by the total number of saccades in the group. This property will only be visible when the Aggregate Mode is turned on.

4.1.1.2.1 Deleting a Group of Trials

To remove a group of trials from the analysis, select the grouping node, click the right mouse button and select the “Remove from Viewing Session” menu item. If trials contained within a grouping node are deleted from the session, they will be permanently removed from the tree view (the EDF file will have to be reloaded before information on that file can be accessed again as there is no undo option in Data Viewer).

4.1.1.2.2 Color Coding Different Participants

Version 2.3 of Data Viewer allows users to apply different colors to code the data from different participants. After importing the EDF file, go to the property table of the trial-grouping node (). First toggle on the "Apply Coloring to Visible Events" box and then choose a customized color. The selected color will be applied to all events contained within the current selection (group, subject, or trial) that have the visibility toggled on.

4.1.1.3 Trial

Data Viewer parses trials using the settings in the “Data Loading” preferences. By default, the start of a Data Viewer trial will be based on the message (“TRIALID”)

defined in the "Trial Load Start Value" preference (in "Data Loading" preferences). If that message is missing, the start of the trial will be the recording start time (i.e., the "START" line in the EDF file which marks the beginning of a block of recorded samples/events). Similarly, the end of a trial will be based on the "Trial Load End Value" setting – the default message is "TRIAL_RESULT". If that message is missing or not supplied, the end of the trial will be the recording end (i.e., the END line, which marks the end of a block of data) or the next start message, whichever comes first. If a user did a long continuous recording, shorter trial segments can be created based on the pair of splitting messages mentioned above. Trial splitting can also be done using a pair of INPUT values—see the options in the Data Loading Preferences.

For performance optimization, Data Viewer dynamically manages its use of computer memory by loading and unloading trials in a viewing session. Filled icons (■) indicate a loaded trial whereas open icons (□) indicate an unloaded trial. Information on participants' performance in individual trials can be retrieved by clicking on the trial node of the tree view—the trial will be loaded upon the click if previously unloaded. Once a trial is selected for analysis, the middle panel of the Data Tab lists all of the visible events in the trial and the bottom panel provides a general summary of performance in that trial. The following table lists the trial-level analysis variables. Those fields that are editable in the viewer are marked with an asterisk.

Field	Contents
Label *	Label of the trial.
Index	Trial sequence.
Recording File	File name of the recording.
Recording Start Time	Timestamp when the trial recording started (in milliseconds since EyeLink tracker was activated).
Recording End Time	Timestamp when the trial recording ended (in milliseconds since EyeLink tracker was activated).
Recording Duration	Duration (in milliseconds) of the trial recording.
Sampling Rate	250, 500, 1000, or 2000 Hz, depending on the version of the eye tracker and setting used during data collection.
Interest Period Label	Label of the currently selected interest period.
Interest Period Start	Start time of interest period (in milliseconds relative to the trial recording start time).
Interest Period End	End time of interest period (in milliseconds relative to the trial recording start time).
Interest Period Start Matched	Whether an event that matches the start of the selected interest period has been found in the current trial.
Interest Period End Matched	Whether an event that matches the end of the selected interest period has been found in the current trial.
Reaction Time	Configurable response time determined by the Reaction Time

	Definition associated with the trial. Uses the value of Recording Duration if no Reaction Time is defined.
RT Event Index	Index of event that triggered the end of the reaction time; -1 when NO_MATCH. The index is relative to a specific event type; for example an index of 5 for a Saccadic RT means the 5 th saccade in the trial.
RT Event Type	The way in which the trial reaction time is ended, possible values are TIMEOUT, BUTTON, INPUT, FIXATION, SACCADE, MESSAGE, or NO_MATCH.
RT Definition Label	Label of the reaction time definition (see section 6.3.1 Managing Reaction Time Definitions). “.” if undefined; “CUSTOM” if the RT definition is a custom one (see Section 7.4 Reaction Time Definitions).
Apply Coloring to Visible Events *	Data Viewer provides default drawing colors for events in the Trial View Window for all trials/participants. Users can change the color of the currently visible (visibility toggled on) events through this property so that a distinct color can be applied to all events in a trial or in all trials of a trial group (or participant). Please make sure the "Apply Coloring to Events" box is checked before choosing the intended color.
Color *	If the "Apply Coloring to Events" box is checked, users can customize the colors of currently-visible (visibility toggled on) events in the Trial View Window so that the selected color can be applied to all events in a trial or in all trials of a trial group (or participant).
Number Samples	Total number of samples in the trial recording.
Number Fixations	Total number of fixations in the trial recording.
Number Saccades	Total number of saccades in the trial recording.
Number Blinks	Total number of blinks in the trial recording.
Number Button Presses	Total number of button presses in the trial recording.
Number Messages	Total number of messages in the trial recording.
Number Input Events	Number of input events that occur during that trial.
Average Fixation duration	Average duration (in milliseconds) of all fixations in the trial.
Average Saccadic Amplitude	Average size (in degrees of visual angle) of the saccades in the trial.
Events Reparsed	Whether eye events are reparsed based on the raw samples. If false, events reported in the viewing session are based on the ones recorded in the EDF files (which were originally generated by the EyeLink host software during data collection).
Exclude from Reports *	When checked, the trials involved will NOT be included in

	any output reports.
Interest Area Set *	Setting of the interest areas (“Custom Interest Area Set” or “Empty Interest Area Set”). If interest areas have been defined, they can be removed by selecting “Empty Interest Area Set”.
Number of IAs	Total number of unique interest areas in the trial. This variable is only visible if the trial contains interest areas.
Run Count	Total number of fixation runs in the trial (two consecutive fixations in the same interest area belong to the same run). This variable is only visible if the trial contains interest areas.
Visited IAs	Total number of unique interest areas visited in the trial. This variable is only visible if the trial contains interest areas.
X Resolution, Y Resolution	X/Y gaze resolution of the trial (in screen pixels per degree of visual angle).
Recorded Display Width	Horizontal resolution of the eye tracker recording (in screen pixels).
Recorded Display Height	Vertical resolution of the eye tracker recording (in screen pixels).
Recorded Display Left	The X coordinate (in screen pixels) for the top-left corner of the recording.
Recorded Display Top	The Y coordinate (in screen pixels) for the top-left corner of the recording.
Mode	Eye-tracking mode (Pupil-only vs. Pupil with CR) used in the trial recording.
Pupil Data Type	Type of pupil size data (AREA or DIAMETER) recorded in the trial.
Eyes	Left, Right, or Binocular.
Event Parse Type	Reports whether eye events (fixations and saccades) were recorded in GAZE or HREF coordinates.
EyeLink Version	Reports which EyeLink eye tracker and which version of the host software was used to do the data collection for the current recording trial.
Mount Type	Reports the mount configuration of the EyeLink eye tracker used to do data collection. This variable is not visible on recordings created with EyeLink II and EyeLink I eye trackers.
File Filtering Level	Filtering level (OFF, STD, or EXTRA) applied to the data saved in the EDF file.
Pupil Tracking Algorithm	This reports the pupil fitting processing type (i.e., ELLIPSE or CENTROID).
Thresholds	This reports the pupil and CR thresholds of the tracked eye(s) at the beginning of the recording.

4.1.1.3.1 Hiding a Trial

To hide a trial from the output reports

- 1) Click the trial to hide in the top panel of the data tab.
- 2) In the bottom panel of the data tab (which contains properties for the trial), find the entry “Exclude from Reports” and change the current setting so that the option is checked (default is unchecked).

4.1.1.3.2 Deleting a Trial

To delete a trial from the Data Viewer, simply place the mouse over that trial node, click the right mouse button and select Remove from Viewing Session. The trial is permanently removed from the data viewing session and all other trial indexes are updated accordingly.

4.1.1.4 Interest Area Templates

An interest area template is an .IAS file that contains a set of interest areas. If the same interest areas are used for several trials, rather than creating interest areas individually for each trial, users may load an interest area template and apply this template to multiple trials. The property panel lists the following summary statistics for an interest area template. Fields that are editable in the viewer are marked with an asterisk.

Field	Contents
Name *	Label of the custom interest area set.
IA Count	Total number of interest areas defined in the trial.
IsCustom	Whether the current set of interest areas is user-defined (true) or an interest area template (false).
Image Name Mapping	If the "Auto Select IAS for Trial" property in the “Output/Analysis” preference settings is true, the value in this field will be used to associate the IAS to trials automatically. This functionality is obsolete – users are suggested to make use of trial grouping feature instead (see section 6.1.3).

Please note that if an interest area template is deleted from a viewing session, interest areas for all those trials that use that template will be removed as well.

4.1.1.5 Custom Interest Area Set/Empty Interest Area Set

For each trial, the tree view also shows whether or not a custom interest area set has been defined for the trial. If there is no interest area set, the node  will be “Empty Interest Area Set”. The property panel lists the same elements as the interest area templates, except that the IsCustom field is “true” for the custom interest area set. When the Aggregate Mode is enabled, summary statistics for the interest area across all trials in the trial group are provided (see section 5.10.2).

4.1.2 Preferences Tab

The preferences tab (Figure 4-2, right panel) provides access to all the elements of the Data Viewer that can be configured by users. These include everything from the default colors used for displaying events, to the elements of an EDF file to load. These elements are broken down into the following categories: General Preferences, Data Loading Preferences, Output/Analysis Preferences, Data Filters Preferences, Data Views Preferences (with sub-categories of Spatial Overlay View Settings, Temporal Graph View Settings, and Animation Playback Settings).

4.2 Trial View Window

The Trial View window displays the data of a selected trial in Spatial Overlay Mode, Temporal Graph Mode, or Animation Playback Mode. Selecting a trial in the Data Inspector tree view shows the trial’s data in the Trial View Window. When Aggregate Mode () is enabled, data from the entire trial group to which the current trial belongs will be displayed in the Trial View Window (Spatial Overlay and Animation Playback modes only). Users can have several Trial View Windows open at one time by right-clicking on a trial in the Inspector Window and selecting “New Window” in the context menu.

4.2.1 Selecting Data Elements to Display

At anytime event visibility can be toggled on/off within the Trial View Window. For example the  button in the Application Desktop toggles the visibility of Fixation Events.

	Toggle Fixation Event Visibility
	Toggle Saccade Event Visibility
	Toggle Blink Event Visibility
	Toggle Eye Sample Visibility
	Toggle Message Event Visibility
	Toggle Button Event Visibility
	Toggle Input Event Visibility
	Toggle Interest Area Visibility



Enter/Exit Aggregate Mode

4.2.2 Cloning a Trial View

From the menu, choose:

Window → Clone View.

This allows, for example, both the Temporal Graph and Spatial Overlay Views to be shown at the same time on the desktop, and for the windows to be tiled for easy comparison. Note that event selection in one view will automatically cause the same events to be selected in the other view.

4.2.3 Tiling/Cascading Windows

To arrange all open Trial View Windows, from the menu, select:

Window → Tile

or

Window → Cascade

Figure 4-3 shows an example of tiling three open Trial View (Spatial Overlay, Temporal Graph, and Animation Playback Modes) windows.

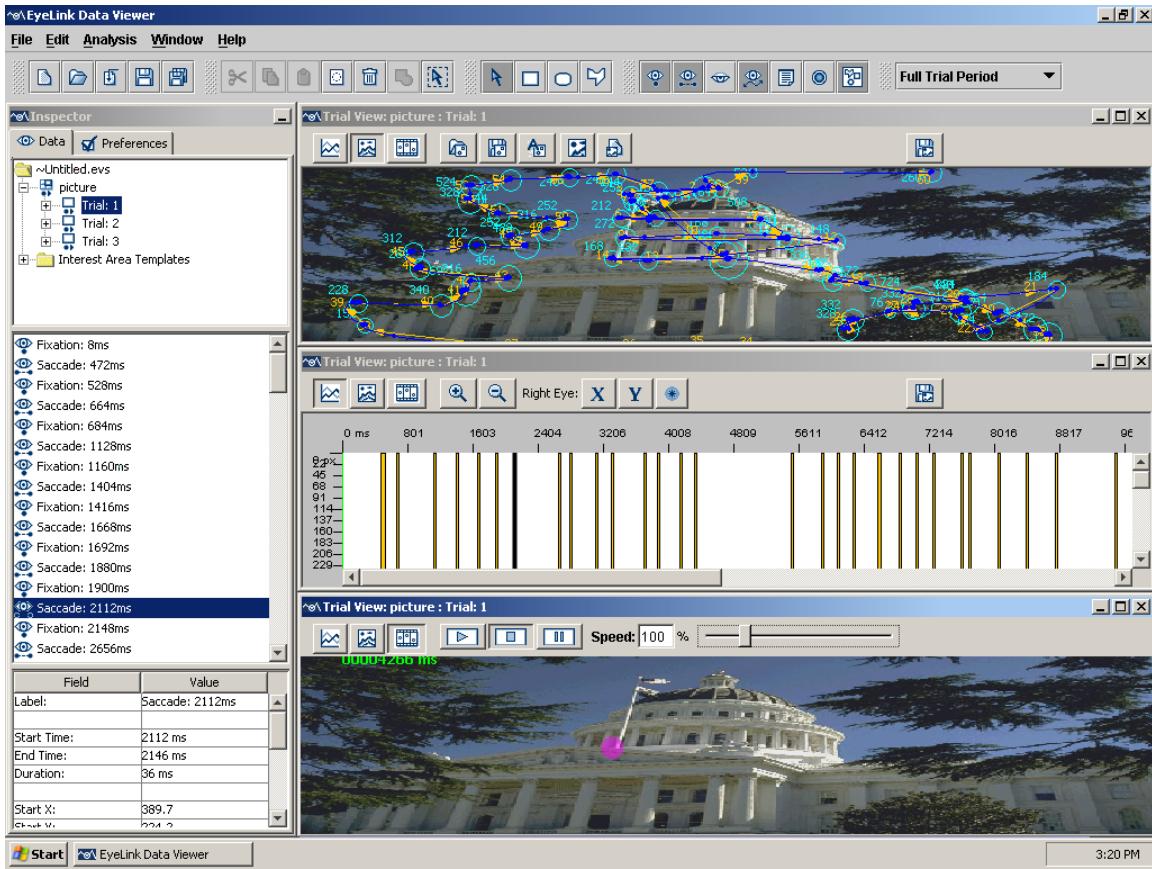


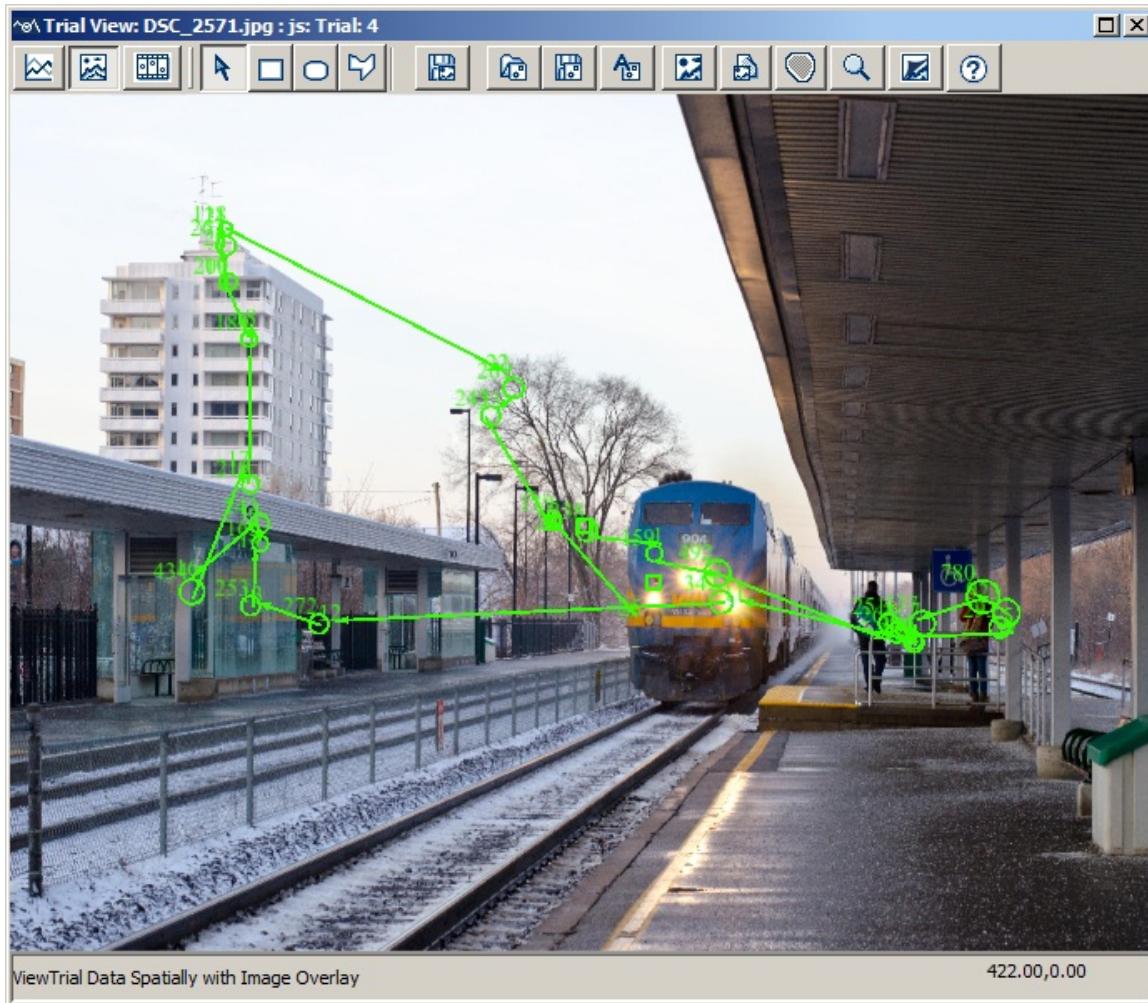
Figure 4-3. Tiling Trial View Windows.

4.3 Spatial Overlay Trial View

The Spatial Overlay view (see Figure 4-4) is selected by pressing the button in the Trial View window. This view displays events and samples spatially, allowing users to visualize eye movements superimposed on the image presented during the trial, if available. The background image can be toggled on or off by clicking on the “Toggle Background Image” button () in the Trial View Window toolbar. The background image for a trial can be manually changed with the “Change the Overlay Image” button () . Note that changing the background image will delete any existing image integration messages, and the operation cannot be reversed. Before replacing the background image, please check the “Fit Overlay Image Change to Display” setting in the Data Views->Overlay preference. If that setting is true, the image is scaled to fit the display dimensions for the trial. If false, the image size is not altered and the image is centered on the trial overlay view.

When the Aggregate Mode is enabled, all of the data in the current trial group (i.e., data from multiple participants) will be displayed in the same Trial View Window for efficient comparison. Users may apply different colors to code the data from different participants

(see section 4.1.1.2.2; see also Figure 4-5). The titlebar of the Trial View Window indicates whether data from a single-trial or aggregate data from the trial group is displayed in the Trial View Window.



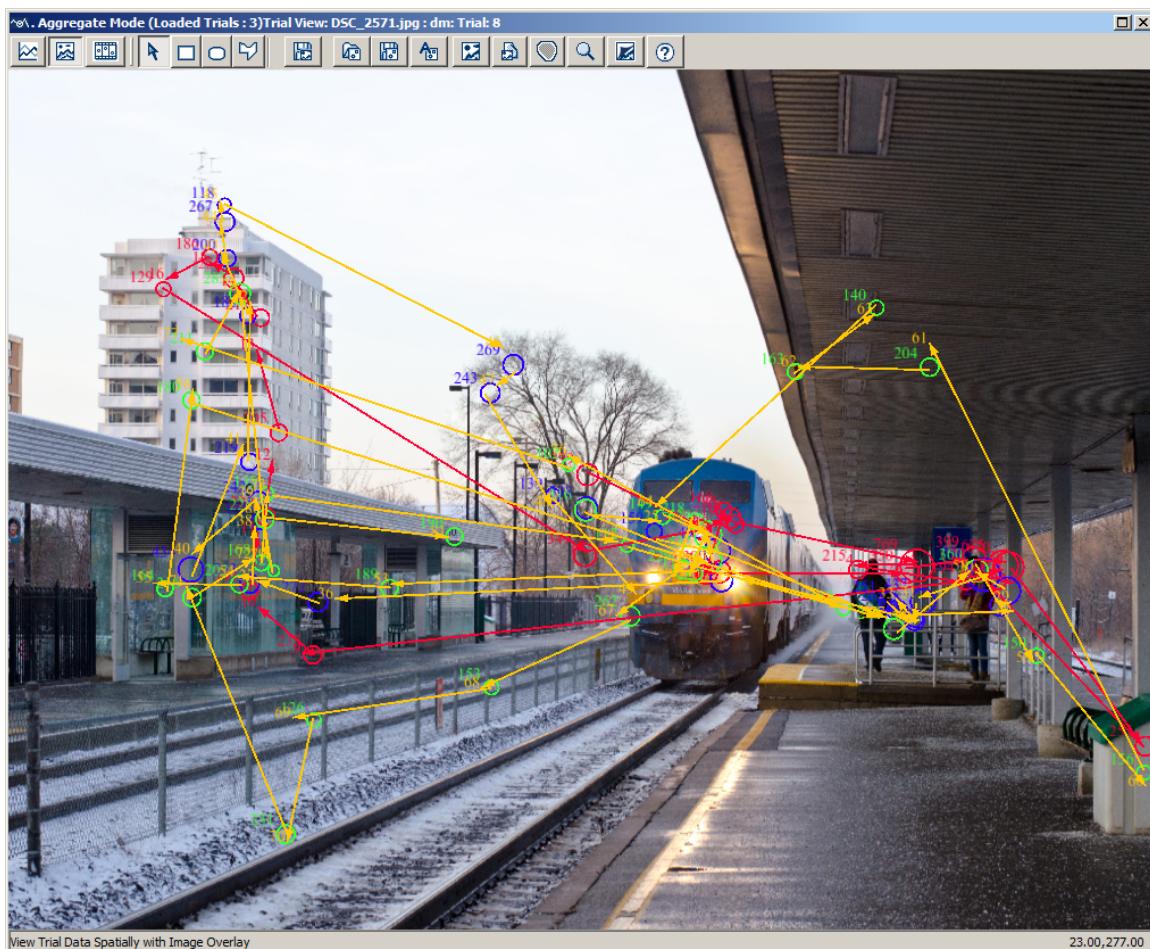


Figure 4-5. Sample Spatial Overlay Trial View from Multiple Participants

Version 2.4 of Data Viewer software supports zooming in or out of the Spatial Overlay View. This can be done in two possible ways.

- 1) Press down the left mouse button and drag the mouse in the Spatial Overlay View until the selection box covers the entire area to be zoomed. Now click the “Zoom Selected/Reset” button (🔍) in the toolbar.
- 2) Zooming in and out can be done with the mouse's scroll wheel while pressing down the Shift key (scrolling up to zoom in the view and scrolling down to zoom out the view). To adjust the position of the zoomed area in the view, press down the Shift key and then drag the mouse to the intended position.

To restore the default view, simply click the “Zoom Selected/Reset” button in the toolbar of the Trial View Window or press the Esc key.

The following buttons are available from the Spatial Overlay View:

	View Trial Data in 2D Temporal Graph Mode: Selects Temporal Graph View.
--	--

	View Trial Play Back Animation: Selects Animation Playback mode.
	Save Trial View as Image: Creates an image of the Spatial Overlay View.
	Import Area of Interest File: Loads an interest area set file and sets the interest areas for this trial. Any existing interest areas are deleted from the trial. After loading, the Interest Area Set for the trial is set to “Custom Interest Area Set”.
	Save the Interest Area Set to Disk: Saves the trials interest area set to a file.
	Auto Segment Image into Interest Areas: Creates interest areas automatically for the trial image.
	Display Overlay View in Actual Recording Resolution. Toggles between displaying eye data and graphics at the recorded resolution and at a custom sized resolution. If enabled, overlay is not scaled to size of Trial View Window and is instead set to actual size (One pixel of overlay corresponds to one pixel of trial display).
	Change the Overlay Image: Selects the image to use as the background of the overlay. Any existing background graphics are deleted.
	Create and Use Fixation Heat Map: This creates a heat map for the data in the current Trial View Window (single-trial data in the non-Aggregate Mode or trial-group data in the Aggregate Mode). Clicking on the button again toggles off the heat map drawing. Since Data Viewer uses the saved heat map for visualization, please make sure you supply a unique file name for the heat map created for the trial or trial group.
	Need to Update Heat Map: Data used to generate the current fixation map may no longer be valid (e.g., trials are removed from the current trial group, fixations are deleted, merged, or moved, a different interest period applied, Aggregated Mode is turned on or off, trials are regrouped). Users are advised to re-create the fixation map.
	Zoom Selected/Reset: Click this button to zoom in the Spatial Overlay View after selecting the intended area to zoom. Press this button again or press the Esc key to restore the default view.
	Toggle Background Image: This button can be used to toggle on/off the background image in the Spatial Overlay View.
	Keyboard Shortcuts: This supplies a list of keyboard shortcuts used in the Spatial Overlay View.

4.4 Temporal Graph Trial View

The Temporal Graph View (see Figure 4-6) allows users to view trial data as a trace plot, where the X axis represents time and the Y axis represents the X / Y gaze location (in screen pixels), pupil size (in arbitrary unit), acceleration (in degrees/second²), and velocity data (in degrees/second). To be consistent with the data presentation in the Spatial Overlay View and Temporal Graph View, version 3.1 or higher of Data Viewer

displays only events and samples from the currently selected interest period (which is marked by two colored vertical lines that correspond to the start and end events of the interest period). Sample traces outside the interest period are grayed out. The Temporal Graph View is zoomed in to fit the selected interest period by default.

To view trial data in the Temporal Graph View mode, select the  button in the top left corner of the Trial View Window.

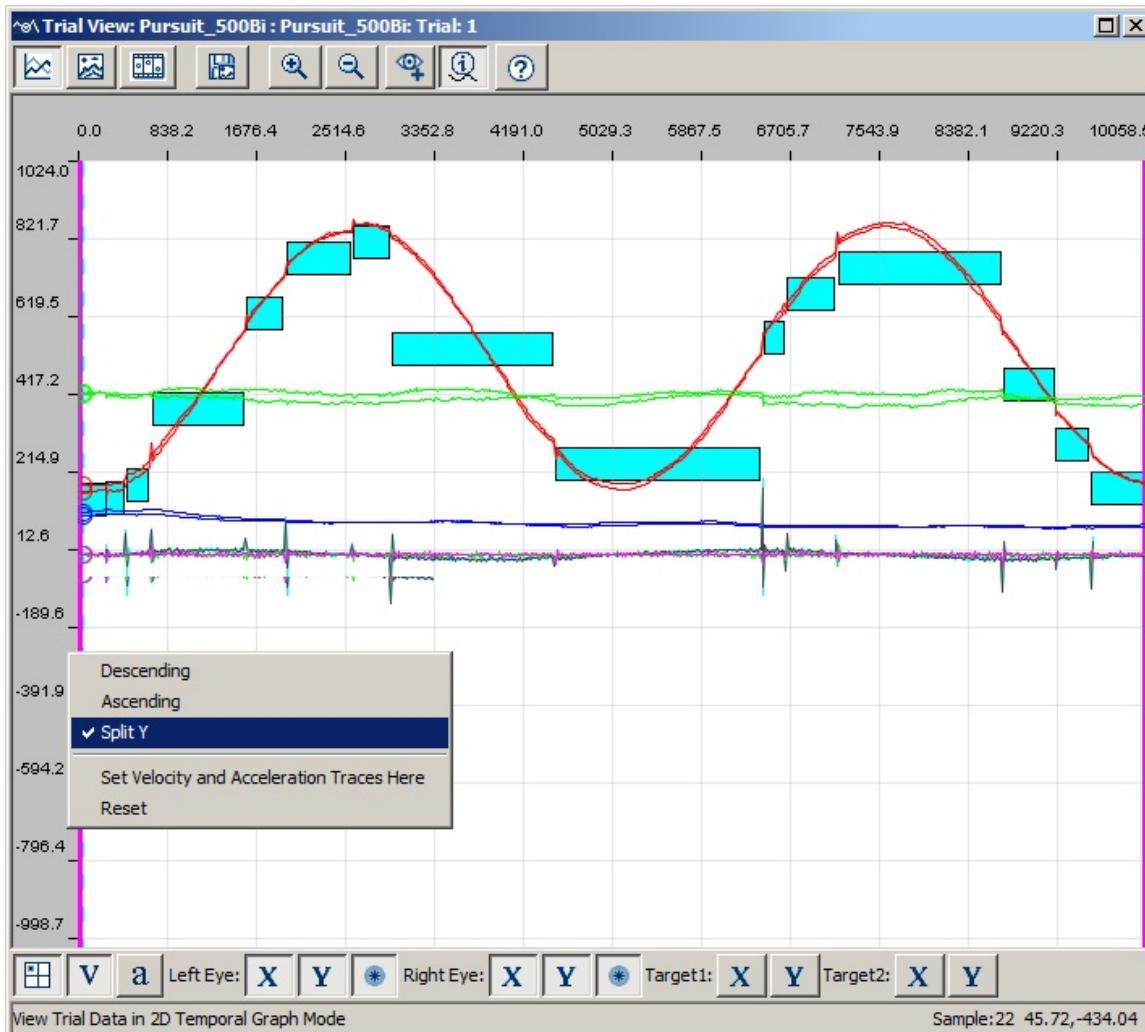


Figure 4-6. Sample Temporal Graph Trial View

4.4.1 Viewing Sample and Target Data

Temporal Graph view will show trace plots only if the EDF file contains samples and if sample are activated for viewing (i.e., the “Toggle Eye Sample Visibility” button  on the Data Viewer tool bar is selected). The position, velocity, and acceleration sample traces can be selected for viewing from buttons within the Trial View Window.

	View Trial Data Spatially with Image Overlay: Select Spatial Overlay View.
	View Trial Play Back Animation: Select Animation Playback View.
	Save Trial View as Image: Creates an image of the Temporal Graph View.
	Zoom In Graph View: Click the button and then drag the mouse to select the area of the graph view to zoom.
	Zoom Out Graph: Zooms out the graph view by a factor of 2.
	Add/Edit Event Mode: Enters a mode that allows users to create and edit eye events in the Temporal Graph View.
	Sample Info: Pops a floating window that shows the data of the current sample (index, time, eye, horizontal/vertical eye position/velocity/acceleration).
	Keyboard Shortcuts: This supplies a list of keyboard shortcuts used in the Temporal Graph View.
	Position Trace: Shows the gaze or target position.
	Velocity Trace: Shows the gaze or target velocity data.
	Acceleration Trace: Shows the gaze or target acceleration data.
	X Sample Trace: Toggles X trace visibility.
	Y Sample Trace: Toggles Y trace visibility.
	Pupil Sample Trace: Toggles Pupil trace visibility.

To show the eye or target traces, users need to select the type of data (position, velocity, or acceleration) and data source (x, y, pupil of left eye and/or right eye, x, y of target1 and/or target2) to be shown. To show the position, velocity, and acceleration traces of target(s) in this view, messages defining the current position of the target(s) must be recorded in the EDF file. These messages should contain a target position keyword (“TARGET_POS” by default; this can be configured in the “Target Position String” of the Data Loading preference settings), followed by parameters of the individual targets. See Section 7.3.6 for details of how to configure these messages.

Version 3.1 of Data Viewer introduces a sample cursor line in the Temporal Graph View. The sample cursor line is a vertical dashed line that moves along with the mouse cursor, with a pointer (circle) drawn at the intersection point of the line and each of the active data traces. Pressing the left or right arrow keys will move the cursor one sample to the left or right, allowing the user to easily step through individual samples. The visibility and color of the cursor line can be configured through the Temporal Graph View preferences.

Another addition to the Temporal Graph View in version 3.1 is a “Sample Info” window. Clicking on the Sample Info button (in the toolbar of the Trial View Window pops up a floating window that displays the information of the current sample, which includes

index and time of the sample, the selected eye and currently visible data traces (e.g., pupil size, horizontal/vertical eye position/velocity and acceleration). The Sample Info window gets updated when a new sample is selected (e.g., by moving the mouse inside the Trial View Window or by pressing the left/right cursor key). Clicking the "Sample Info" button automatically enables the "Toggle Eye Sample Visibility" button in the Data Viewer application toolbar, as well as the X/Y position and pupil trace buttons of the recorded eye(s) in the Trial View Window toolbar, if those buttons haven't been toggled on yet.

To configure the plotting of data in the Y axis, right-click on the Y-axis and choose one of the following options: Ascending (lower values on the Y-axis appear on the top of the screen), Descending (higher values on the Y-axis appear at the top of the screen), or Split (0 appear in the middle of the screen, positive values on the top and negative values at the bottom).

The X, Y, and Pupil traces can be highlighted for better visibility. Press the 'X' key to highlight the X trace, the 'Y' key to highlight the Y trace, and the 'P' key to highlight the Pupil trace. (If pressing one of these keys does not highlight the intended sample trace, please make sure that the Trial View Window is currently in focus by double-clicking inside the Temporal Graph plot.)

Various aspects of the Temporal Graph View can be configured in the preference settings (Preferences -> Data Views -> Temporal Graph). Users may change the colors of the sample traces, cursor line, grid line, and interest period boundary lines, the scaling factor for plotting the acceleration, velocity, and pupil size data, total number of initially visible samples in the Temporal Graph View window, etc.

4.4.2 Zooming Operations

The Temporal Graph View can be zoomed in and out to inspect a particular region. To zoom into an area of the Temporal Graph:

- 1) Hold the Shift key down or press the  button.
- 2) Position the mouse on the Temporal Graph the upper left hand corner of the area you wish to zoom into.
- 3) Press the mouse button and drag the mouse to the lower right corner of the area you wish to zoom into.
- 4) Release the mouse button.
- 5) Release the Shift key.

The graph will be magnified so that the area you selected fills the Trial View Window.

To zoom across only the X axis (leaving the full range of the Y axis visible):

- 1) Hold down both the Shift and Ctrl keys (Shift and Command ⌘ in Mac), or click the  button and then hold down Ctrl (Command ⌘ in Mac)
- 2) Position the mouse on the Temporal Graph at the left edge of the area you wish to zoom into.
- 3) Press the mouse button and drag the mouse to the right edge of the area you wish to zoom into.
- 4) Release the mouse button.
- 5) Release the key(s).

To zoom out the graph, press the  button. The Temporal Graph View will be zoomed out by a factor of 2.

4.4.3 Add/Edit Event Mode

Version 3.1 of Data Viewer allows users to create new eye events or edit event time in the “Add/Edit Event” mode () of the Temporal Graph View. A new fixation event can be created by dragging the mouse inside an existing saccade event (if the latter itself doesn’t contain a blink event) and a new saccade event can be created by dragging the mouse inside a fixation event. Data Viewer automatically computes the summary statistics (e.g., duration, position, velocity) of the newly created event based on the eye samples included in the event.

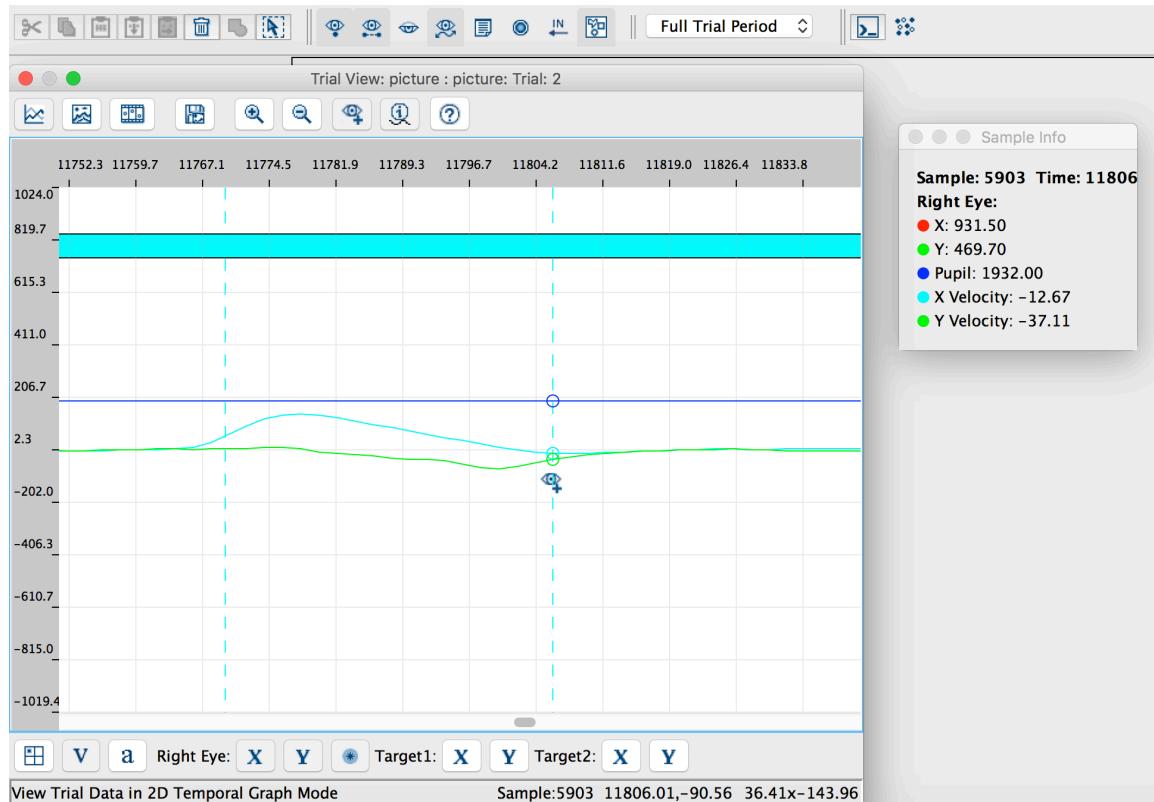


Figure 4-7. Creating a New Saccade in the Add/Edit Event Mode

The following steps illustrate how to create a new saccade within an existing fixation event. A fixation can be created within an existing saccade event in a similar fashion.

- 1) On the Application toolbar of the software, enable the “Toggle Fixation Event Visibility”, “Toggle Saccade Event Visibility”, and “Toggle Eye Sample Visibility” buttons.
- 2) In the Trial View Window toolbar, make sure the “Position Trace” button and the “Left/Right Eye X/Y Sample Trace” buttons are enabled. Since the event parsing decision will likely be based on the velocity and/or acceleration data, it will be useful to enable the velocity and acceleration trace buttons (and use the “Split Y” option for the vertical scale so that the velocity and acceleration traces are displayed in the center of the screen). Users may also toggle on the “Sample Info” button so that the current sample time, X/Y position, and velocity/acceleration data are displayed in a floating window and updated along with the mouse movement.
- 3) Users may also zoom in the part of the Temporal Graph View where the new event should be created (see section 4.4.2 for instructions on zooming in the view).
- 4) Now click the “Add/Edit Event Mode” button in the Trial View Window toolbar. A warning dialog box will be displayed when the mode is entered for the first time. Note that the  icon is displayed below the current mouse cursor position when the viewing session is in the add/edit event mode.
- 5) Place the cursor line on top of the first sample inside the fixation event that marks the beginning of the new saccade event—the sample information displayed in the “Sample Info” floating window may be used to determine the desired start sample. Click the left mouse button and start dragging the mouse. This will leave a dotted sample line at the start sample; a new dotted cursor line follows the mouse to indicate the current sample.
- 6) Pay attention to the sample information displayed in the “Sample Info” window while dragging the mouse. Release the mouse at the intended end sample. A new event will be now created. If the time of the end sample exceeds the end time of the original event, the end time of the new event will be adjusted to be within the original event.
- 7) Toggle off the “Add/Edit Event Mode” button when you finish creating/editing event. The mode will be toggled off automatically when you move away from the Temporal Graph View to other modes.

After creating a new event, users may need to perform further adjustments (in case for example a wrong start or end sample was used). To adjust the start or end sample of a fixation or saccade event, please follow the steps below:

- 1) Make sure the “Add/Edit Event Mode” button is toggled on.

- 2) Select the event to be adjusted in the Temporal Graph View. Note the borders of the event are bolded upon selection.
- 3) Hold down the Alt key. When you approach the left/right border of the selected event, the mouse cursor will change (). Hold down the left mouse button and drag the selected border to the intended position. If keyboard shortcuts are preferred, use Alt + Left /Right to modify the end time the selected event, and Alt + Shift + Left/Right to modify the start time of the selected event.
- 4) Toggle off the “Add/Edit Event Mode” button when you finish creating/editing events.

Note: Users can also edit the start time and end time of an event in the property table in any of the viewing modes.

4.5 Animation Playback View

The Animation View (see Figure 4-7) is selected by pressing the button in the Trial View Window. This view plays back the gaze position (superimposed on the background image or video clip that the participant was looking at while the data was being recorded), with a concurrent time code displaying the time from the start of trial recording. When the Aggregate Mode is enabled, gaze positions from several trials/participants are displayed simultaneously over time creating a "beeswarm" playback. Users may color code the participants for easy comparison (see section 4.1.1.2.2). If the “Use Average Aggregate Cursor” option in the Animation View preferences (through “Preferences -> Data Views -> Animation”) is enabled, a unified/averaged gaze cursor will be displayed during the playback instead.

In addition to the current gaze cursor, Data Viewer allows users to display a gaze history trail in the Animation View; the default gaze cursor history duration is 300 milliseconds. Both settings can be changed in the Animation View Preferences. Version 2.4 of the software supports dynamic heat map presentation in the Animation View (see section 6.2.2 “Dynamic Heat Map”). This can be done by enabling the “Aggregate Mode” () and then toggling on the “Enable Dynamic Heat Map in Aggregate Mode” button ().

Several controls are available for the animation view. Users can start, stop, or pause the playback by clicking the appropriate button. The speed of playback can also be adjusted (users can modify the speed value and then press the “Enter” key to register the change). A trackbar displays the progress of the playback relative to the currently selected interest period and lets users select a position to start playback.

	View Trial Data in 2D Temporal Graph Mode: Selects the Temporal Graph View.
	View Trial Spatially with Image Overlay: Selects the Spatial Overlay View.

	Save Trial View as Image: Creates an image of the Animation Playback View.
	Import Area of Interest File: Loads an interest area set file and sets the interest areas for this trial. Any existing interest areas are deleted from the trial. After loading, the Interest Area Set for the trial is set to “Custom Interest Area Set”.
	Save the Interest Area Set to Disk: Saves the trials interest area set to a file.
	Save Trial to Video File: Saves the playback of the trial into a movie file.
	Enable Dynamic Heat Map in Aggregate Mode: Click this button to show the dynamic heat map in the Animation View. This option is only available when the Aggregate View is enabled.
	Keyboard Shortcuts: This supplies a list of keyboard shortcuts used in the Animation Playback View.
	Playback Trial: Starts playing back the trial data. Spacebar is the shortcut key for play/pause when the Trial View Windows has focus.
	Stop Trial Playback: Stops the playback and resets the time code and gaze cursors. The Esc key is the keyboard shortcut for stopping playback when the Trial View Windows has focus.
	Pause Trial Playback: Pauses the playback. Spacebar is the shortcut key for play/pause when the Trial View Windows has focus.
	Backward Step: Each click on this button steps backwards the playback by 33 milliseconds. The keyboard shortcut is Shift + Left arrow key (make sure you click on the Trial View Window first). Pressing the Left arrow key itself steps back the playback by one millisecond.
	Forward Step: Each click on this button advances the playback by 33 milliseconds. The keyboard shortcut is Shift + Right arrow key (make sure you click on the Trial View Window first). Pressing the Right arrow key itself steps forward the playback by one millisecond.
	Backward Frame: Each click on this button seeks to the previous drawing message if available (so the seeking is locked to actual stimulus drawing instead of by a fixed amount of time). In case of video clip playback, this allows you to step backward one video frame. The keyboard shortcut is Ctrl + Left arrow key on Windows and Command + Left arrow key on Mac OS X (make sure you click on the Trial View Window first). Pressing the Left arrow key by itself steps back the playback by one millisecond.
	Forward Frame: Clicking on this button seeks to the next drawing command if available (so the seeking is locked to actual stimulus drawing instead of by a fixed amount of time). In case of video clip playback, each click on this button advances the playback by one video frame. The keyboard shortcut is Ctrl + Right arrow key on Windows and

Command + Right arrow key on Mac OS X (make sure you click on the Trial View Window first). Pressing the Right arrow key by itself steps forward the playback by one millisecond.

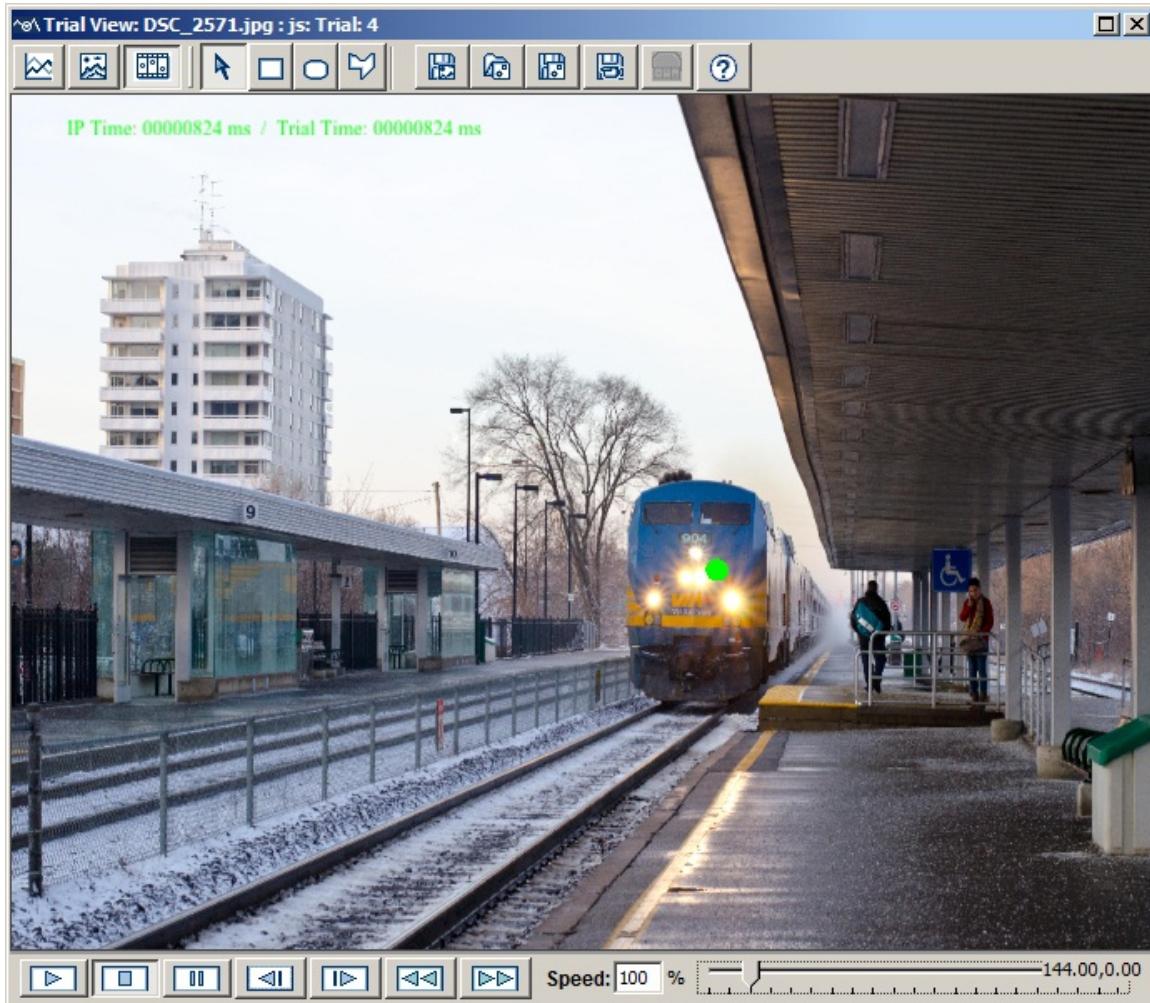


Figure 4-8. Sample Animation Playback View

To save the playback of trial data into a movie file, click the "Save Trial to Video File" button (REC) on the Trial View Window toolbar. In the following "Movie Save Options" dialog box, enter the movie file path/name, file type and compression method. Click "Start" to begin saving the movie. Depending on the size of the recording file, this may take a long time to finish. At any point, the user can press the "Esc" key to stop the saving process.

Playing back video clips in the animation view is supported if the EDF file is created from an SR Research Experiment Builder recording. The video clip must be encoded in XVID format, and a computer with at least a P4 CPU is required for playback in Data Viewer. The current frame number is displayed in the top-left corner of the video. If you want to hide this frame number indicator, please go to "Preferences -> Data Views ->

Animation" and uncheck the "Display Frame Number" option. Playing .XVD videos in the Animation Playback View on Mac OS X is supported in version 2.4 or later of Data Viewer.

5 Working with Events, Samples, and Interest Areas

EyeLink Data Files (EDF files) contain two streams of data: eye position **samples** (up to 2000 per second, depending on the system model / sampling rate) and **events** (eye movement events such as saccades and fixations, participant responses, and synchronizing events from the experimental application). Both data streams are time-synchronized for easy analysis. The file is organized into trials of data, one for each of the tracker recording cycles. Each trial may have samples, events, or both.

Samples are time-stamped in milliseconds and contain monocular or binocular eye-position data—Data Viewer currently only reports the eye position in screen coordinates (GAZE), ignoring other sample data formats (RAW and HREF). Pupil size as area or diameter is also recorded. Samples may also contain eye-movement resolution data (a pixel per degree value that can be used to compute true velocity or saccadic amplitudes).

Eye movement events record eye position changes identified by the EyeLink tracker's on-line parser, such as fixations, blinks, and saccades. Both the start and end of these events are marked, allowing samples to be assigned to eye-movement periods without complex algorithms. Important summary data, such as average position for fixations and peak velocity for saccades, are recorded in the end event marker. Other events record participant responses (such as button presses) and synchronization and data messages from stimulus presentation applications. These can be used to record the time of a change in the display (such as stimulus onset), or an experimental condition.

In addition to providing a file-based and a trial-based summary of performance, Data Viewer allows a detailed examination of event data such as fixations, saccades, blinks, buttons, inputs, and messages, as well as sample data. Version 2.3 of Data Viewer adds support for Aggregate Mode, which allows users to visualize event data from multiple participants/trials and provides summary statistics for the entire trial group.

5.1 Event Reparsing

The eye movement events in EyeLink data files are generated by the Host Software's on-line parser in real-time during recording, based on an internal heuristic saccade detector that uses a velocity- and acceleration-based saccade detection method. To detect a saccade, the online parser computes instantaneous velocity and acceleration for each data sample and compares these values to specified thresholds. If either value is above threshold, a saccade onset signal is generated. The online parser checks that the saccade signal is on or off for a critical time before deciding definitively that a saccade has begun or ended. A blink is defined as a period of saccade-detector activity with the pupil data missing for three or more samples in a sequence. A fixation event is defined as any

period that is not a blink or saccade. A detailed discussion of the online event parsing algorithm can be found in section "4. Data Files" of the EyeLink II or EyeLink 1000/1000 Plus/Portable Duo User Manual.

Versions 3.2 and later of EyeLink Data Viewer provide an option to reparse eye events post-hoc. To reparse eye events, full sample data must be recorded in the EDF files and loaded in the viewing session. Simply select the trial node or trial grouping node in the Inspector window, then right-click and select "Reparse Eye Events". Detailed parser configuration can be found in the Preferences tab of the Inspector Window ("Output/Analysis -> Event Reparsing" preferences). Some of the important preference settings for post hoc event reparsing are discussed below.

Velocity and acceleration can be calculated with different algorithms. The "Velocity Calculation" preference allows the user to choose which algorithm is used to calculate velocity and acceleration for event reparsing. The velocity calculation implemented by the EyeLink host software during data collection ("Fast/Online") uses a fast algorithm that looks "ahead" only a few samples in the data. This minimizes delays in the on-line calculation of velocity and acceleration, but limits the data checking the parser can perform. The outcome of the host parser may therefore be susceptible to noise in the data. Data Viewer provides an alternative algorithm ("Slow/Data Viewer"). Since Data Viewer does not need to do the velocity calculations and event parsing in real time, this "slow" algorithm can include more samples in the calculation, emphasizing reliability instead of speed.

While the EyeLink host software provides a general-purpose event parsing solution that works well for the majority of eye tracking research, Data Viewer allows the user to adjust the configuration of the parser in ways that may help optimize its performance for specific applications. For instance, during constant eye motion, the EyeLink host parser algorithm raises the saccade velocity threshold by the average velocity of a short preceding time window, allowing saccades to be detected properly when the eye velocity is already raised because of smooth pursuit motion. The "Disable Pursuit Adjustment at Saccade End" option allows users to remove this velocity threshold adjustment at the end of the saccade. In general, enabling this option will slightly prolong a saccade, especially for those saccades that exhibit slow motion at the end similar to drift or pursuit.

Another important aspect of event reparsing is the selection of reparsing thresholds. The thresholds chosen will typically depend on the user's application. For example, neuropsychophysical researchers may want to lower the parser velocity and acceleration thresholds to detect small saccades that occur during pursuit or nystagmus, while reading researchers may wish to adopt more conservative thresholds to detect only large saccades and consequently maximize fixation durations. Occasionally, researchers may wish to evaluate the same data by reparsing it with different parameter settings.

Data Viewer groups these parameter settings under the “Reparsing Settings Group” option. The default reparsing group is “STANDARD (COGNITIVE) [0]”, but users can either select the “PSYCHOPHYSICAL [1]” option or create a customized parameter setup by choosing the “CUSTOM [2]” group. Please note that any changes to the factory-supplied parameters in the STANDARD or PSYCHOPHYSICAL group will automatically switch the parser group to “CUSTOM [2]”.

Upon performing event reparsing, Data Viewer will replace the existing events with the reparsed ones, and update the details (e.g., start time, end time, duration, average position or start/end position, velocity, resolution data) of the reparsed fixation and saccade events. Users can visualize the eye-movement data in the Temporal Graph View with saccades and fixations overlaid to confirm the parsing accuracy, and can edit, create or delete individual events if desired (see section “4.4.3 Add/Edit Event Mode”).

5.2 Common Operations

Data Viewer allows users to perform various manipulations of events, such as selecting a portion of data for further scrutiny, excluding or deleting a subset of events from analysis, performing drift correction on fixations, merging neighboring fixations and saccades, etc. Selecting, hiding, and deleting operations are common to all event types (fixations, saccades, buttons, blinks, inputs, and messages) whereas merging and drift correction is available to fixation and saccade events only. The common operations are discussed in this section whereas the unique operations pertaining to certain types of events are documented in the relevant event section.

5.2.1 Selecting Events

To select an event (fixation, saccade, blink, button, input, or message), place the mouse cursor over the event either in the Spatial Overlay/Temporal Graph View or in the event list of the Inspector Window and click the left mouse button. When in the Animation Playback View, clicking on an event in the event list will set the playback position of the trial to the time (message, button, input event) or start time (fixation, blink, saccade) of the event.

To select more than one event, hold down the Ctrl key in Windows or the command key in OS X and click on each event until all desired events are selected. If all events in a trial are to be selected, simply click the **Select All Visible Items** button  on the main toolbar (please note that this is not the “Select Mode” button  in the toolbar of the Trial View Window) or click the right mouse button and select “Select All”.

To select a group of events within a square region of the Trial View Window, place the mouse cursor at the top-left corner of the region. Click and hold down the left mouse button, drag the mouse cursor to the bottom-right corner of the square region, and then release the left mouse button.

To select a group of temporally contiguous events, click on either the first or last event to be selected in the event list. Then hold down the Shift key and press the Down arrow key to select later events, or press the Up arrow key to select earlier events.

Tip: Holding the Ctrl or Command key while selecting an event leaves previously selected events selected. If the Ctrl or Command key is not pressed, selecting an event will cause previously selected events to be unselected.

5.2.2 Deleting Events

Select the events and click the Delete Selected Items button  on the toolbar (or click the right mouse button and select “delete”). If an event is deleted, it will be permanently removed from the Temporal Graph View, Spatial Overlay View, as well as the output reports, and cannot be “undeleted” (there is no “undo” operation). In addition, deleting a fixation or saccade event will have an impact on other temporally contiguous events. For example, deleting a fixation will merge the saccades on either side of the fixation into one saccade. Similarly, deleting one saccade will merge the fixations on either side of the saccade into a longer one.

5.3 Fixations

To examine the fixation information in the data file, first make sure that the fixation events are visible. This is done by selecting the Toggle Fixation Event Visibility button  in the application toolbar.

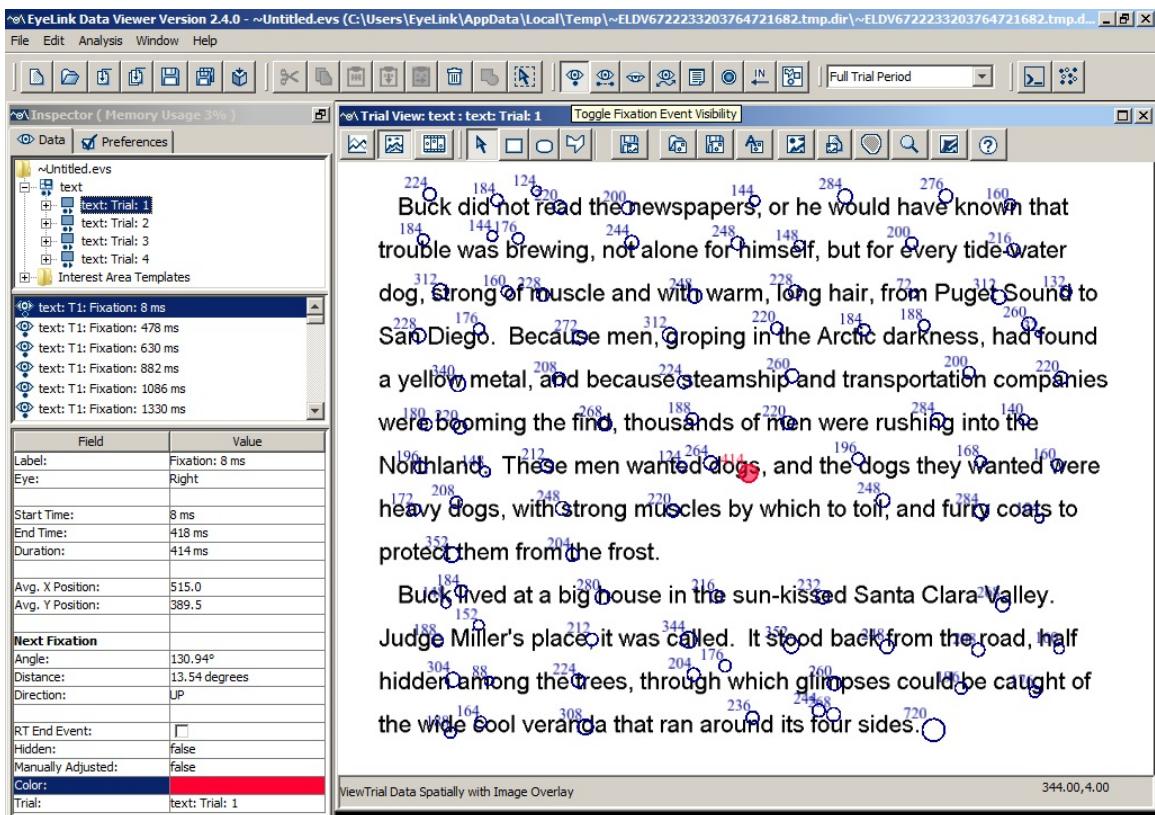


Figure 5-1.Sample Spatial Overlay View of Fixation Events

Fixations can be viewed and selected if the Trial View Window (Figure 5-1, right panel) is showing either a Spatial Overlay View or a Temporal Graph View. In the Spatial Overlay view, fixations are represented as a hollow circle located on the trial image at the average gaze x, y coordinates for the samples contained within the fixation, with fixation duration displayed near the top-left corner of the circle. In the Temporal Graph View, fixations are represented as a filled block. All fixation events in a selected trial are listed sequentially in the middle panel of the Inspector Window. Properties of a selected fixation are shown in the bottom panel of the Inspector Window. Each field of the fixation event property is described in the following table. Fields that are editable are marked with an asterisk.

When Aggregate Mode is enabled in the viewing session, fixations from the current trial will be displayed together with fixations from other trials in the trial group. Color coding can be applied (by enabling the “Apply Coloring to Visible Events” option in the trial node or the trial group node and choosing the intended color) to assist in the identification of the source of the fixations. While all of the visible fixations can be selected, only those fixations belonging to the current active trial can be modified (deleted, moved, drift corrected, or merged).

Field	Contents
-------	----------

Label *	Label of the fixation.
Eye	The eye to which the current fixation event is associated.
Start Time	Trial time ¹ when the fixation starts. Please note that if an interest period is applied, the duration, start time, and end time of the fixations that overlap with the start or end of the interest period will be adjusted accordingly.
End Time	Trial time ¹ when the fixation ends.
Duration	Duration (in milliseconds) of the fixation. The fixation duration may be adjusted if the fixation spans the start or end of an interest period and the "Trim Spanned Fixation Time" option is enabled in the Data Filter preferences.
Avg. X Position *, Avg. Y Position *	Average X, Y of the gaze location.
Angle	Angle between the horizontal plane and the line connecting the current fixation and the previous/next fixation. ²
Distance	Distance (in degrees of visual angle) between the current fixation and the previous/next fixation.
Direction	Direction ("LEFT", "RIGHT", "UP", or "DOWN") ³ relative to the current fixation in which the previous/next fixation is located.
RT End Event *	Whether the current fixation is the reaction time end event (see section 6.3.1 for reaction time definition).
Hidden	Whether the current fixation is hidden from viewing and output analysis.
Manually Adjusted	Whether the fixation has been shifted manually.
Trimmed	Whether the fixation's start or end time has been trimmed by the interest period.
Color *	To achieve better visibility, the color of the currently selected fixation can be changed by clicking on the color toolbox.
Trial:	Label of the trial to which the current fixation belongs.

Note¹ : System time refers to the timestamp (in milliseconds) since the EyeLink tracker was activated whereas the trial time refers to the time since the trial started. The default trial start time is the start of the trial recording (i.e., "START" message). If reaction-time definitions are applied, the trial-start time is reset at the start event of the RT definition (e.g., "SYNCTIME" message). A negative trial time means that the event or message occurred before the trial start time.

Note² : The calculation of the angle between the previous/next fixation and the current fixation is directional, with the arrow pointing towards the previous/next fixation. (See Figure 5-2 for an illustration of angle calculation—the angle from the Current Fixation to the Previous/Next Fixation would be about 135°.)

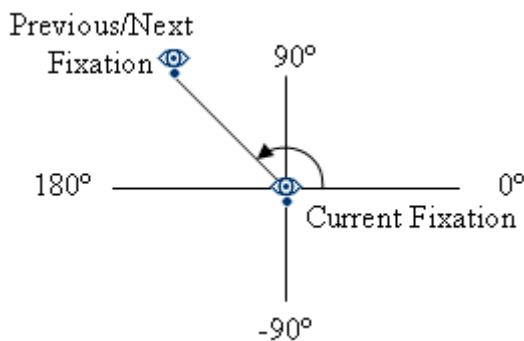


Figure 5-2. Diagram for Angle Calculation

Note³: The direction of the previous/next fixation relative to the current fixation is determined as “LEFT” if the angle is greater than 135° or less than -135°, “UP” if the angle is between 45° and 135°, “RIGHT” if the angle is between -45° and 45°, and “DOWN” if the angle is between -135° and -45°.

5.3.1 Selecting Fixations

In addition to selecting a group of events with the mouse as mentioned above, a group of temporally contiguous fixations may also be selected by with the keyboard. Select the first fixation by mouse in the event list of the Inspector Window and hold down the Shift key. Press the down cursor key to select the next fixation, until all target fixations are selected. Use the up cursor key to unselect the recently selected fixations or go to fixations before the first selection.

5.3.2 Merging Fixations

In some cases, two or more temporally contiguous fixations can be merged and represented as a “larger” fixation. To merge fixations, select the fixations and click the Merge Selected Items button on the toolbar (or click the right mouse button and select “merge”). Data Viewer version 3.1 and higher takes the duration of each original fixation into consideration (i.e., duration-weighted) when calculating the position of the newly created fixation. Users can revert to the old calculation method (i.e., using a simple average of the original fixation positions) by turning off the “Apply Time Weighted Merge” option in the Data Filters preferences.

Note: Only two or more temporally contiguous fixations can be merged. Merging two neighboring fixations will remove the intermediate saccade that connects between them. The parameters of the saccades before and after the merged fixations will also be adjusted accordingly. Fixation merging cannot be performed if there is a blink between the selected fixations (unless the “Adjust Saccades with Fixations” in the “Data Views” preferences is turned off).

5.3.3 Drift Correcting Fixations

Sometimes, a drift in the gaze position may occur due to poor system setup, headband slippage, or excessive head/body movement. Normally, the eye tracker operator would notice this problem and perform a recalibration or drift correction. If, however, the issue was not addressed during recording, it may be possible to manually adjust the fixation events so that some degree of data analysis can still be performed. Please note that performing a drift correction will only affect event data, including fixation location and associated saccade beginning/end points. The sample data will be unaffected by the drift corrections performed in Data Viewer.

5.3.3.1 Drift-correcting a Group of Selected Fixations

To perform drift correction:

- 1) Select the fixations to be drift corrected
- 2) Hold the Alt key down
- 3) Click anywhere on the Trial View Window so that it receives the input focus
- 4) Move the selected fixations with the cursor keys to the desired locations

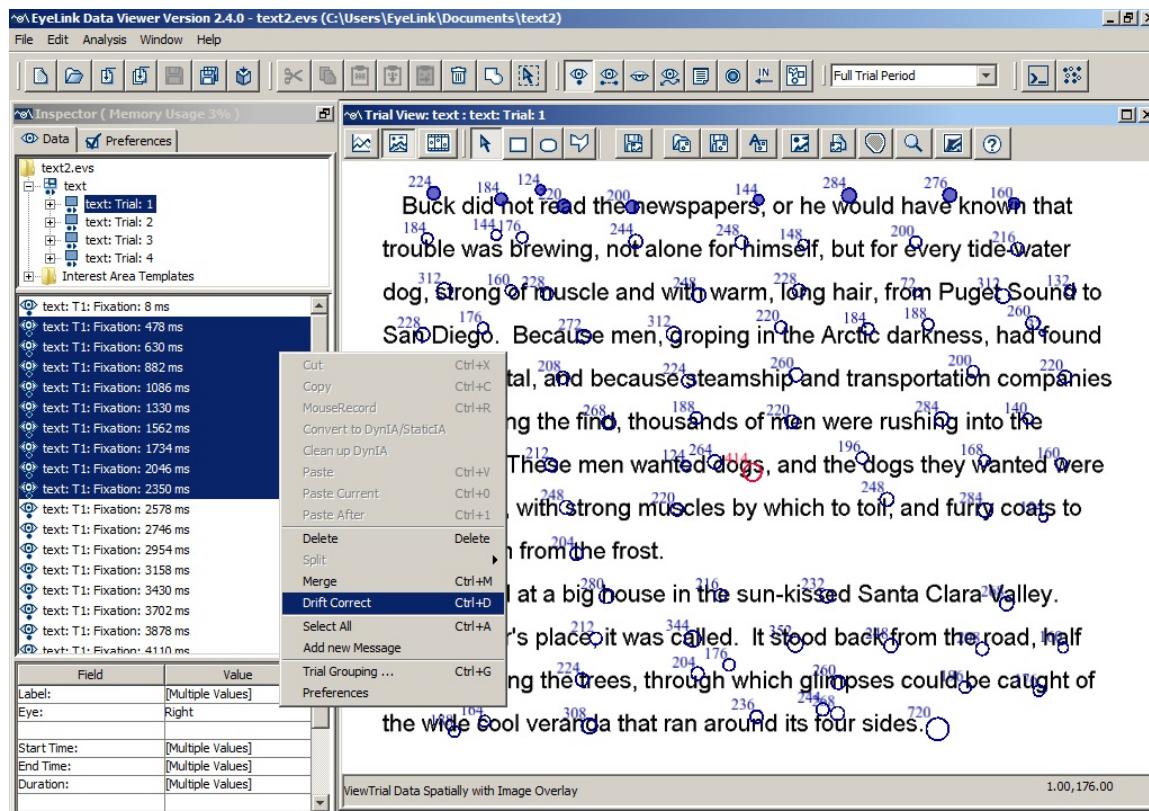


Figure 5-3. Drift Correcting Fixations on One Line of Text.

Tip: In cases where several fixations on one single line (such as in reading research) are to be drift-corrected, another method is to select all of the desired fixations, then right-click in the Trial View Window and select “Drift Correct”) to align them to their average

Y position (see Figure 5-3). Alternatively, select all of the desired fixations, then press Ctrl+D on Windows (or Command D on Mac OS X). This operation will fail if one or more fixations deviate more than 30 pixels in the Y dimension from the mean of the group of fixations to be drift-corrected in a batch (for example when fixations from different lines are selected). The tolerable deviation threshold is set to 30 as a default and can be modified in the Data Views section of the preference settings, as can whether the X or Y dimension is used for alignment.

5.3.3.2 Precise Drift Correction of a Single Fixation

To carry out more precise drift correction of one fixation,

- 1) Select the fixation to be drift corrected
- 2) In the property panel of the Inspector Window, select the entry for "Avg. X Position" and type in the desired X position.
- 3) Select the entry for "Avg. Y Position" and enter the desired Y position.

Note: Drift correcting one fixation or a group of fixations changes the properties of some relevant events, such as the start/end point of a preceding or following saccade and its amplitude.

Tip: Before moving the fixations, it is desirable to turn off the interest area set by pressing **Toggle Interest Area Visibility** button  in the application desktop toolbar. Otherwise, the interest area(s) within which the fixations appear will also be moved along.

5.3.3.3 Cleaning Fixations

For some studies, researchers may want to clean up fixations based on certain rules. Data Viewer provides two options for fixation cleaning.

1) Fixation Filter preferences

Users can filter out small fixations with the "Merge Nearby Fixations", "Fixation Merging Amplitude Threshold", and "Fixation Duration Threshold" settings of the Data Filters preferences. If the "Merge Nearby Fixations" option is checked, a fixation with a duration shorter than the value set in the "Fixation Duration Threshold" will be merged with a neighboring fixation, if the latter is within the distance set by the "Fixation Merging Amplitude Threshold".

2) Four-stage Fixation Cleaning

(Please Note: this option is intended for use only by reading researchers who want to follow a cleaning procedure that is established in their field. It is not intended, nor is it necessary, for other users to clean their data using this function.)

For some reading studies, users may want to apply a more refined fixation cleaning algorithm. To apply a cleaning in Data Viewer, select the intended Trial node or Recording session node, then right-click and select the “Perform 4-stage Fixation Cleaning” option. A log file will be created in the “Output” folder of the current viewing session.

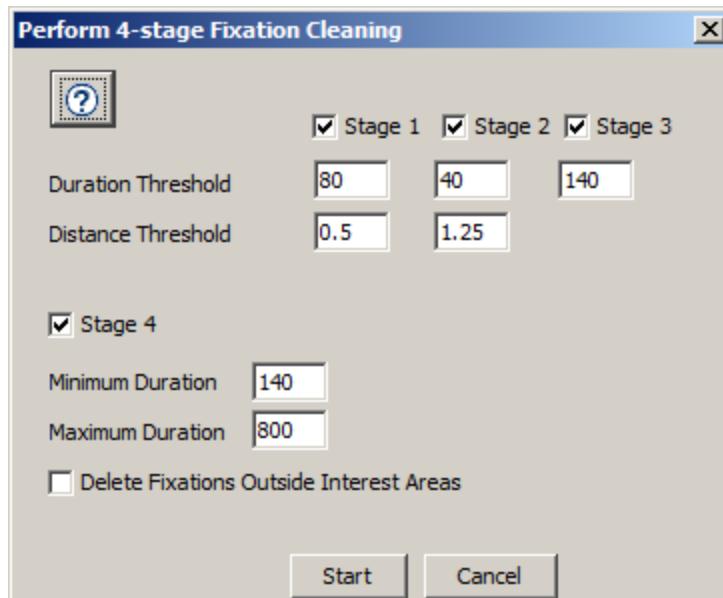


Figure 5-4. Options for Fixation Cleaning.

- i) STAGE 1. Within each interest area (typically a word in reading studies), Data Viewer checks whether each fixation's duration is shorter or equal to the Stage 1 Duration Threshold. For those short fixations, the software further checks the duration and distance of the fixations immediately before and after the current fixation. The fixation will be merged to one of its neighboring fixations if the neighbour's duration is longer than the threshold value and its distance along the x-axis (in degrees) from the current fixation is shorter or equal to the Stage 1 Distance Threshold. If both the previous and next fixations meet the above criteria, the current fixation will be merged to the longer of the two. Uncheck the "Stage 1" box to skip this stage.
- ii) STAGE 2. This stage is similar to STAGE 1 except that different fixation Duration and Distance Threshold values are used. For this stage to be effective, a shorter duration and a larger distance threshold should be used compared to Stage 1. Uncheck the "Stage 2" box to skip this stage.
- iii) STAGE 3. Data Viewer searches for interest areas that include at least three fixations shorter than the Stage 3 Duration Threshold value and no fixations longer than the Duration Threshold. In such cases the shorter fixations are merged into a single fixation. Uncheck the "Stage 3" box to skip this stage.

- iv) STAGE 4. Data Viewer deletes every fixation shorter than or equal to the Stage 4 Minimum Duration threshold, or longer than or equal to the Stage 4 Maximum Duration threshold. Uncheck the "Stage 4" box to skip this stage.
- v) If the "Delete Fixations Outside Interest Areas" box is checked, this will remove all fixations falling outside of any interest area. **Important:** If no interest area is defined, checking this option will result in all fixations being removed!

5.3.4 Creating a New Fixation Event

Version 3.1 of Data Viewer allows users to create a new fixation event by dragging the mouse inside an existing saccade event (if the saccade doesn't contain a blink). Please see section 4.4.3 “Add/Edit Event Mode” for details on how to create a new event in the Temporal Graph View. For the newly-created fixation event, Data Viewer automatically computes the event statistics such as duration, average X/Y eye positions and pupil size based on the eye samples included in the event. Properties of the neighboring events are also updated following the creation of the new fixation event.

5.4 Saccades

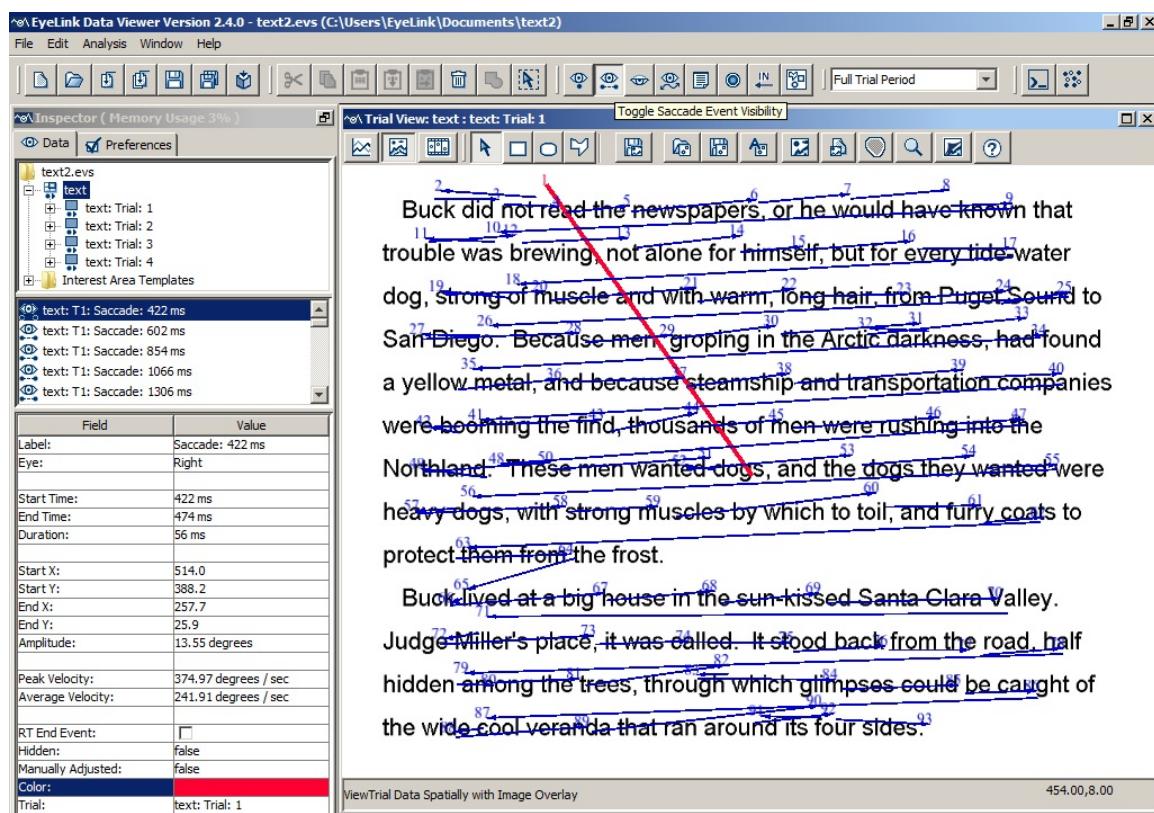


Figure 5-5. Sample Spatial Overlay View of Saccade Events

Saccade events (see Figure 5-5) can be toggled on/off in both the Spatial Overlay and Temporal Graph Views by clicking the Toggle Saccade Event Visibility button . A saccade is represented as an arrow in the Spatial Overlay View (pointing towards the endpoint) and as a colored solid line in the Temporal Graph View. The following table lists the properties of a saccade event. Fields that are editable in the viewer are marked with an asterisk.

Field	Contents
Label *	Label of the saccade.
Eye	The eye to which the current saccade event is associated.
Start Time	Trial time (in milliseconds relative to the start of the current trial) when the saccade starts.
End Time	Trial time (in milliseconds relative to the start of the current trial) when the saccade ends.
Duration	Duration (in milliseconds) of the saccade.
Start X *, Start Y *	X, Y coordinates of the start position.
End X *, End Y *	X, Y coordinates of the end position.
Amplitude	Size (in degrees of visual angle) of the saccade.
Peak Velocity, Average Velocity	The average and peak values of gaze velocity in degrees of visual angle per second. The peak velocity calculation depends on whether the samples are loaded in the viewing session.
RT End Event *	Whether the current saccade is the reaction time end event (see section 6.3.1 for reaction time definition).
Hidden	Whether the current saccade is hidden from viewing and output analysis.
Manually Adjusted	Whether the saccade has been adjusted manually.
Color*	To achieve better visibility, the color of the currently selected saccade can be changed by clicking on the color toolbox.
Trial	Label of the trial to which the current saccade belongs.

When Aggregate Mode is enabled, saccades across all of the trials in the trial group will be drawn in the Spatial Overlay View. For ease of identifying the source of the saccades, users can apply color coding (by enabling the “Apply Coloring to Visible Events” option in the trial node or the Recording session node and choosing the intended color). While all of the saccades can be selected, only those saccades from the current active trial can be modified.

5.4.1 Merging Saccades

Sometimes, a large saccade is followed by a small corrective saccade or vice versa. In certain circumstances users may wish to merge two or more such temporally contiguous

saccades. This can be done by selecting the saccades and clicking the Merge Selected Items button  on the toolbar (or clicking the right mouse button and selecting “Merge”). Once the saccades are merged, information on the ordinal sequence for the current and subsequent saccades is updated and the fixation between the two merged saccades is deleted.

Note: Only two or more temporally contiguous saccades can be merged. If saccades are selected that are not all temporally contiguous, only the neighboring saccades will be merged.

5.4.2 Adjusting Saccade Position

The start and end position of a saccade event can be adjusted precisely through the property table of the event. To set the start or end position of a saccade,

- 1) Select the saccade to be adjusted.
- 2) In the property panel of the Inspector Window, select the entry for “Start X”, “Start Y”, “End X”, or “End Y” and enter the new value.

Note: Adjusting the start/end position of the saccade may also modify the average positions of the neighboring fixations. This default behavior can be changed by unchecking the “Adjust Fixations with Saccades” option in the Data Views preferences.

5.4.3 Creating a New Saccade Event

Version 3.1 of Data Viewer allows users to create new eye events in the “Add/Edit Event” mode  of the Temporal Graph View. A new saccade event can be created by dragging the mouse inside an existing fixation event—please see section 4.4.3 “Add/Edit Event Mode” for details on how to create a new event in the Temporal Graph View. For the newly-created saccade event, Data Viewer automatically computes the event statistics such as duration, start/end eye positions, average/peak velocity, and amplitude based on the eye samples included in the saccade event. Properties of the neighboring events are also updated following the creation of the new event.

5.5 Blink Events

In an EyeLink recording file, a blink event brackets parts of the eye-position data where the pupil size is very small, or the pupil in the camera image is missing or severely distorted by eyelid occlusion. Data Viewer reports a blink as part of a saccade event and therefore events in the Event List of the Inspector Window appear in a sequence like Fixation -> Saccade -> Blink -> Fixation. It is important to maintain this event sequence in order to achieve sensible report statistics.

Blink events can be toggled on/off by clicking the Toggle Blink Event Visibility button . Blinks are represented as a colored solid line in both the Spatial Overlay View and the Temporal Graph View. Each field of the blink event properties is listed in the following table. Fields that are editable in the viewer are marked with an asterisk.

Field	Contents
Label *	Label of the blink.
Eye	The eye to which the current blink event is associated.
Start Time	Trial time (in milliseconds relative to the start of the current trial) when the blink starts.
End Time	Trial time (in milliseconds relative to the start of the current trial) when the blink ends.
Duration	Duration of the blink.
Hidden	Whether the current blink is hidden from viewing.
Color *	To achieve better visibility, the color of the currently selected blink can be changed by clicking on the color toolbox.

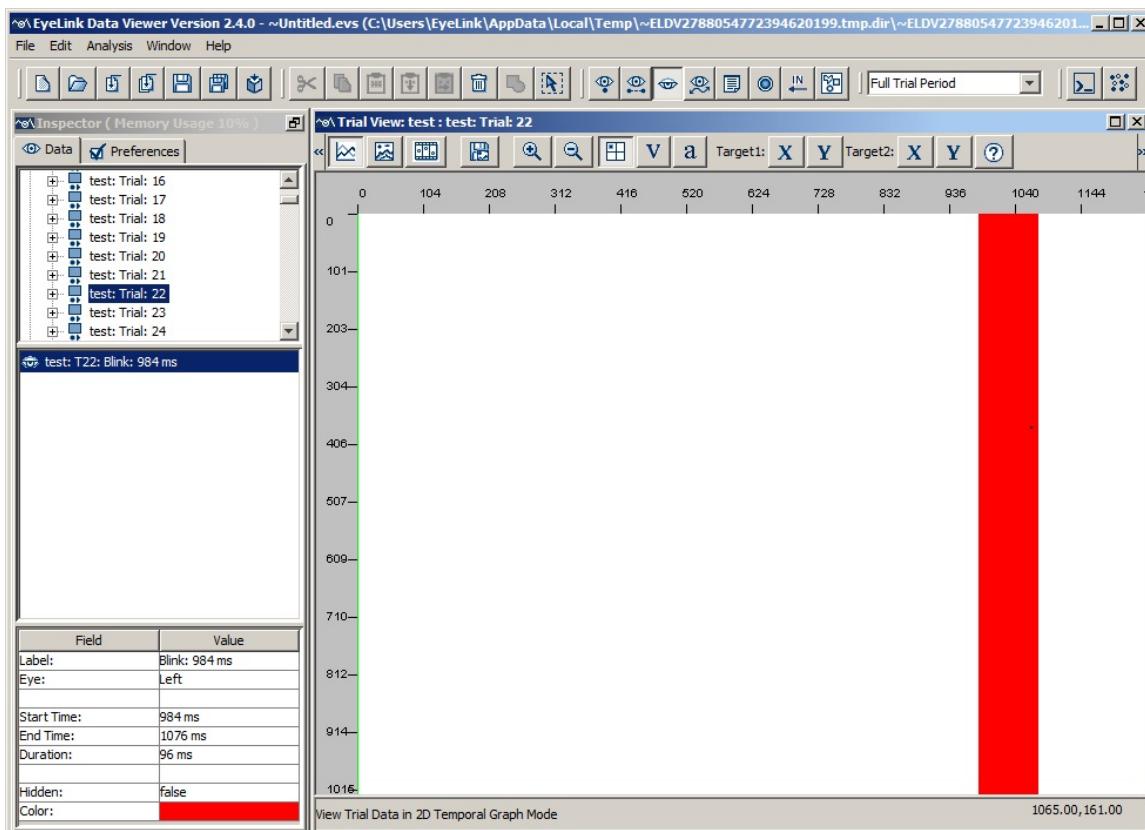


Figure 5-6. Sample Temporal Graph View of Blink Events

5.6 Messages

Messages, including messages for built-in EyeLink commands, can be placed in the EDF file to mark the start and end of a trial or important events such as display changes.

Message events can be toggled on/off by clicking the **Toggle Message Event Visibility** button  in the application desktop toolbar. A message is represented as a colored triangle at the top of the Temporal Graph View and a colored square in the Spatial Overlay View, centered on the gaze position at the time of the message. Each field of the message event property is listed in the following table. Fields that are editable in the viewer are marked with an asterisk.

Field	Contents
Label *	Label of the message.
Time	Trial time (in milliseconds relative to the start of the current trial) when the message was presented. Note that if the message is presented before the trial recording starts, a negative time value will be displayed.
Command	If the message is a command message, this lists the actual command used. The commands include simple drawing, built in audio messages, interest area commands, etc. The display commands and audio commands are not shown in the message list unless the “Include Display Command Messages” and “Include Display Command Messages” settings in the Data Filters preferences have been enabled.
Text	Message text.
X, Y	Concurrent gaze coordinates when the message is recorded (-100 if no gaze information is available for the time of the message event).
RT End Event *	Whether the current message is the reaction time end event (see section 6.3.1 for reaction time definition).
Hidden	Whether the current message is hidden from viewing.
Color *	To achieve better visibility, the color of the currently selected message can be changed by clicking on the color toolbox.

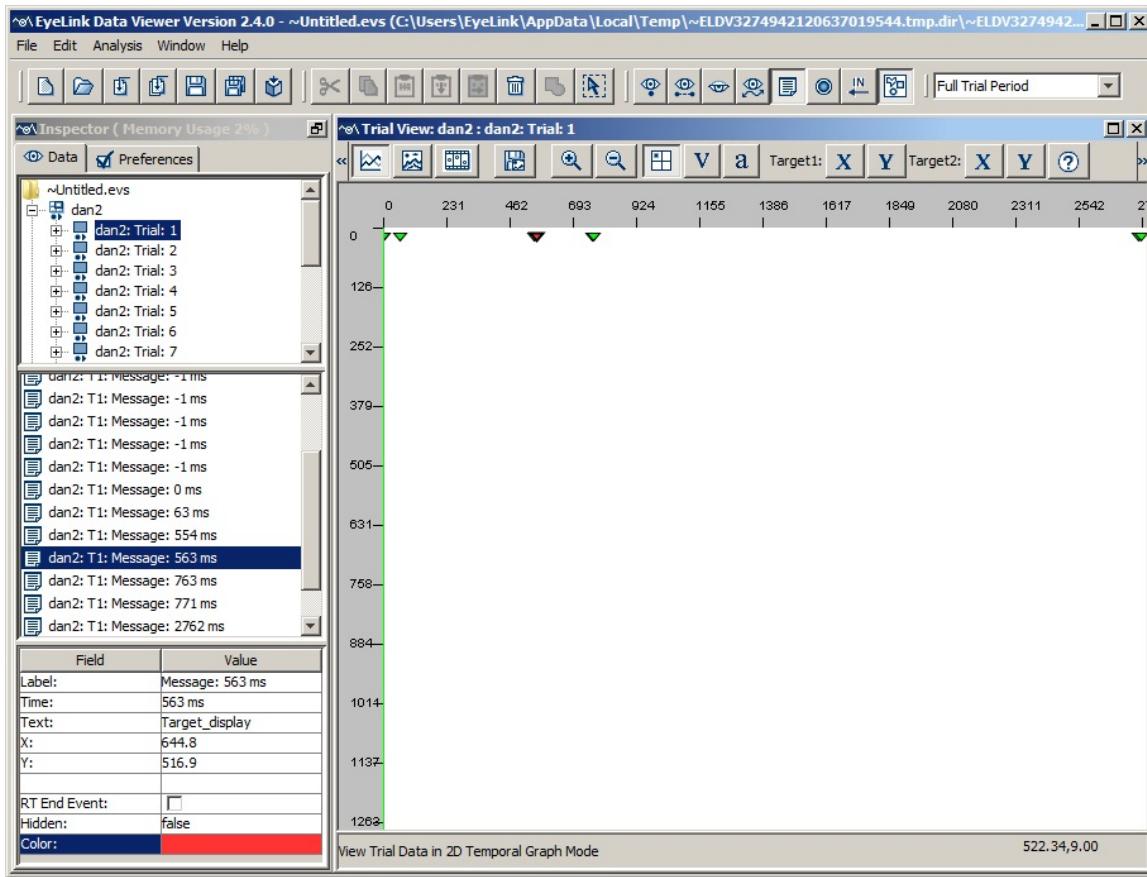


Figure 5-7. Sample Temporal Graph View of Message Events.

When Aggregate Mode is enabled, messages across all of the trials in the trial group will be drawn in the Spatial Overlay View. To more easily identify the source of the messages, users may apply color coding by enabling the “Apply Coloring to Visible Events” option in the trial node or the Recording session node, then choosing the intended color. While all of the messages can be selected, only messages from the currently active trial can be modified.

5.6.1 Inserting a New Message

New messages can be added to the Data Viewing session by clicking the right mouse button and choosing the “Add New Message” option. In the following dialog box (see Figure 5-8), fill in the intended text in the “Message” field and the value of the time (either a value relative to the start of the trial or the start of the currently selected interest period, or an absolute EDF file time). The default value for the time is set to the current playback position in the Animation View, the current cursor line position in the Temporal Graph View, and 0 in the Spatial Overlay View.

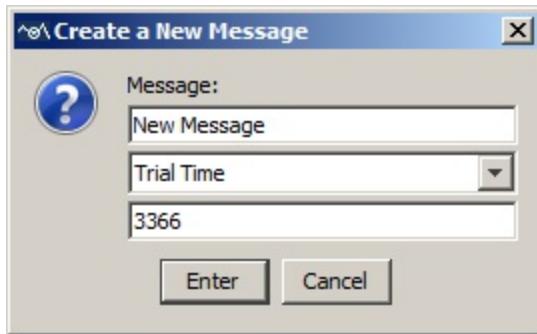


Figure 5-8. Inserting a New Message in a Data Viewing Session

5.6.2 Import Message List

Experiments should place certain messages into the EDF file to enable Data Viewer to process the files more efficiently. Examples of these commands include defining the image to overlay, specifying trial variables, defining the start time of an RT definition, etc. These messages will be time-stamped with an accuracy of 1 millisecond from the time sent, and can be used to mark important events such as display changes. If users forgot to write these messages when the experiment was created, these messages can still be imported from a text file.

The loaded message list file must be a plain tab-delimited text file. Each line must be a valid EyeLink MSG line in the format of:

MSG EDF_time [Offset] Message_text

or:

MSG -Trial_Index [Offset] Message_text

where:

- The EDF_time/Trial_Index value must be an integer. The sign of this field determines whether it will be treated as EDF_time or Trial_Index. If the value is positive, it is treated as EDF_time, the absolute EDF timestamp to be used for the message. For example, a value of 62798072 for the EDF_time field will place the message into the trial that includes the time 62798072. If the value is negative, it is treated as the Trial_Index, and the message will be assigned to the trial with that index value. For instance, a Trial_Index value of -1 would mean the first trial in the file, and -4 would mean the 4th trial. If no offset value is included after the Trial_Index, the message EDF time will be set to the start of the currently-applied interest period. (If the default Full Trial Period is currently applied, the message will be set to the start time of the trial.)
- "Offset" is optional, and must be an integer if specified. If a positive EDF_time is used, the Offset is subtracted from EDF_time to generate the real message time. For example, a message line of "MSG 2435806 -14 !V APLAYSTART 0 1 waves/1.wav" suggests that the event the message was referring to (APLAYSTART) actual happened at time 2435820 (as 2435806 - (-14) = 2435820). If a negative Trial_Index value is specified instead, the Offset is used

- to specify the time relative to the currently-selected interest period (or to the start of the trial if the default Full Trial Period is selected). As with EDF_time, Offset values used with Trial_Index will be subtracted from the start time of the currently selected interest period. A negative Offset value thus specifies a time after the start of the currently selected interest period, and a positive value specifies a time before the start of the interest period.
- "Message_text" can be any string up to 100 characters in size that starts with a non-numeric character.
 - Lines that do not follow these rules are ignored.

For example,

```

MSG 2435806 -14 !V APLAYSTART 0 1 waves/1.wav
MSG 2436376 -14 !V APLAYSTOP 12578 1 waves/1.wav
MSG 62798072 0 POSN 174 384
MSG 62798072 0 POSN 185 384
MSG -1 -1500 VERB_ONSET
MSG -2 -1800 VERB_ONSET

```

To load the message list file:

- 1) Select the EDF file label in the tree view panel of the Inspector Window.
- 2) Click the right mouse button and select "Import Message List".
- 3) In the following "Open" dialog box, go to the directory where the message list file is stored and choose the file.

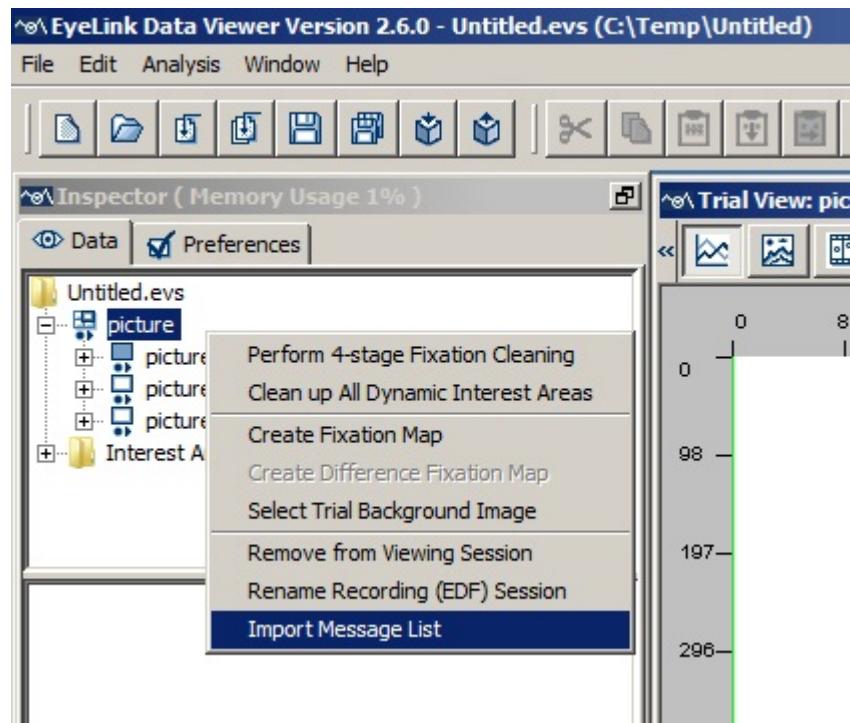


Figure 5-9. Import Message List File

After the message list file is imported into the session, a dialog box will be presented to show the number of valid messages imported.

5.7 Button Events

If an optional, supported button box is attached directly to the Host PC, participants' responses can be recorded to the EDF file for accurate synchronization with the eye movement data. Each button press or release is reported as a button event in Data Viewer to reflect a change in the state of the button box. Button events can be toggled on/off by clicking the Toggle Button Event Visibility button  . A button event is represented as a colored triangle in the Temporal Graph View and a colored square in the Spatial Overlay View, centered on the current gaze position. The following table lists the properties of a button event. Fields that are editable in the viewer are marked with an asterisk.

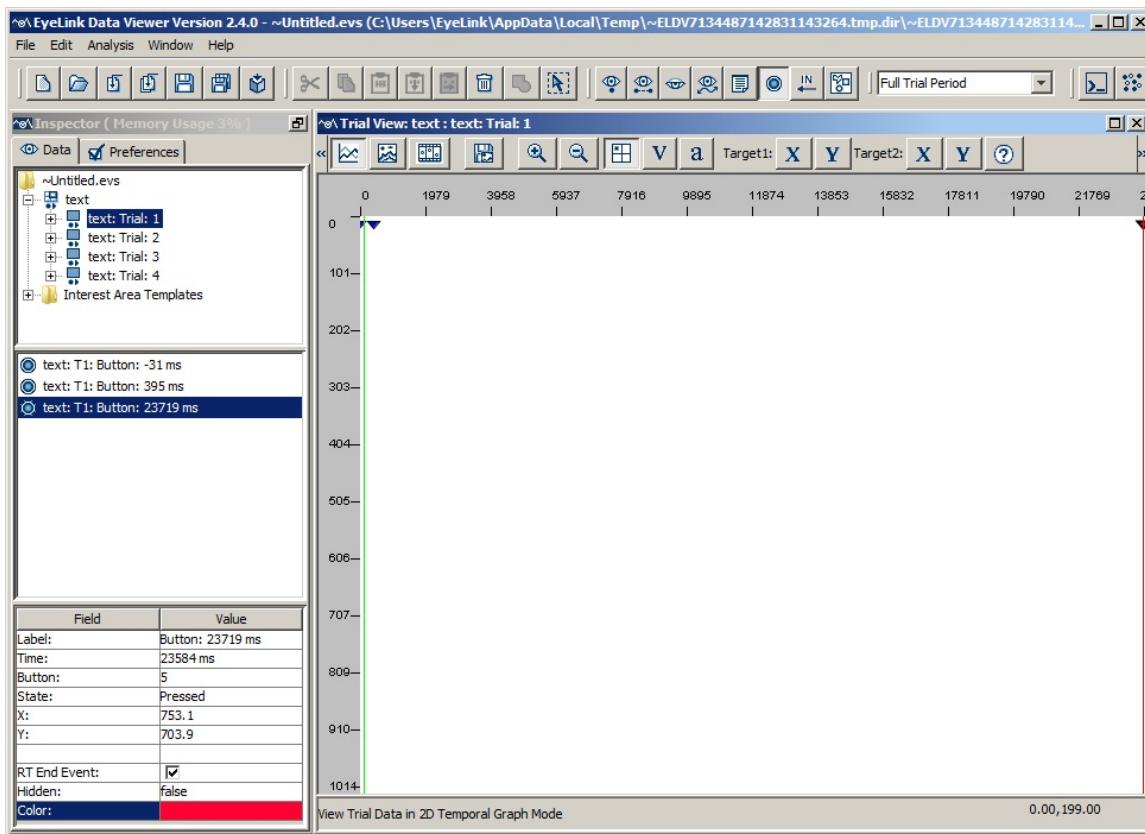


Figure 5-10. Sample Temporal Graph View Showing the Button Events .

Field	Contents
Label *	Label of the button event.
Time	Trial time (in milliseconds relative to the start of the current trial) when the button was pressed/released. Note that if the

	button event occurs before the trial starts, a negative time value will be displayed.
Button	Button ID.
State	Button pressed or released.
X, Y	Concurrent gaze coordinates when the button is pressed/released (-100 if no gaze information was available for the time of the button event).
RT End Event *	Whether the current button event is the reaction time end event (see section 6.3.1 for reaction time definition).
Hidden	Whether the current button event is hidden from viewing and output report.
Color *	To achieve better visibility, the color of the currently selected button event can be changed by clicking on the color toolbox.

5.8 Input Events

EyeLink host software can monitor the status of the input port data lines on the host PC (e.g., the digital input port of the supported analog card, the status/data register of the parallel port on the host PC with proper configurations) and record the input data to the EDF file. Any changes in state of the input port data lines, if recorded to the EDF file, will be reported as an INPUT event in Data Viewer. Input events can be toggled on/off by clicking the Toggle Input Event Visibility button . An input event is represented as a colored triangle in the Temporal Graph View and a colored square in the Spatial Overlay View, centered on the current gaze position. The following table lists the properties of an input event. Fields that are editable in the viewer are marked with an asterisk.

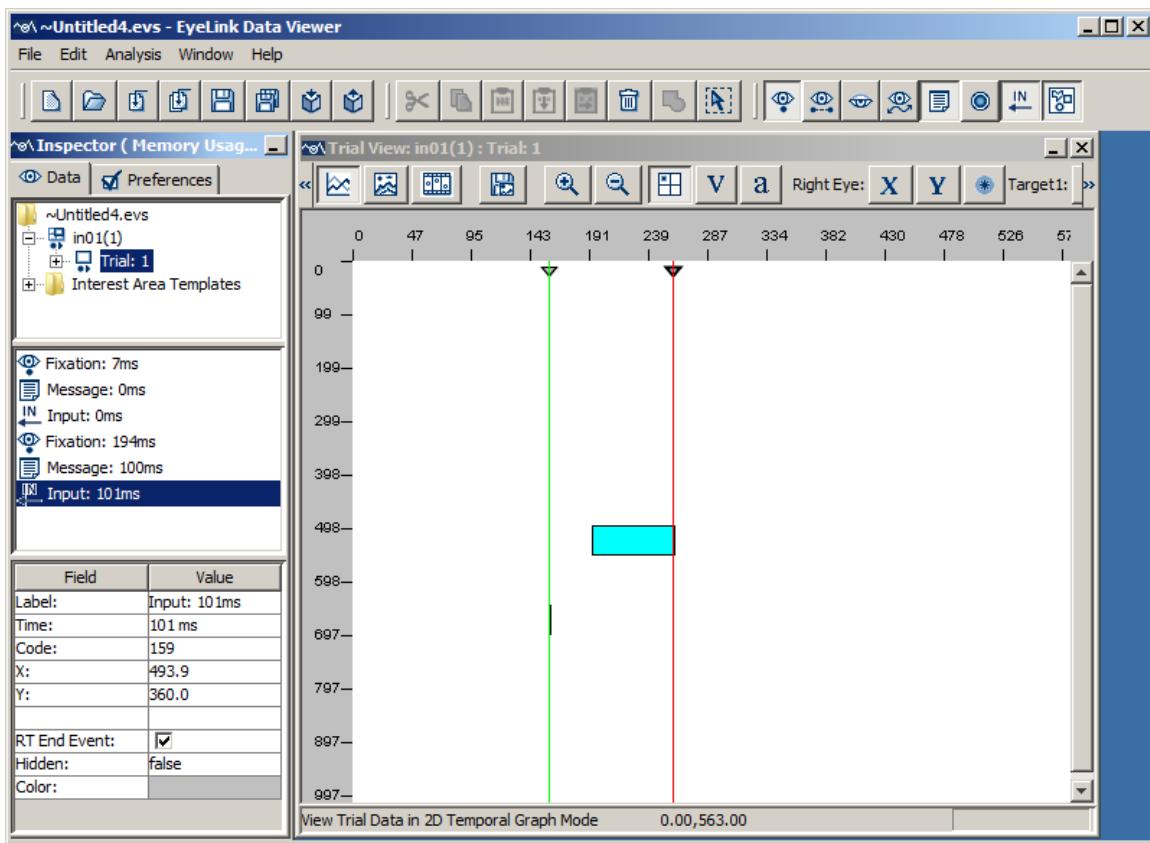


Figure 5-11. Sample Temporal Graph View Showing the Input Events.

Field	Contents
Label *	Label of the input event.
Time	Trial time (in milliseconds relative to the start of the current trial) when the input event was received. Note that if the input is received before the trial starts, a negative trial time value will be displayed.
Code	The value of the input event received (it should be a number between 0 and 255).
X, Y	The X, Y coordinate of the eye position when the input event is recorded (NaN if no gaze information is available at the time of the input event).
RT End Event *	Whether the current input event is the reaction time end event (see section 6.3.1. for reaction time definition).
Hidden	Whether the current input event is hidden from viewing and output report.
Color *	To achieve better visibility, the color of the currently selected input event can be changed by clicking on the color toolbox.

5.9 Samples

Samples can be toggled on/off by clicking the Toggle Eye Sample Visibility button  in the desktop toolbar. In the Spatial Overlay View (Figure 5-12, left panel), the samples are overlaid on the trial image, forming the sample path of the viewing process. Please note that when the Aggregate Mode button is enabled, unlike all other events, only samples corresponding to the current active trial are displayed in the Trial View Window. In the Temporal Graph View (Figure 5-12, right panel), the *Xy* coordinates of the samples, as well as the concurrent pupil size, are plotted as a function of trial time.

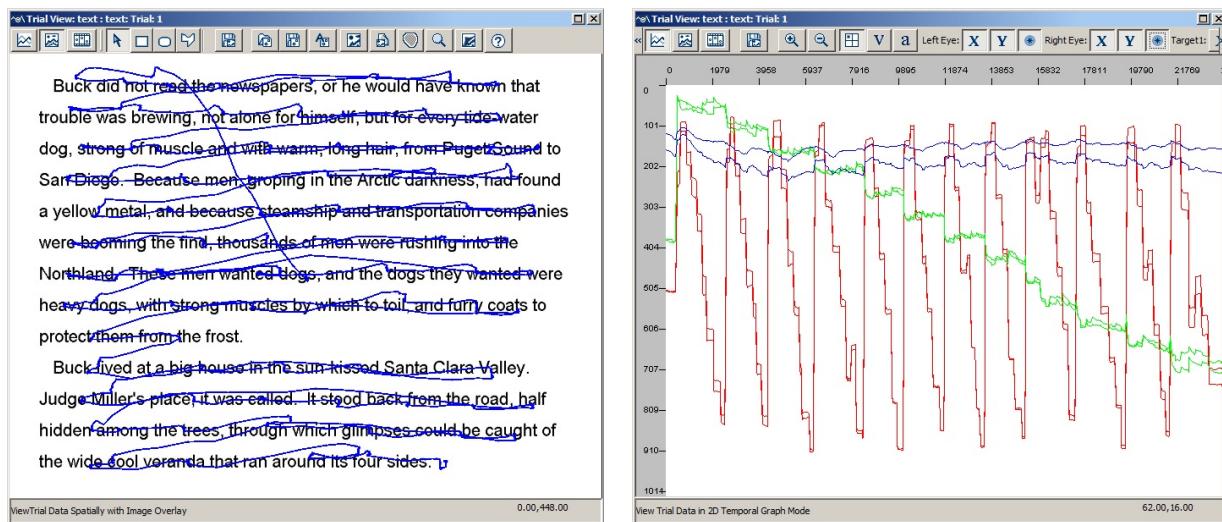


Figure 5-12. Sample Spatial Overlay View (left) and Temporal Graph View (right) of Raw Sample Data

Note: Version 2.1 of Data Viewer loads the samples into the viewing session by default. If you are using an old version of Data Viewer or default settings from old viewing sessions, please check the Load Samples property in the Data Loading preference settings. If you want this change to be persistent over future viewing sessions, you may consider saving this as a default setting. This can be done by selecting any preference tree node, clicking the right mouse button and selecting "Save Properties as Defaults" (see Preference Settings).

Tip: In the Spatial Overlay View, if samples are visible at the same time as events, when an event is selected, all samples contained within that event are also selected.

5.10 Interest Areas

To work on interest areas in a viewing session, first make sure the main Toggle Interest Area Visibility button  in the application toolbar is turned on. To access interest area data for individual trials, expand the trial by clicking on the  node next to it in the tree

view panel of the Inspector Window (see Figure 5-13). The node will be labeled "Custom Interest Area Set" if custom interest areas are loaded or created or "Empty Interest Area Set" if no interest areas are defined. The middle panel of the Inspector Window lists all of the available interest areas for the currently selected trial. The lower panel shows the properties of the selected interest area.

The following sections discuss the format and properties of interest areas, how to create (manually, through image segmentation, mouse record, or template import), delete, copy/paste, save interest areas, and how to modify interest areas (e.g., move, convert, resize/rescale, flip, rotate, edit points, split, merge, link/unlink). Most of the operations can be performed through the right-click context menu when an interest area is selected. Version 3.1 of Data Viewer added an “IA Shape Actions” option to the right-click context menu to support batch processing of interest area rotation, conversion, flipping, resizing/rescaling or moving, when one or multiple interest areas are selected from the Trial View Window, when an interest area set is selected from a trial node in the treeview, or when a trial group is selected.

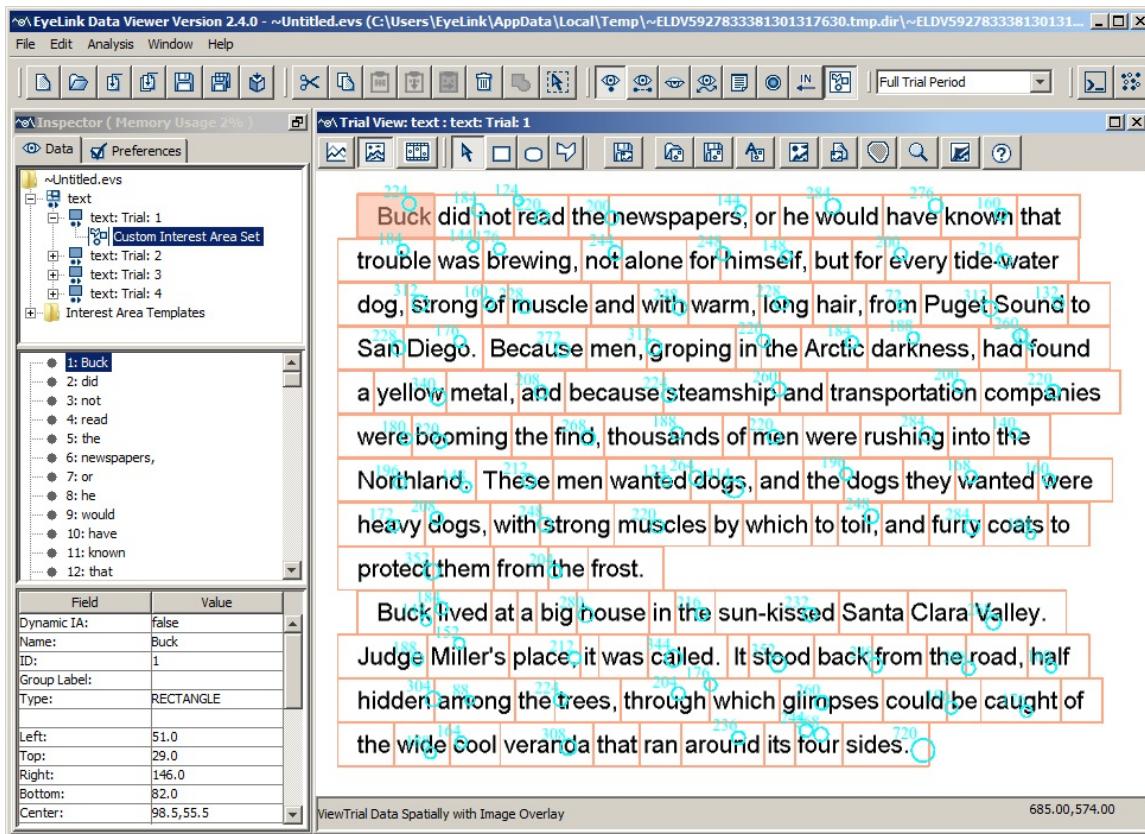


Figure 5-13. Sample Text Display Overlaid with Interest Areas

5.10.1 Format of static and dynamic interest areas

Versions 2.1 and above of Data Viewer allow both static and dynamic interest areas. Static interest areas either have no time stamp (in which case they are present for the entire duration of the trial or selected Interest Period) or a single time stamp which indicates the time of their onset relative to the beginning of the trial. Dynamic interest areas have two time stamps - the first indicating the time of their onset, and the second indicating the time of their offset.

Thus, interest areas can be encoded in one of the following three formats:

Type 1 (no time stamp):

RECTANGLE <id> <left> <top> <right> <bottom> [label]

ELLIPSE <id> <left> <top> <right> <bottom> [label]

FREEHAND <id> <x1, y1> <x2, y2> ... <xn, yn> [label]

e.g., RECTANGLE 1 0 0 512 384 images\hearts.jpg

Type 2: (one time stamp)

start_offset RECTANGLE <id> <left> <top> <right> <bottom> [label]

start_offset ELLIPSE <id> <left> <top> <right> <bottom> [label]

start_offset FREEHAND <id> <x1, y1> <x2, y2> ... <xn, yn> [label]

e.g., -500 RECTANGLE 1 0 0 512 384 images\hearts.jpg

Type 3: (two time stamps)

start_offset end_offset RECTANGLE <id> <left> <top> <right> <bottom> [label]

start_offset end_offset ELLIPSE <id> <left> <top> <right> <bottom> [label]

start_offset end_offset FREEHAND <id> <x1, y1> <x2, y2> ... <xn, yn> [label]

e.g., -500 -1500 RECTANGLE 1 0 0 512 384 images\hearts.jpg

The first two examples are static interest areas, and the third example is a dynamic interest area. The "start_offset" and "end_offset" values are usually negative, indicating a future time relative to the start of the currently selected interest period (the default Full Trial Period will be used if no interest periods have been created for the viewing session). For example, if the current interest period starts at 800 ms following the trial start, the particular interest area of the Type 3 example above would start at 1300 ms and end at 2300 ms following the trial start. If the interest areas are read from a file that a message in the EDF file specifies (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.

As with other events in a viewing session (such as fixations and saccades), interest areas are displayed in the event list. Static interest areas are represented by a dot and dynamic ones are represented by a folder; there will be a separate folder for each of the dynamic interest areas in a trial. Each dynamic interest area may contain several instances to describe the position of the interest area across different time segments (a dynamic interest area object must contain at least one instance). For example, a fixation screen (with a "FIXATION_SCREEN" message written to the EDF file) is shown for 1000 ms before a target screen (with a "SYNCTIME" message) is presented with a red object

appearing at (674, 546, 774, 646). The object moves to (462, 634, 562, 734) at time 800 ms after its onset, to (249, 546, 349, 646) at 1600 ms, and to (162, 334, 262, 434) at time 2400 ms and stays there for 800 ms before a blank screen is shown (with a “BLANK_SCREEN” message). A dynamic interest area of four instances can be coded (shown below) to describe the behavior of the red object, assuming that an interest period is created starting from the SYNCTIME message and this interest period is selected.

0	-799	RECTANGLE	2	674	546	774	646	red
-800	-1599	RECTANGLE	2	462	634	562	734	red
-1600	-2399	RECTANGLE	2	249	546	349	646	red
-2400	-3199	RECTANGLE	2	162	334	262	434	red

You will see the following four entries in the “2:red” folder of the event list, representing four instances of the dynamic interest area (2:red). See section 5.10.24 for a summary of the various methods available for creating dynamic interest areas in a viewing session.

- 2:red (0:799)
- 2:red (800:1599)
- 2:red (1600:2399)
- 2:red (2400:3199)

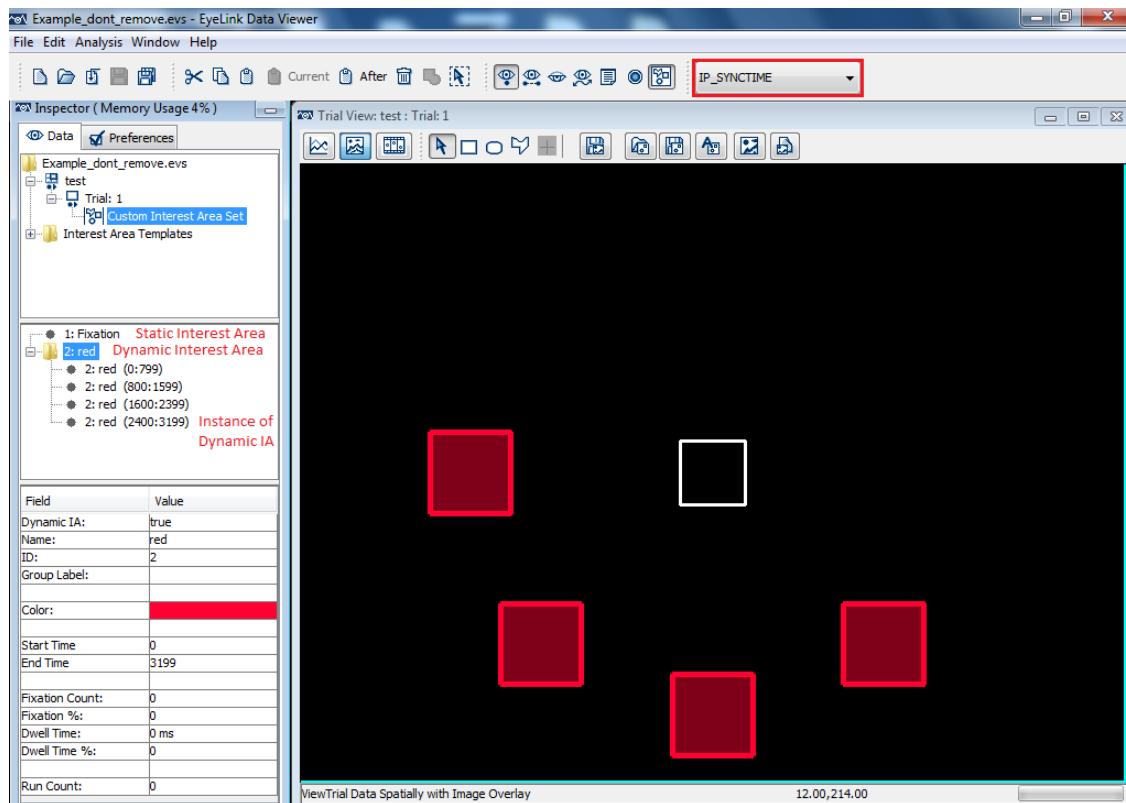


Figure 5-14. Sample Interest Area Instances in One Interest Period

The start time and end time of the instances will be different if you then change the interest period. For example, the start time and end times will look like the following if

you create and select a new interest period starting from the “FIXATION_SCREEN” message time.

-1000 -1799	RECTANGLE2	674	546	774	646	red
-1800 -2599	RECTANGLE2	462	634	562	734	red
-2600 -3399	RECTANGLE2	249	546	349	646	red
-3400 -4199	RECTANGLE2	162	334	262	434	red

You will see the following four entries in the “2:red” folder of the event list, representing four instances of the dynamic interest area (2:red) under the new interest period.

- 2:red (1000:1799)
- 2:red (1800:2599)
- 2:red (2600:3399)
- 2:red (3400:4199)

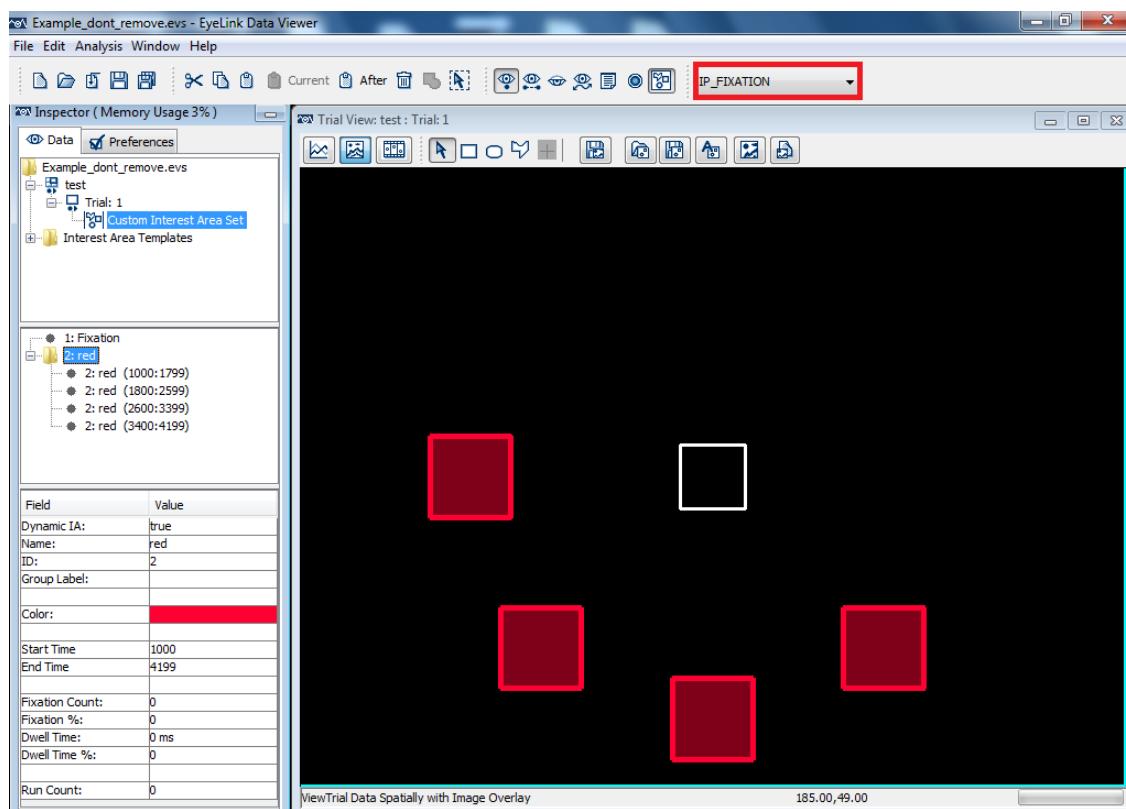


Figure 5-15. Sample Interest Area Instances in Another Interest Period

Clicking on the instance in the event list will highlight the interest area in the Spatial Overlay View and vice versa. If the Trial View Window is set to the Animation Playback View, clicking on the instance will set the playback time of the View to the start time of the instance if the target interest area is not currently displayed.

5.10.2 Interest Area Properties

The following table lists the properties of an interest area. Fields that are editable in the viewer are marked with an asterisk (*). When the Aggregate Mode is enabled, additional statistics are provided for the interest area aggregated across all trials in the trial group – those properties are marked with a #.

Property	Description
Dynamic IA	Whether the current interest area is dynamic (if checked) or static (unchecked). This field is not directly editable. You can convert a static interest area into a dynamic one or vice versa through the “Convert to DynIA/StaticIA” option in the popup menu when you right click on the interest area.
Name *	Text of the interest area.
ID	Ordinal ID of the interest area.
Group Label	Label of the group to which the current interest area belongs.
Type	Type of interest area (rectangular, elliptical, or freehand).
Number of Instances	The total number of individual instances of the current dynamic interest area. This is only applicable when the dynamic interest area folder is selected, not individual instances.
Interpolation	Checking this box makes all instances of the interest area interpolate their position and shape across a time frame starting at the start time of the current instance and ending at the start time of the next instance. Basically, enabling this option will make all instances of the interest area move to the location of the next instance from the location of the current instance (over the time frame determined by subtracting the start time of the first instance from the start time of the next instance). The “Allow Interpolation” property in the Output/Analysis preferences should also be enabled to see the effect.
Left *	X-coordinate of the left-most edge of a rectangular or elliptical interest area.
Top *	Y-coordinate of the top-most edge of a rectangular or elliptical interest area.
Right *	X-coordinate of the right-most edge of a rectangular or elliptical interest area.
Bottom *	Y-coordinate of the bottom-most edge of a rectangular or elliptical interest area.
Center *	Pixel coordinate (x, y) for the center of the interest area. This is only applicable for Rectangle and Ellipse interest areas.
Bound's Center *	The center of the bounding rectangle for the freehand interest area.
Selected Freehand Point *	This field is usually empty and not editable. The coordinates of the vertex will be displayed here only when the vertex of a freehand interest area is selected for modification. To do this, first select the freehand interest area, then hold the Alt key

	down while clicking the left mouse button on top of the vertex. The coordinates of the vertex are then updated constantly, and users can edit the coordinates by typing the number in rather than using the mouse.
Angle	Angle of the rotated interest area (or its instance) relative to its original orientation.
Pixel Area	Area of the interest area in pixels.
Color *	To achieve better visibility, the color of the interest area or its instances can be changed through a color selector.
Time	EDF file time of the message specifying the interest area if it was created using the '!V IAREA' command during recording. If the interest area was created manually or from an interest area template file during the viewing session, the time value will be -1 and this attribute will not be visible from the property table. This time stamp is useful in case you need to filter interest areas based on the currently-selected interest period (see "Show Interest Areas Pre Interest Period" and "Show Interest Areas Post Interest Period" preferences in "Preferences -> Data Filters"). This field is for static interest areas only.
Start Time relative to IP / End Time relative to IP	The start time / end time (in milliseconds) of the dynamic interest area or its instance relative to the start of the currently selected interest period. This field is for dynamic interest areas only. After instances of dynamic interest areas are created in the viewing session or imported from an interest area file, the start time and end time will be adjusted if a new interest period is chosen.
Start Time relative to Trial / End Time relative to Trial	The start time / end time (in milliseconds) of the dynamic interest area or its instance relative to the start of the trial. This field is for dynamic interest areas only and its value remains fixed regardless of the interest period that is currently selected.
(Instance) Fixation Count	Total number of fixations within the interest area (instance) in the current interest period.
(Instance) Fixation %	Percentage of total fixations in a trial falling within the current interest area (instance) in the current interest period.
(Instance) Dwell Time	Total time (in milliseconds) spent on the current interest area (instance) in the current interest period.
(Instance) Dwell Time %	Percentage of trial dwell time spent on the current interest area (instance) in the current interest period.
(Instance) Run Count	Number of times the interest area (instance) was entered and left in the current interest period.
Loaded Trial Count #	Total number of trials loaded into memory for aggregated data analysis (if all trials are loaded, this should be total number of trials in the trial group). This property is only visible if the Aggregate Mode is turned on.

Loaded Trial Indices #	A list containing indices of trials in the trial group that are loaded into memory for aggregated data analysis. This property is only visible if the Aggregate Mode is turned on.
Number of Trials Using this IA #	Total number of trials in the current trial group that have an interest area with this ID in the current interest period.
Average Fixation Count #	Average number of fixations falling within the interest area in the current interest period. This is calculated as the total number of fixations into the interest areas with this ID, divided by the number of trials using this interest area (TRIALS_USING_THIS_IA). This property is only visible if the Aggregate Mode is turned on.
Average Fixation Count % #	Percentage of total fixations in a trial falling in the current interest area. This is calculated as the total number of fixations into the interest areas with this ID, divided by the total number of fixations in those trials using this interest area (TRIALS_USING_THIS_IA). This property is only visible if the Aggregate Mode is turned on.
Average Dwell Time #	Total time (in milliseconds) spent in the current interest area in the current interest period. This is calculated as the sum of the duration of all fixations into the interest areas with this ID, divided by the number of trials using this interest area (TRIALS_USING_THIS_IA). This property is only visible if the Aggregate Mode is turned on.
Average Dwell time % #	Percentage of trial dwell time spent on the current interest area. This is calculated as the sum of all fixation duration into the interest areas with this ID, divided by the total fixation dwell time of those trials using this interest area. This property is only visible if the Aggregate Mode is turned on.
Average Run Count #	Average number of times the Interest Area was entered and left (runs). This is calculated as the sum of run count from all trials using this interest area, divided by the number of trials using this interest area (TRIALS_USING_THIS_IA). This property is only visible if the Aggregate Mode is turned on.
Percent of Trials Visited #	This is calculated as the total number of trials with at least one fixation on the interest area with this ID divided by the total number of trials using this interest area (TRIALS_USING_THIS_IA). This property is only visible if the Aggregate Mode is turned on.

Note: The coordinate information (Left, Top, Right, and Bottom) is applicable to rectangular and elliptical interest areas only.

5.10.3 Manually Creating Interest Areas

To create an interest area:

- 1) Select the Trial View Window by clicking on or in it, so that the window is active.

- 2) Select the Interest Area shape that you want to create from the toolbar of the Trial View Window:

	Rectangular Interest Area Shape
	Ellipse Interest Area Shape
	Freehand Interest Area Shape

For rectangle and ellipse interest areas:

- 3) Hold down the left mouse button in the top-left corner of where you want the interest area to be created.
- 4) Drag the mouse down to the right until the selection region covers the area that you want to select.
- 5) Release the mouse button.
- 6) In the “New Area of Interest Data” dialog box, fill out the “Label” field. If you are creating a static interest area, leave the “Dynamic IA” box unchecked and press Enter. For a dynamic interest area, you will need to further configure its properties - please see the subsection below on configuring dynamic interest areas for details.
- 7) Repeat steps 3-6 to create more interest areas of the same type. Press the Select Mode icon () from the toolbar of the Trial View Window to stop creating interest areas.

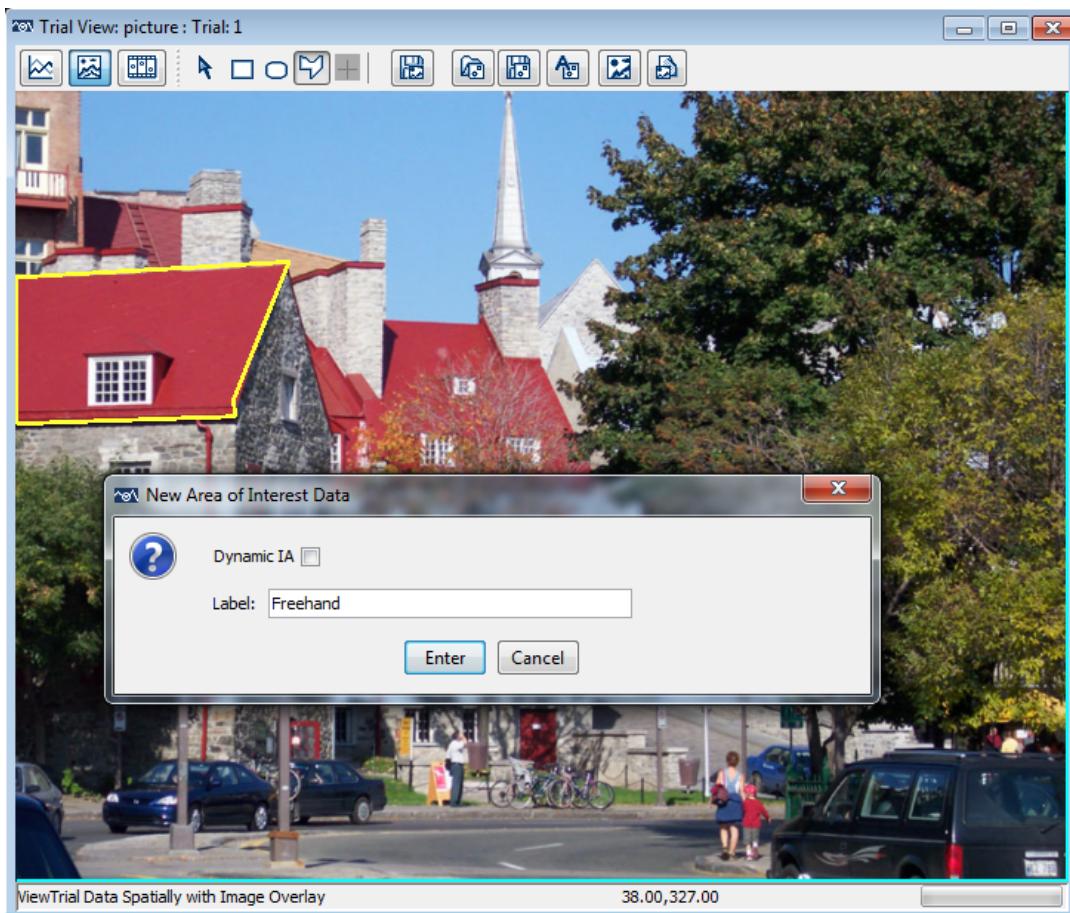


Figure 5-16. Creating a Freehand Interest Area

For Freehand interest area shapes:

- 3) Click the left mouse button on the first point of the shape you want to create.
- 4) Move the mouse to the second point and click the left mouse button again. A line joining the points will be displayed.
- 5) Repeat step 4 for each point of the freehand shape.
- 6) Press the ENTER key when you have specified all points you wish to create. Data Viewer will automatically join the first and last points of the interest area. Note that you can cancel the creation of a freehand interest area by pressing the Esc key.
- 7) In the “New Area of Interest Data” dialog box, fill out the “Label” field. If you are creating a static interest area, leave the “Dynamic IA” box unchecked and press Enter. For a dynamic interest area, you will need to further configure its properties - please see the following section for details.
- 8) Repeat steps 3-7 to create more interest areas of the same type. Press the Select Mode icon () from the toolbar of the Trial View Window to stop the creation process.

Note: Please avoid creating self-intersecting freehand interest areas, as this will cause problems for the proper calculation of pixel area and determination of whether the gaze position is within the interest area.

Configuring Dynamic Interest Areas:

If the “Dynamic IA” checkbox is ticked additional properties will be shown in the New Area of Interest Data dialog:

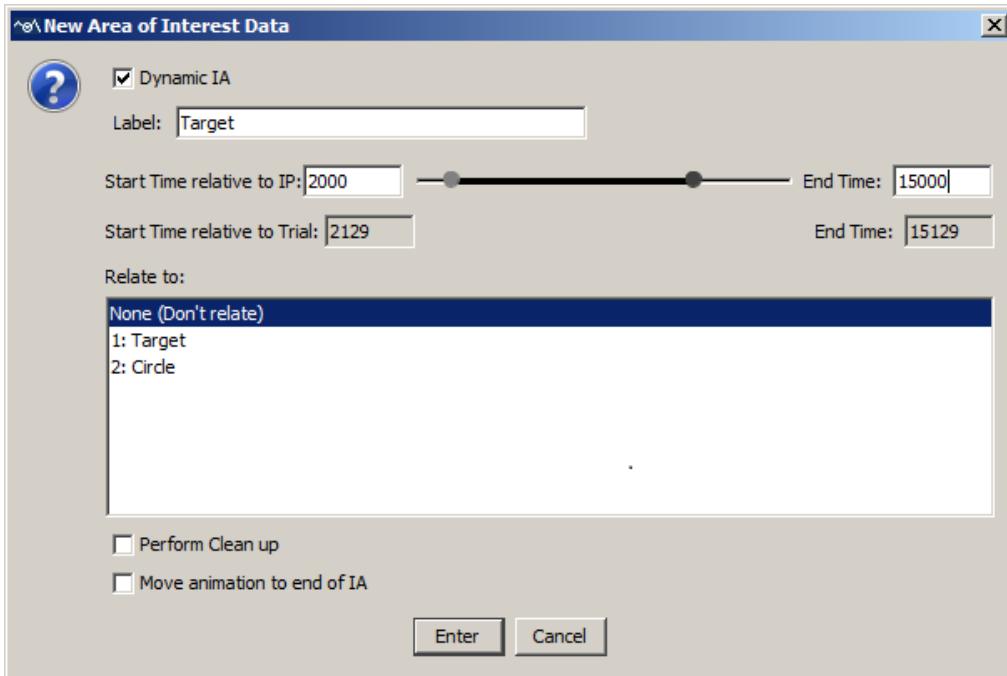


Figure 5-17. Sample Interest Area Instances in another Interest Period

- 1) Start Time relative to IP: The start time (in milliseconds) of the current instance of the interest area relative to the start of the currently selected interest period. **It is critical that an interest period has been created and selected before creating a dynamic interest area.** You can either type in the value in the edit box or click the left indicator on the sliding bar and drag it to the intended position.
- 2) IP End Time: The end time (in milliseconds) of the current instance of the interest area relative to the start of the interest period. You can either type in a value in the edit box or click the right indicator on the sliding bar and drag it to the intended position.
- 3) Start Time relative to Trial: The start time (in milliseconds) of the current instance of the dynamic interest area relative to the start of the trial. This field is read-only and changes along with the “Start Time relative to IP”.
- 4) Trial End Time: The end time (in milliseconds) of the current instance of the dynamic interest area relative to the start of the trial. This field is read-only and changes along with the “Trial End Time”.
- 5) “Relate to”: this specifies whether the current instance is a member of a new interest area (“None (Don’t relate)”) or a new instance of an existing dynamic interest area. If the latter is the case, select the existing interest area from the list below. The newly-created instance will be created in the folder of the selected interest area in the event list.

- 6) Perform Clean up: If this option is checked, Data Viewer will perform a Clean up operation on the instances of the interest area (e.g., to trim instances with overlapping times - see section “5.10.13 Cleaning Up Dynamic Interest Areas” below).
- 7) Move animation to end of IA: If this option is checked, the playback time of the Animation View will be set to 1 millisecond after the end point of the newly created interest area instance.

5.10.4 Creating Interest Area: Image Segmentation

If a trial image has already been loaded, Data Viewer can create interest areas for the trial by auto-segmentation. This is done by clicking the “Auto Segment Image to Interest Area” button () in the toolbar of the Spatial Overlay View window.

Note: If the trial already has existing interest areas, version 3.1 of Data Viewer prompts users to choose “Replace” (remove all of the existing interest areas for the trial), “Add to” (keep the existing interest area setup and create newer ones), or “Cancel” option when the Auto Segment button is clicked. Please note that auto segmentation is more feasible for those displays in which the individual items can be easily isolated, such as in reading and visual search studies where a background of a single color is present, but not good for some visual scenes in which the boundaries between individual elements are not clearly defined (see Section 8.9 on preference settings for image segmentation).

5.10.5 Saving Interest Areas

Interest areas that have been created for any one trial can be saved into a template file and re-used on other trials. To save interest areas:

- 1) Click the Save the Interest Area Set to Disk button () on the toolbar of the Trial View Window.
- 2) In the Save dialog box, go to the directory where the interest area set should be saved.
- 3) In the File name text box, type in the name of the file. Data Viewer will automatically fill in the file extension (.ias).
- 4) Press the Save button. **Note:** if it is the first time you save an .ias file in the viewing session, a prompt will appear asking if the .ias set should be saved as a template for use in the current session.

In the saved interest area file, static interest areas will not have a time stamp. For dynamic interest areas, the time stamps associated with each instance of the interest area will be based on the currently selected interest period. So it is critical that the interest period is set correctly before saving the template. Please note that the time stamps will change if an incorrect interest period is selected when saving—this will mean that when the template is applied to other trials (when the interest period is set properly) the instances will not have the correct time stamps.

Note: If there are non-ASCII characters in the labels of the interest areas, you need to enable the “Use UTF8 Encoding” option in the “Output / Analysis” preferences to ensure the labels saved properly.

Version 3.2 or later of the software allows users to save the color and group label info into the interest area file so that this can be re-used in future sessions.

5.10.6 Importing Interest Area File (for a specific trial)

Interest areas from a file can be imported and applied to a specific trial.

- 1) Click the Import Area of Interest File button () on the toolbar of the Trial View Window
- 2) In the Open dialog box, browse to the location of the interest area file that you want to import and select it.
- 3) Click Import.

The interest areas imported from the file will be added on top of the existing interest areas in the trial. For dynamic interest areas, the start and end time will be mapped relative to the currently selected interest period. If no interest period is created for the session, the default “Full Trial Period” will be used.

5.10.7 Emptying an Interest Area Set

To empty the current interest area set for a trial:

- 1) Select the target trial in the tree view whose interest areas are to be emptied
- 2) In the property panel of the trial, find the entry “Interest Area Set” and choose “Empty Interest Area Set”.

Existing interest areas in a recording session file or a group of trials can be similarly cleared by setting the “Default Interest Area Set” entry of the property table to “Empty Interest Area Set”.

5.10.8 Loading Interest Area Templates

If the same interest areas are used across a group of trials, instead of repeating the procedure of creating interest areas for each individual trial, an interest area template can be used to supply the interest area information to a group of trials. To import an interest area template file into a viewing session:

- 1) From the application menu, choose:
File -> Import Data -> Interest Area Template
- 2) In the Load dialog box, browse to the location of the interest area (.ias) file(s) that you want to import and select it/them. Version 3.2 of Data Viewer now supports loading multiple interest area files on Mac OS X.

- 3) Click Load.

The interest area template files imported will be listed in the “Interest Area Templates” section, which is at the bottom of the tree view in the Inspector Window.

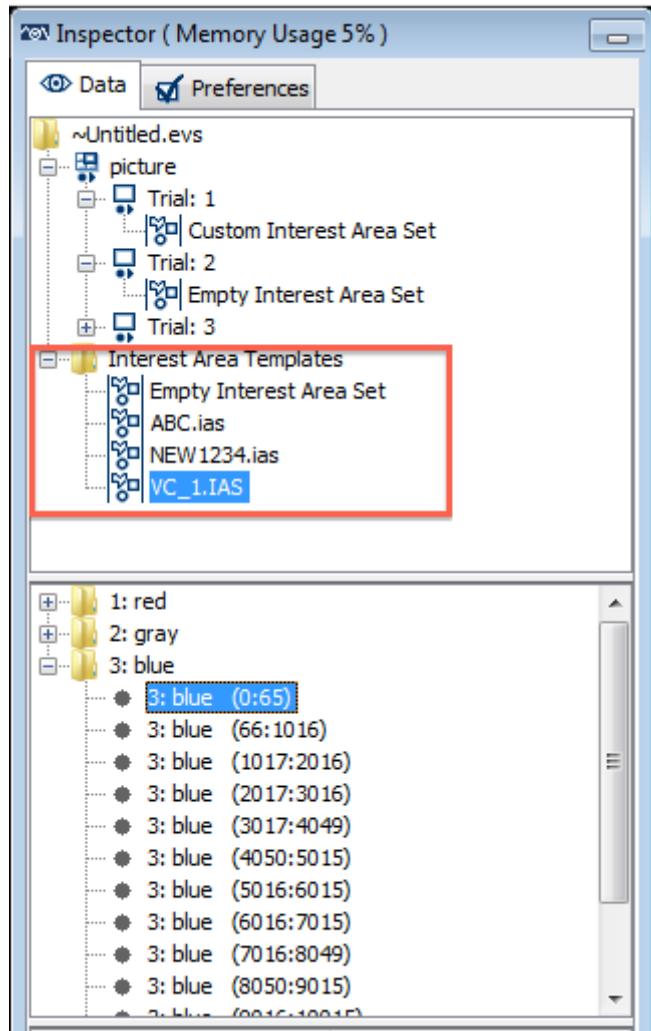


Figure 5-18. Interest Area Templates Listed in the Tree View

5.10.9 Using Interest Area Templates

An interest area template, if already loaded into the viewing session, can be used to apply the interest area data across a group of trials (see section 6.1.3 for information on the trial grouping feature of Data Viewer). To apply an interest area template to a trial or group of trials,

- 1) Click the viewing session icon (■) and perform trial grouping if necessary.
- 2) In the tree view panel of the data tab, select the trial/group onto which the interest area template should be applied.

- 3) In the property panel of the target trial or trial group, find the entry “Interest Area Set” (“Default Interest Area Set” for a trial group) and select the intended interest area template from the dropdown list.

Important: When applying an interest area template to a trial or a group of trials, the start time and end time of the dynamic interest areas that are applied to the trial/group of trials will be set relative to the currently selected interest period. If no interest period is created for the viewing session, the default “Full Trial Period” will be used. So it is very important that a proper interest period be created and selected before applying interest area templates containing dynamic interest areas to a trial or group of trials!

5.10.10 Deleting Interest Area Templates

Interest area templates can be deleted from the template list. In the tree view panel of the Inspector Window, find the "Interest Area Templates" folder where all of the interest area templates are located. Select the target interest area template from the list, click the right mouse button, and select "Delete". If the deleted interest area template is used by a trial, the "Interest Area Set" property of that trial will be set to "Empty Interest Area Set" and existing interest areas will be removed.

5.10.11 Selecting Interest Areas

To select an interest area or an instance of a dynamic interest area, place the mouse cursor over the interest area in the tree view window and click the left mouse button. The interest area is highlighted in both the Trial View Window and the event list. To select more than one interest area, hold down the Ctrl key on Windows or the Command key ⌘ on Mac OS X and select the desired interest area by left-clicking; repeat until all of the desired interest areas are selected. If all of the interest areas in a trial are to be selected, simply click the **Select All Visible Items** button () on the main application toolbar (or click the right mouse button and select “Select All”).

Selection can also be made from the event list in the Inspector Window by clicking on the “Custom Interest Area Set” node of the trial in the tree view and selecting the interest areas from the event list panel. The selected interest area will be highlighted in the Trial View Window. When an instance of a dynamic interest area is selected from the event list, the playtime of the animation view will be set to the start time of that instance.

Note: If you are not able to select any interest area or instance, please make sure none of the interest area shape buttons (, , or ) are active. You may press the Select Mode icon () from the toolbar of the Trial View Window to stop creating interest areas.

If there are eye events within the interest area to be selected, clicking on the interest area may end up selecting the eye events instead. To make a more precise interest area selection, you may toggle off the visibility of the eye events first, make the interest area selection, and then toggle the visibility of the eye events back on if desired.

5.10.12 Copying and Pasting Interest Areas

A new interest area can be created by copying and then pasting an existing one. Select the target interest area, click the right mouse button, choose the “Copy” option from the popup menu, and then choose the “Paste” option. The new interest area will be centered at the current mouse position if the “Paste to Current Mouse Position” option is enabled in the Output/Analysis preferences; otherwise, it will be pasted around the original copy, with or without an offset (according to the “Apply Offset to Pasted Items” setting).

The Copy-and-Paste procedure can be used to create a copy of an existing static interest area, the entire dynamic interest area folder, or an instance of a dynamic interest area.

Additional “Paste Current” and “Paste After” options are available after copying an instance of a dynamic interest area. The “Paste Current” option, applicable to the animation view only, will create a new interest area instance with the start time being the current playtime of the animation view. The duration of the new instance is the same as the original instance. The “Paste After” option is available in both the animation view and the Spatial Overlay View. This option will create a new interest area instance of the same duration immediately following the end time of the original one.

5.10.13 Cleaning Up Dynamic Interest Areas

When creating dynamic interest areas, you may occasionally create instances of an interest area that overlap in time. The overlapping interest area instances can pose a problem for data analysis (e.g., when calculating dwell time on a dynamic interest area). Data Viewer provides a clean up option so that you can fix any overlapping timing issues for an interest area, a trial, a group of trials, or the entire viewing session. When cleaning up two interest area instances with overlapping times, if the two instances start at the same time, the more recently-created one will be preserved; otherwise, the overlapping portion of the instance that starts earlier in time will be removed. For example, instance A (start time a_1 and end time a_2) starts before instance B (start time b_1 and end time b_2). The cleanup process will preserve the original instance B while trimming the original instance A so that only the portion from a_1 to b_1-1 remains.



Figure 5-19 Cleaning up Overlapping Dynamic Interest Area Instances

5.10.14 Mouse Record Mode

Mouse Record mode provides an easy interface to create new instances of dynamic interest areas in the Trial Playback Animation view. This mode allows you to copy the last instance of an interest area and insert new instances with a mouse click at the intended playback time and position.

- 1) Select an instance of a dynamic interest area either in the tree view or by clicking on it in the Trial View Window.
- 2) Right-click in the Trial View window and select “Mouse Record” the popup menu (see the screen capture below).
- 3) Now click the “View Trial Playback Animation” button in the toolbar of the Trial View Window.
- 4) Set the Animation Playback View to the intended playback time, by using the slider bar at the bottom of the Trial View window, using the Forward/Backward Step and Forward/Backward Frame buttons or keyboard shortcuts, or by playing the video. If playing the video, you may want to adjust the playback speed during mouse recording to a lower value, particularly if you have fast moving stimuli. If the video is playing, click the “Pause Trial Playback” button in the video playback progress bar or press the Spacebar to pause the trial playback.
- 5) Then move the mouse into the Trial View Window (note that the mouse cursor changes into a +), and click the left mouse button at the intended location to add a new instance of the selected interest area with the same dimensions as the previous instance. If the mouse button is held after clicking, the new interest area can be dragged to the intended location and placed by releasing the mouse.
- 6) Click the Play button or press the Spacebar to resume video playing, or use the Forward/Backward Step and Forward/Backward Frame navigation buttons to navigate to the time of the next instance. Repeat steps 5-6 until all of the instances are created.
- 7) End the Mouse record mode by clicking on the Select Mode icon () from the toolbar of the Trial View Window, or by pressing the Esc key.

Note: Although Mouse Record mode can be used to create interest areas while the animation is playing, it is best practice to set the exact time position by pausing the video clip first, then to create the interest area(s) at that specific time point. To create interest areas while the playback is in progress (e.g., for longer video clips), it is best to slow the playback speed before playback; otherwise you may see large lags in the start time of the interest areas (due to slow human reaction times!) and may have to adjust the start times manually. By default, Mouse Record mode will enable the “Interpolation” property of a dynamic interest area and its instances, so that Data Viewer will interpolate the position and size/shape of the interest area between successive instances. In the Animation View, interpolated interest areas are drawn in dashed lines. If using non-continuous dynamic interest areas, it may be useful to disable the “Interpolation” property for the interest area or the non-continuous instances.

In the Mouse Record mode, a mouse click will trim the end time of an existing instance and start a new interest area instance at the current playback time. Version 3.1 of Data Viewer added hotkeys that allow users to terminate a dynamic interest area in mouse

record mode to better support applications where instances of a dynamic interest areas are not temporally continuous (e.g., the object is briefly occluded or goes off screen). A mouse click while the Ctrl key (or the Command key on Mac OS X) is pressed creates no new instance of interest area but rather trims the end time of the first active instance to be found to the current time. Pressing the Shift key in the mouse record mode creates a new instance of interest area without extending the end time of the previous instance to the current time.

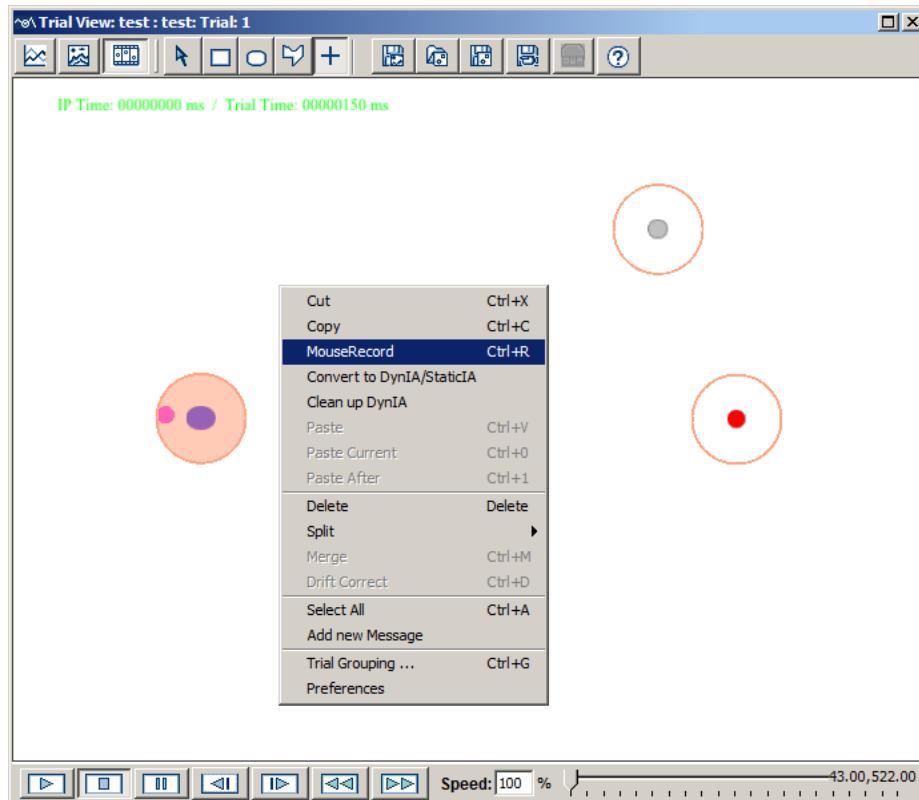


Figure 5-20. Mouse Record Mode

5.10.15 Moving an Interest Area

Selected interest area(s) can be moved by following the steps below:

- 1) Select the interest area(s) (make sure the selection is highlighted in either the Spatial Overlay or Temporal Graph View of the Trial View Window).
- 2) Hold down the Alt key (on Linux, hold down both the Alt and Windows key).
- 3) Place the mouse cursor on top of the interest area(s) and press and hold the left mouse button. The mouse cursor now turns into a four-headed arrow .
- 4) Drag the interest area(s) to the intended location.
- 5) Release the mouse button.

The position of the selected interest area(s) can also be adjusted by pressing the left, right, up, and down keys while holding down the Alt key. Users can also adjust the location of an interest area by editing the “Center” value in the property table. The

position of Rectangular and Elliptical interest areas can be further adjusted by editing the “Left”, “Top”, “Right”, and/or “Bottom” values.

Version 3.1 of Data Viewer added an “IA Shape Actions -> Move” option on the right-click context menu to move selected interest area(s) by a specified pixel value when one or several interest areas are selected from the Trial View window, when the interest area set is selected from the trial node of the treeview, or when a trial group is selected.

5.10.16 Flipping Interest Areas

To facilitate redrawing of interest areas for flipped images, Data Viewer allows users to horizontally or vertically flip selected interest areas (rectangle, ellipse, or freehand) with the “IA Shape Actions -> Flip Horizontal/Flip Vertical” option on the right-click context menu. The flipping is performed based on the center of the screen - users may need to move the interest areas to the intended locations after the flip. The interest area flipping can be done when individual interest areas are selected, when the interest area set is selected from the trial node of the tree view, or when a trial group is selected.

5.10.17 Conversion between Different Interest Area Shapes

Version 3.1 of Data Viewer added options to convert between different interest area types (rectangle, ellipse, or freehand). Users can select an interest area and then choose the intended interest area type provided in the “Type” field of the property panel. Alternatively, users can select the interest area and choose the “IA Shape Actions -> Convert to Freehand/Rectangle/Ellipse” option from the right-click context menu.

Note: The conversion from an ellipse to a freehand interest area is done by creating a polygon of 12 equally-spaced points across the original shape. Conversion from a freehand interest area to a rectangle or ellipse is based on the minimum bounding rectangle.

5.10.18 Resizing Rectangular and Elliptical Interest Areas

A rectangular or elliptical interest area can be resized by following these steps:

- 1) Select the interest area (make sure the selection is highlighted in the Trial View Window).
- 2) Hold down the Alt key (on Linux, hold down both the Alt and Windows key).
- 3) Place the mouse over the edge to be dragged (the arrow cursor changes into a sizing cursor \leftrightarrow).
- 4) Press the left mouse button and drag the edge to the desired location.
- 5) Release the mouse button.

To carry out a more precise adjustment for a rectangular or elliptical interest area:

- 1) Select the interest area to move or adjust.

- 2) In the property panel of the interest area, select the entry for “Left” and type in the desired x-coordinate of left-most edge.
- 3) Select the entry for “Top” and type in the desired y-coordinate of top-most edge.
- 4) Select the entry for “Right” and type in the desired x-coordinate of right-most edge.
- 5) Select the entry for “Bottom” and type in the desired y-coordinate of bottom-most edge.

Please note that the coordinates must be made such that the “Left” value will be smaller than the “Right” value and the “Top” value will be smaller than the “Bottom” value.

Version 3.1 of Data Viewer allowed batch resizing of selected interest area(s) through the “IA Shape Actions” option on the right-click context menu. When the "Resize Edges" option is selected, a dialog box will be displayed to allow users to specify the intended pixel value of adjustment to Left, Right, Top, and Bottom edges – a positive value expands the existing interest areas whereas a negative value shrinks the existing interest areas. When “Resize by %” option is selected, a dialog box will be displayed to allow users to enter a resizing factor (100 is the original width/height) to expand/shrink the selected interest areas.

5.10.19 Resizing Freehand Interest Areas

A freehand interest area can be resized by following these steps:

- 1) Select the interest area (make sure the selection is highlighted in the Trial View Window).
- 2) Hold the Alt key down (on Linux, hold down both the Alt and Windows key).
- 3) Place the mouse over the vertex to be moved (the move cursor changes into a hand cursor  and a red circle is drawn on top of the vertex).
- 4) Press the left mouse button and drag the vertex to the desired location.
- 5) Release the mouse button.

Version 3.1 of Data Viewer allowed users to resize freehand interest areas through the “IA Shape Actions -> Resize by %” option on the right-click context menu. A dialog box will be displayed to allow users to enter a resizing factor (100 is the original width/height) to expand/shrink the selected interest areas.

5.10.20 Rescaling Interest Areas to a Different Screen Resolution

Data Viewer provided an option for users to rescale interest areas from one screen resolution to another. This is useful, for example, if users had existing interest areas prepared for one screen resolution and would like to re-use them for data collection at a different screen resolution. To rescale interest areas, select the desired interest areas and choose the “IA Shape Actions -> Rescale Screen Resolution” option on the right-click context menu. In the following dialog box, specify the intended horizontal and vertical scaling factors (100 is the original resolution).

5.10.21 Rotating Interest Areas

When one or several rectangle, ellipse, or freehand interest areas are selected, the following rotation operations can be performed using the right-click context menu option “IA Shape Actions”: Rotate Left 90° and Rotate Right 90°. More rotation options are provided when freehand interest areas are selected. A “Rotate by Angle°” option is available for the left or right rotation by an angle value specified in the dialog box.

Version 3.1 of Data Viewer also implemented a fully interactive rotation of freehand interest areas using computer mouse. To do that,

- 1) Select the freehand interest area in the Trial View Window.
- 2) Press down the Ctrl and Alt keys (Command and Alt keys on Mac OS X)
- 3) Hover the mouse on top of any vertex of the freehand interest area. The shape of the mouse cursor will change into .
- 4) Now drag the mouse in the direction you want. The freehand interest area will rotate around its bound's center. The rotation angle relative to the original position is displayed in both the property panel of the interest area and in the Trial View Window (0 is the angle when the interest area was originally created).

5.10.22 Adding a Point to a Freehand Interest Area

To add a new point to a freehand interest area:

- 1) Select the interest area (make sure the selection is highlighted in the Trial View Window)
- 2) Hold the Alt key down (on Linux, hold down both the Alt and Windows key).
- 3) Place the mouse over the existing edge where a point will be added (the arrow cursor changes into a hand cursor ).
- 4) Click and hold the left mouse button, then drag the mouse towards the intended location. As you drag, a new vertex will be created.
- 5) Release the mouse button at the intended location.

5.10.23 Deleting an Existing Point from a Freehand Interest Area

To remove an existing point from a freehand interest area:

- 1) Select the interest area (make sure the selection is highlighted in the Trial View Window)
- 2) Hold the Alt key down (on Linux, hold down both the Alt and Windows key).
- 3) Place the mouse over the vertex to be removed and click the left mouse button (the arrow cursor changes into a hand cursor and a red circle is drawn on the vertex).
- 4) Click the right mouse button, and choose the “Delete” option from the popup menu.
- 5) When the delete confirmation dialog box is displayed (“Do you want to delete the selected point from the Freehand Interest Area?”), choose “Yes”. Data Viewer will automatically join the two points around the deleted one.

5.10.24 Deleting Interest Areas

To delete interest areas or instances of an interest area:

- 1) First toggle off all of the eye event visibility buttons in the application toolbar so that interest areas can be deleted without removing any eye events within them.
- 2) Select the interest areas or instances of an interest area to be deleted.
- 3) Press the right mouse button.
- 4) Select the Delete option from the popup menu.
- 5) Confirm that the IAs should be deleted.

Interest areas can also be deleted by clicking the **Delete Selected Items** button () or the **Cut Selected Items** button () on the application toolbar.

When you delete an instance from a dynamic interest area, Data Viewer will automatically select the instance immediately prior to the deleted instance.

5.10.25 Splitting Interest Areas

Rectangular and elliptical interest areas can be split either horizontally or vertically. To split an interest area:

- 1) Select the interest area to split.
- 2) Press the right mouse button.
- 3) Select “Split” and then “Horizontally” or “Vertically” from the popup menu.

When splitting an instance of a dynamic interest area, the duration of the instance is split as well—one of the newly created instances takes the first half of the original duration, and the other takes the second half of the duration. If only the time of the interest area instance should be split, simply select the “Time only” option from the popup menu.

5.10.26 Merging Interest Areas / Instances of a Dynamic Interest Area

Two selected rectangular or elliptical interest areas can be merged in the following way:

- 1) Click "Toggle Fixation Event Visibility" button () on the application toolbar to turn off the fixation visibility so that fixation events will not be merged.
- 2) Press the Ctrl key on Windows or the Command key  on Mac OS X to select the interest areas to be merged.
- 3) Click the right mouse button to bring up a popup menu, select "Merge" from the list.

Multiple instances of a dynamic interest area can also be merged. The start time of the newly created instance will be the start of the earliest instance and the end time will be end of the latest instance.

5.10.27 Linking/Unlinking Interest Areas

The above-mentioned “merge” operation creates a minimum bounding rectangle interest area that encompasses the original interest areas. This may not be ideal for some applications as it may include regions that are not part of the original interest areas (e.g., Figure 5-21). Version 3.1 of Data Viewer provides a “link” option for freehand interest areas that replaces the selected interest areas with a new one that contains their original shapes linked to each other by a line via their closest points. This linking allows the representation of multiple shapes in one interest area that aids in the combined analysis of gaze data (e.g., calculation of the dwell time, fixation count, run count, regression-related variables, etc. for spatially non-contiguous objects). Rectangle and ellipse interest areas need to be converted into freehand interest areas before they can be linked. An “Unlink” option is used to reverse the link process to restore the original interest area shapes. **Note: presently dynamic interest areas do not support the link/unlink operations.**

The following figure illustrates the difference between the “merge” and “link” operations. Panel A: Two original interest areas (note the fixation falling outside of the two IAs). Panel B: Rectangle interest areas are first converted into freehand ones and then linked together – note the linked interest area includes the same number of fixations as in the original interest areas. Panel C: A new interest area created by the merge operation – note the larger area and more fixations included after the merge.

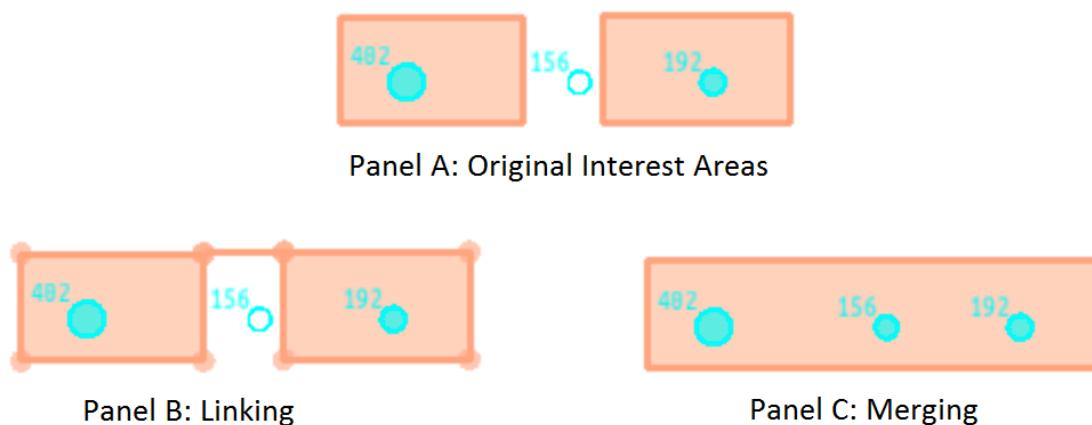


Figure 5-21. Interest Area Linking versus Merging

5.10.28 Conversion between a Static Interest Area and a Dynamic Interest Area

Unlike a static interest area, a dynamic interest area consists of one or multiple instances, each of which has a start time and end time. Data Viewer supports the conversion between these two types of interest areas: instances of a dynamic interest area can be converted into static interest areas by removing the start time and end time whereas a static interest area can be converted into a dynamic one, with the start time being 0 and end time being the duration of the trial. The conversion process preserves the spatial coordinate of the original interest area. The conversion can be done in the following way:

- 1) Select the interest area(s) to convert

- 2) Click the right mouse button and select “Convert to DynIA/StaticIA” from the pop-up menu
- 3) Modify the start time and end time as appropriate if converting to a dynamic interest area

5.10.29 Examples of Creating Dynamic Interest Areas in a Viewing Session

This section briefly summarizes various methods for creating dynamic interest areas using the example given at the beginning of the Chapter. A fixation screen (with a “FIXATION_SCREEN” message written to the EDF file) is shown for 1000 ms before a display screen (with a “SYNCTIME” message) is presented with a red object appearing at (674, 546, 774, 646 (Left, Top, Right, Bottom)). The object moves to (462, 634, 562, 734) at time 800 ms after its onset, to (249, 546, 349, 646) at 1600 ms, and to (162, 334, 262, 434) at time 2400 ms and stays there for 800 ms before a blank screen is shown (with a “BLANK_SCREEN” message). A dynamic interest area of four instances can be coded (shown below) to describe the behavior of the red object, assuming that we create an interest period starting from the onset of the SYNCTIME screen.

0	-799	RECTANGLE2	674	546	774	646	red
-800	-1599	RECTANGLE2	462	634	562	734	red
-1600	-2399	RECTANGLE2	249	546	349	646	red
-2400	-3199	RECTANGLE2	162	334	262	434	red

There are several possible ways to create the instances of this dynamic interest area. Regardless of the method chosen, the first step would be creating an interest period and selecting it as the active interest period.

- 1) Click the "Interest Period List" combo box at the far-right hand of the application menu bar and select "Edit ...".
- 2) Click the New Interest Period button () on the Interest Period Manager dialog box.
- 3) In the general tab, enter a label for the current interest period in the label edit box and choose "Message Event" in the "End Event Type" drop-down list.
- 4) Now click the "Details" tab. Set the "Start Event" as Message and its "Start Time Message Text" as "SYNCTIME" and "End Time Message Text" as "BLANK_SCREEN" (both message texts are case-sensitive without quotation marks).
- 5) Close the Interest Period Editor dialog. The "Interest Period List" combo box should now display the label of the newly created interest period.

Next, create the first instance of the interest area following the steps discussed in section “5.10.3 Manually Creating Interest Areas”. In the property table of the interest area instance, set the “Left” value to 674, “Top” to 546, “Right” to 774, “Bottom” to 646, “Start Time relative to IP” to 0, and “End Time relative to IP” to 799. The subsequent interest area instances can be created using one of the methods described below.

Method 1: Manual Creation in Animation View

Set the Trial View Window to the Animation Playback View, as this view is useful for displaying, creating, and editing of instances of a dynamic interest area. You may play back the trial to the intended interest period time and manually draw each of the subsequent instances (please note that the top-left corner of the animation view displays both the current playback time relative to the currently selected interest period and to the start time of the trial). The coordinates, start time and end time can be adjusted through the property table of the instances.

Method 2: Copy and Paste

First copy the existing instance either from the event list in the Inspector Window or by clicking on it in the overlay / animation view and then paste it. If needed, for the newly created instance, edit the “left”, “top”, “right”, “bottom”, “Start Time relative to IP”, and “End Time relative to IP” fields in the property table of the instance (the position of the interest area can also be adjusted by holding down the Alt key and then dragging it to the intended position). Repeat this process until all of the instances are created.

Method 3: Copy and Paste Current

First copy the existing interest area instance. Set the Trial View Window to the animation view and play back the trial to the intended interest period time (you may first drag the indicator on the slider at the top of the Trial View Window, and then use the left/right arrow key to get to the precise playback time). Now click the right mouse button and choose the “Paste Current” option. A new instance with proper time stamps will be created. You can adjust the position of the instance by holding down the Alt key and dragging the instance to its intended location, or by editing the “Left”, “Top”, “Right”, “Bottom” values in the property table of the instance. Repeat this process until all of the instances are created.

Method 4: Mouse Record mode in Animation Playback View

First copy the existing interest area instance. Click the right mouse button and choose the “Mouse Record” option. Set the Trial View Window to the Animation Playback View and play back the trial to the intended interest period time (you may first drag the indicator on the slider at the top of the Trial View Window, and then use the left/right arrow key to get to the precise playback time). Now place the mouse cursor on top of the intended location and click the left mouse button—a new instance will be created following the mouse click. Repeat this process until all of the instances are created.

It may take some time for you to create the interest area instances for the very first recording file. Once the interest areas are saved into an .ias file, you can import that .ias file into the viewing session and use it as a template for subsequent similar trials across recording sessions.

5.10.30 Output Reports and Preferences

Versions 2.1 and above of EyeLink Data Viewer support report creation for both static and dynamic interest areas. However, dynamic interest areas introduce a number of

complexities to data analysis. For example, you may run into scenarios where a single fixation lands in multiple interest areas. Some Data Viewer variables (e.g., the "CURRENT_FIX_INTEREST_AREA_INDEX" variable in the Fixation Report) require a fixation to be assigned to a single interest area. If a fixation lands in multiple dynamic interest areas, by default, this assignment will be based on the duration of fixation on respective interest areas—the interest area with the longest duration gets the fixation assignment. To assign fixations based on the index of the interest areas instead of duration, go to the preference setting "Preferences -> Output/Analysis -> Assign Fixations to Dynamic IA Ordered by Relative Duration". The default value is true (checked), so to assign fixations by interest area index, set this to false (unchecked).

Another related issue when a fixation lands in multiple interest areas is the calculation of actual dwell time on each of the interest areas and fixation count. Data Viewer has an "Include Fixation in Single IA" option in "Preferences -> Output/Analysis". When selected, the fixation is assigned to one of the interest areas only (see the above paragraph on how the "winning" interest area is determined)—the interest area assigned gets the full length of the fixation when calculating dwell times. If this option is disabled (default setting), the fixation can be assigned to multiple interest areas, and effective duration (the total amount of time that fixation and instances of the same IA intersect) for each of the interest areas is used for the calculation of dwell times. This option will affect the calculation of some variables in the Fixation Report (e.g., CURRENT_FIX_INTEREST_AREAS, CURRENT_FIX_INTEREST_AREA_DWELL_TIME, etc.) and Interest Area Report (e.g., IA_DWELL_TIME, IA_FIXATION_COUNT, etc.). The following table illustrates the effect of this option with four consecutive fixations. Columns "IA_1 Duration", "IA_2 Duration", "IA_3 Duration" are the duration of fixation onto each of three interest areas.

Fixation	Fixation Duration	IA_1 Duration	IA_2 Duration	IA_3 Duration	Winning IA
1	516	376	141	516	3
2	33	33	0	0	1
3	137	137	0	0	1
4	552	411	143	0	1

If the "Include Fixation in Single IA" option is checked, the first fixation is assigned to interest area 3, and the other three fixations are assigned to interest area 1. The IA_DWELL_TIME for interest area 1 will be 722 ms—the sum of full duration of the three fixations that are assigned to the interest area (33, 137, 552). The IA_DWELL_TIME value will be 0 ms for interest areas 2, and 516 ms for interest area 3. The IA_FIXATION_COUNT for each of the three interest areas will be 3, 0, and 1, respectively. If the "Include Fixation in Single IA" option is not checked, then the IA_DWELL_TIME calculation will be based on the effective duration (instead of the full fixation duration) on the target interest area. Thus, the IA_DWELL_TIME value for interest area 1 will be 957 ms (=376 + 33 + 137 + 411). The value for interest area 2 will be 286 ms (=141 + 143) and for interest area 3 it will be 516 ms. The

IA_FIXATION_COUNT for each of the three interest areas will be 4, 2, and 1, respectively.

Another important parameter to consider is whether the interest area matching is sample-based or fixation-based (“Perform Sample Based Calculation” in Output /Analysis preferences). By default, the average x, y position of the fixation is used to identify a matching interest area. However, this may not be suitable in cases where dynamic stimuli (e.g., pursuit task following a moving object, or some video clips) are used where the recorded eye position data may contain smooth pursuit segments where there are large spreads of samples in the parsed fixation event. If the interest area calculation is sample-based, samples within fixations (if loaded) are used for interest area matching and report calculation. The latter may provide a better estimate of the actual dwell time in tasks using dynamic stimuli.

6 Data Analysis and Output

One of the goals of the Data Viewer software is to allow users to extract useful eye-movement information and export data to a tab-delimited text file that can be processed by most statistical packages. Before performing any data analysis, the first question you may ask yourself is what part of the recording data you need to look at? Do you need to analyze the eye movement data for the entire duration of the trial or just a small portion of it? For example, if you conducted a reading experiment in which each trial displays a sentence followed by a comprehension question, do you need to look at the portion of eye movement data from when the participant was answering the comprehension question? If not, you may create an interest period for the reading part (i.e., from the onset of the reading screen to the onset of the comprehension questions). Once one or more interest periods have been set, any reports from Data Viewer will only reflect data from within the selected interest period.

Next, you will need to determine which report is appropriate for your analysis. Data Viewer organizes the output reports based on different levels of analysis. Trial Report provides summary statistics for each trial in each edf (e.g., the duration of the trial recording in ms, the number of fixations that were made, etc.). The Fixation, Saccade and Sample Reports provide detailed eye movement measures for each of these event types – with one row of data per fixation, saccade, or sample. The Interest Area Report provides eye-movement data outputs related to each of the interest areas. The Message Report provides an output for each of the message events recorded in the data file with the corresponding fixation/saccade event. The Aggregate Event Statistics and Aggregate Interest Area Report provide summary statistics for a group of trials/participants. While most of the research questions can be answered by extracting and analyzing the data from one or several of those reports, it is possible that you will need to further process the report outputs in order to derive measures of interest beyond those produced by Data Viewer.

When performing analysis, you may organize each of the viewing sessions by loading one or multiple EDF files. The settings from one viewing session (a "template") can be exported to different viewing sessions. Thus users may go through each of the output reports to configure the selection of variables in an intended order, and then export the variable selection into a property file by clicking on the "Analysis -> Reports -> Export Report Variable Selection" option in the application menu. For all future viewing sessions, the variable selection in the reports can be automated by importing the previously saved property file (by clicking on the "Analysis -> Reports -> Import Report Variable Selection" option in the application menu). The export/import feature is similarly available to the interest period definitions and properties of the viewing session.

6.1 Managing Trial Variables

The Trial Variable Manager (Figure 6-1) and the Trial Variable Value Editor (Figure 6-2) allow users to review the currently available variables, to assign a default value for the variables, to create or remove variables, and to change the variable values on a trial-by-trial basis.

6.1.1 Trial Variable Manager

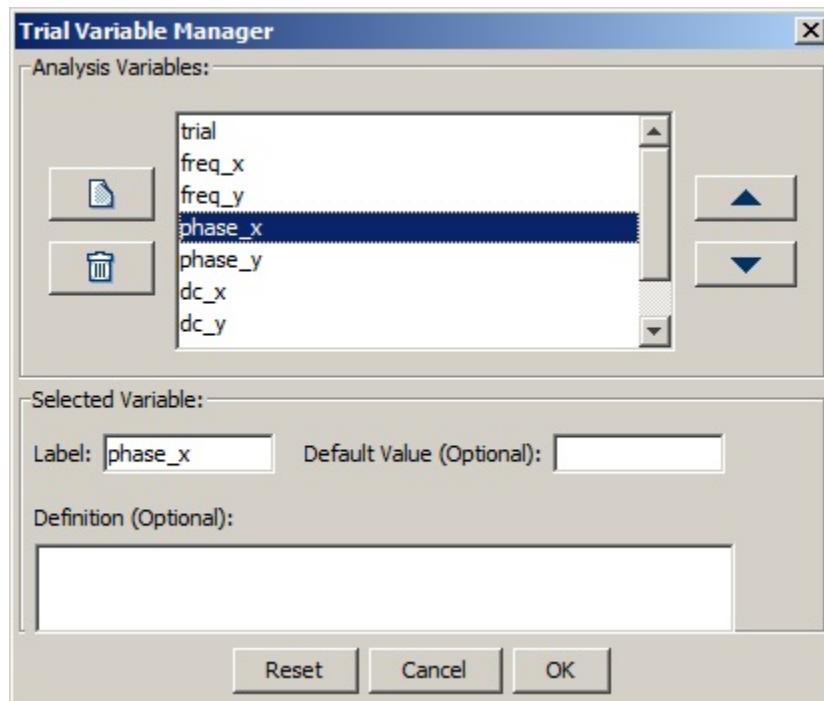


Figure 6-1. Trial Variable Manager

The Trial Variable Manager Dialog, activated by selecting **Analysis → Trial Variable Manager** from the menus, lists the filename (DATA_FILE) and other variables imported from the EDF file, if the TRIAL_VAR_LABELS or !V TRIAL_VAR command is used.

To create a new variable, click the button on the left. A new variable (“label”) with a default value (“default value”) will appear. To assign a different default value to a variable, select the variable in the list, and type in the default value in the Default Value edit box. The label of the variable can be similarly changed through the “Label” edit box. To remove one variable, select it in the list and click the Delete button .

Sometimes, the order in which the variables are listed is important. This is especially true when you want to match the variable labels created with the Trial Variable Manager to values from other sources (e.g., to facilitate cut and paste from Excel spreadsheets into

the trial variable value editor discussed below). To change the position of a variable, simply select the variable and use the ▲ or ▼ button to move it to the desired position.

6.1.2 Trial Variable Value Editor

The variables and their values can be viewed and edited in the Trial Variable Value Editor dialog box.

File	Trial	image	Condition
dm	Trial: 1	DSC_1000.jpg	undefined
dm	Trial: 2	town_blur.jpg	default value
dm	Trial: 3	DSC_3561.jpg	default value
dm	Trial: 4	DSC_3152.jpg	default value
dm	Trial: 5	DSC_3711.jpg	default value
dm	Trial: 6	town.jpg	default value
dm	Trial: 7	DSC_7641.jpg	default value
dm	Trial: 8	DSC_2571.jpg	default value
dm	Trial: 9	DSC_5682.jpg	default value

Figure 6-2. Trial Variable Value Editor Dialog

To activate the dialog box, from the menus, choose:

Analysis → Trial Variable Value Editor

The top row of the dialog box lists the filename, variables imported from the EDF file, as well as variables created by the Trial Variable Manager. The following rows list the corresponding values for the variables in each individual trial. To change the value for a particular cell, double-click on the cell, type in the new value (do not include quotes for text strings), and press Enter to register the change. (It is expected that users will load EDF files from the same experiment with the same condition labels into one viewing session. Loading EDF files containing different condition labels from each other may cause complications.)

Version 1.11.1 added support for copying and pasting directly into the Trial Variable Value Editor. To copy a new column into the editor, prepare an Excel sheet with the first row being the label of the column. Copy the selection from Excel and paste it into the top-left cell in the editor (the first row of the “File” column). The new variable will be added as the last column. If the columns are already created, to update the content of the column, you can paste the content directly onto the first cell of the particular column (do not include the column label).

6.1.3 Trial Grouping

Trial condition variables are important for identifying one specific trial or grouping trials belonging to the same experimental condition. Thus, instead of going through each of the individual trials, a trial grouping mechanism can be applied to manipulate all trials of a certain type collectively. For example, practice trials can be removed from the viewing session in a batch, interest area templates can be applied to those trials using the same search display, and a fixation map can be created for the same display image with data collected from several participants to identify the informative parts of the display. After trial grouping is performed, Aggregate Mode can be enabled to visualize eye-tracking data from multiple participants/trials in the same Trial View Window and to export summary statistics for the entire trial group.

By default, Data Viewer groups all of the trials by the data file. To regroup trials within a viewing session, select the viewing session icon (⌚), click the right mouse button, and choose the “Trial Grouping” option. You can also bring up the Edit Trial Grouping dialog box by clicking “Edit -> Trial Grouping ...” from the application menu, or by using Ctrl + G keyboard shortcut. In the following “Edit Trial Grouping” dialog, choose the variable with which the grouping should be performed and press the “Regroup” button. Multiple grouping variables can be selected and the order of the grouping can be adjusted by use the ▲ and ▼ buttons. For each of the trial grouping variables, users can further configure whether the trial groups should be sorted in an Ascending or Descending order. If no grouping variable is chosen, grouping will be performed based on the data file each trial belongs to.

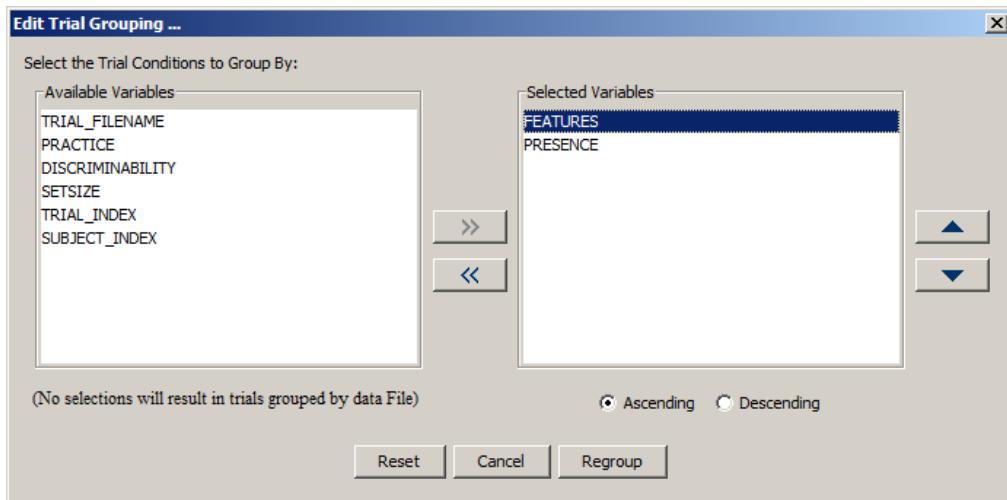


Figure 6-3. Trial Grouping Interface

Once grouping is performed, the trials will be listed by the conditions of the grouping variables selected (see the right panel of Figure 6-4). The property panel of each group lists the label (values of the grouping variables), total number of trials, and configurable

interest area information for the group. Users can apply an interest area template to all trials in the group by setting the Default Interest Area property for the grouping node (see section 5.10.9 Using Interest Area Templates).

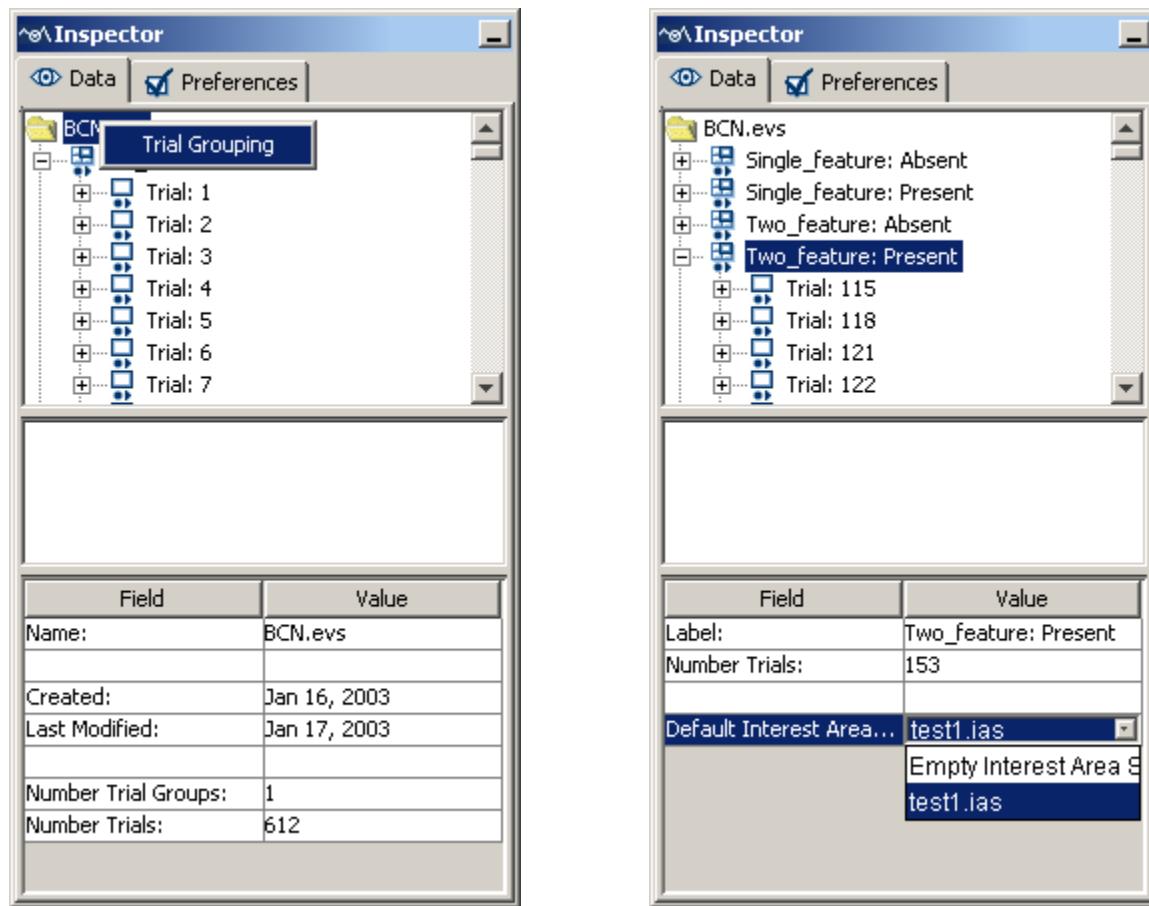


Figure 6-4. Applying Trial Grouping by a Trial Condition Variable and setting an Interest Area Template for a group of trials.

Data Viewer Versions 1.11.1 and higher include an “Exclude from Reports” option in the property panel of the groups so that users can block outputting particular groups of trials.

6.2 Fixation Map

EyeLink Data Viewer allows users to create a fixation map to identify informative parts of a display based on trials from a single participant or multiple participants viewing the same background image. To create a fixation map (or heat map), a 2D Gaussian is applied to each of the fixations—the Gaussian center is the fixation location, the width of the Gaussian is influenced by an adjustable sigma value in degrees of visual angle (the larger the sigma value, the larger the area that will be influenced by the fixation), and the height of the Gaussian can be weighted either equally for all fixations or by the duration of individual fixations. This 2D Gaussian is added to an internal map by adding weight to

that area of the map. After the above process is applied for all fixations, the internal map is normalized so it can be applied to the color or brightness scale used to create a composite view (see Figure 6-5).

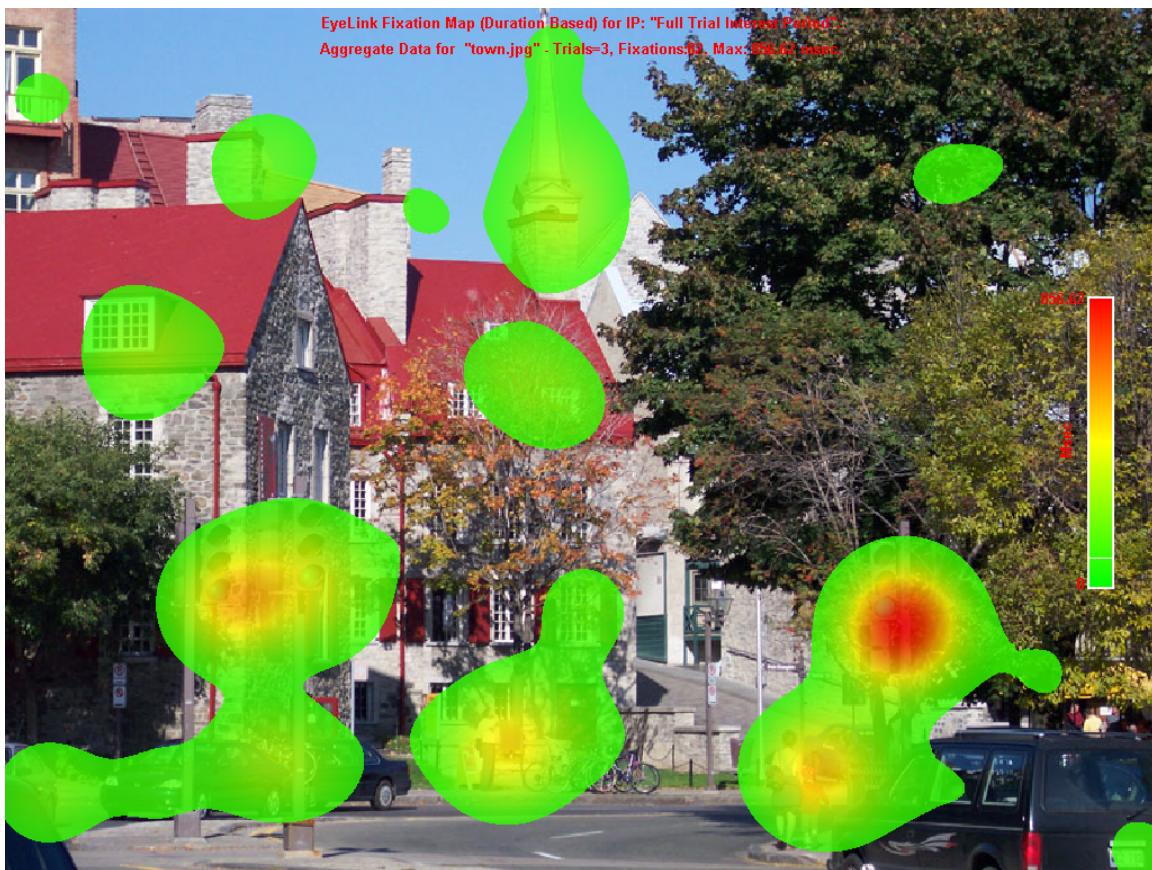


Figure 6-5. Example Fixation Map

To create a fixation map for a single trial, select the relevant trial node (⊕) in the top-panel of the Inspector Window, click the right mouse button and select the "Create Fixation Map" option (see Figure 6-6). To create a fixation map for a group of trials, select the relevant group node (⊕). Click the right mouse button and select the "Create Fixation Map" option. In the following "Save Fixation Map ..." dialog box, enter the intended file name with a proper file extension .BMP, .JPG, or .TIFF. Properties for a fixation map can be configured through the Output/Analysis preferences settings.

Versions 2.3 and above of EyeLink Data Viewer provide a convenient interface to create a fixation map, save it as an image file, and display it in the Trial View Window. To create the fixation map, click the Fixation Heatmap button on the Trial View Window toolbar (⊕). The fixation map will be based on whatever data that is currently displayed—if Aggregate Mode is enabled, the fixation map will include data from the entire trial group; if Aggregate Mode is not enabled, the fixation map will reflect the current trial only. (Check the title of the Trial View Window to see whether Aggregate Mode is enabled). Clicking the Fixation Heatmap button again toggles off the fixation map drawing. It is possible that the data used to generate a fixation map may no longer be

valid at a later stage of analysis (e.g., trials are removed from the current trial group, fixations are deleted, merged, or moved, a different interest period applied, aggregated mode is turned on or off, trials are regrouped). Data Viewer will attempt to detect such scenarios by displaying a different fixation map icon (⊕). Users are advised to create the fixation map again if this happens. Please note that if the “Exclude from Reports” property of a trial or trial group is checked, fixation data from that trial/trial group will not be included when generating the fixation map, even though fixations from that trial/trial group may still be displayed in the Spatial Overlay View.

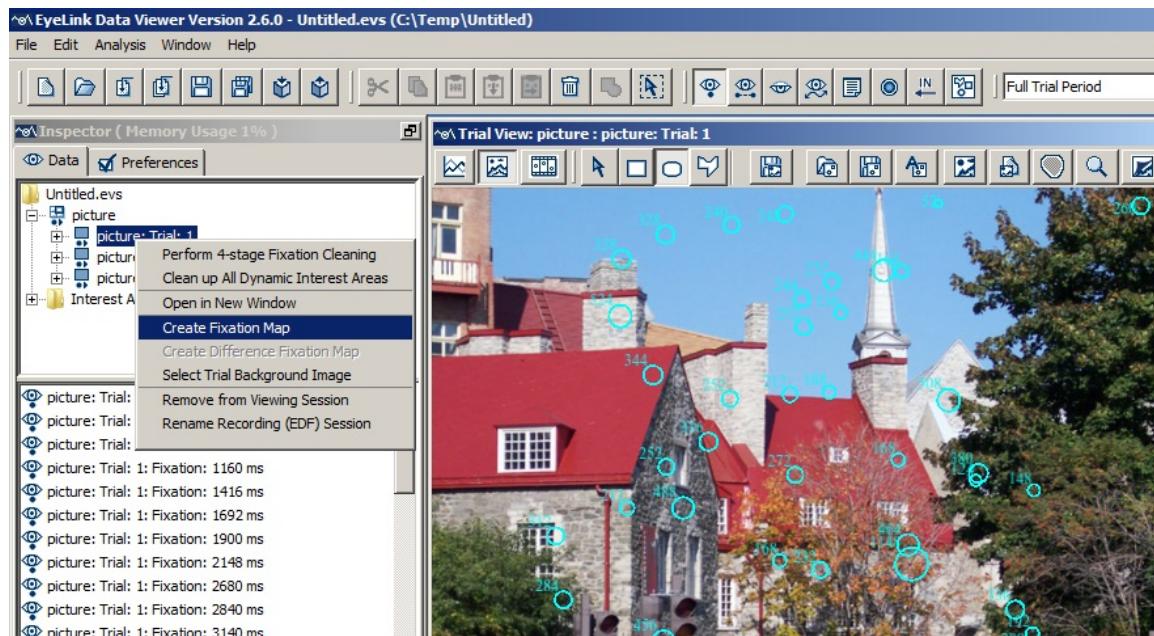
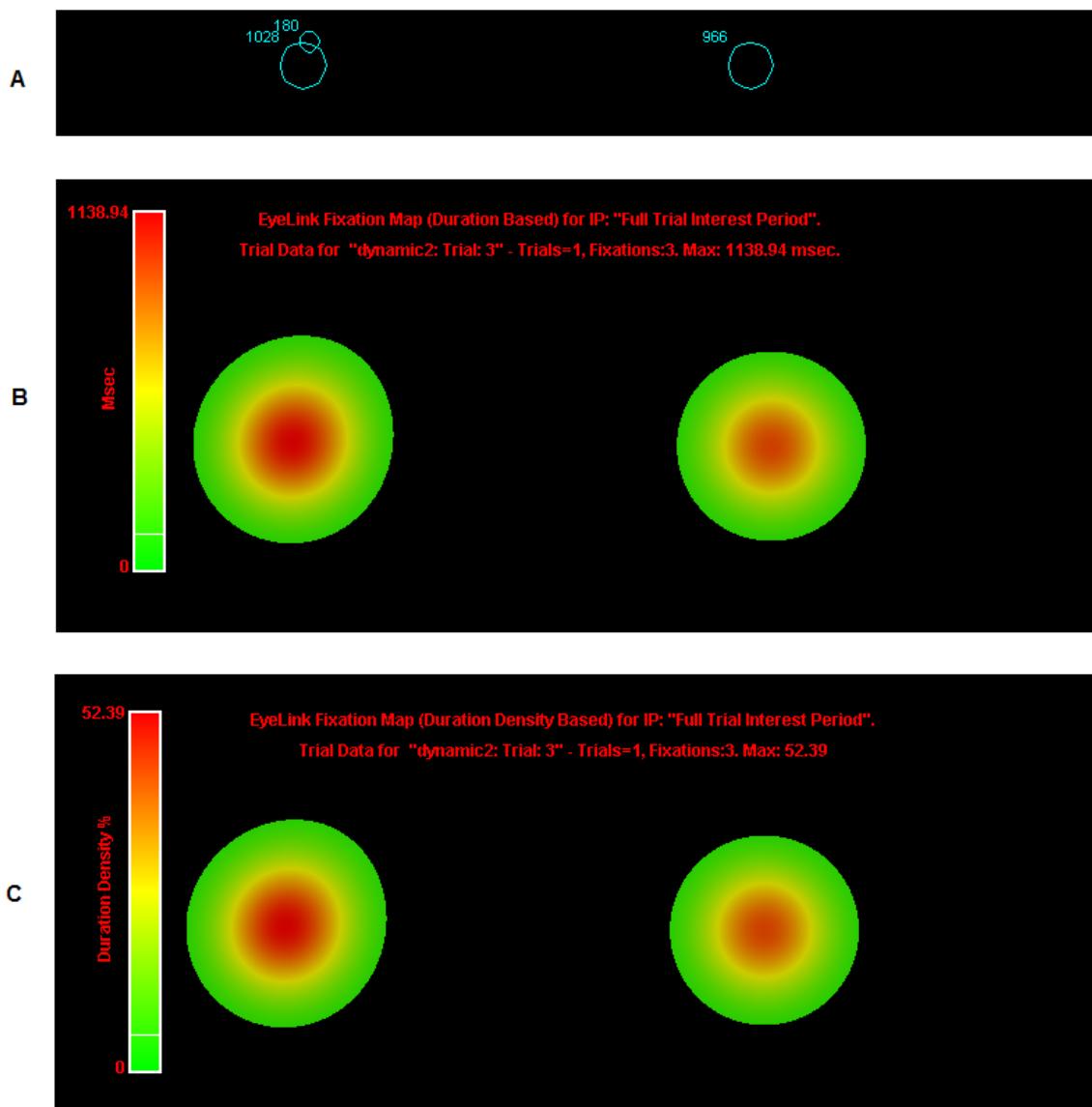


Figure 6-6. Creating a Fixation Map

EyeLink Data Viewer supports creating fixation maps based on the duration of fixations, count of fixations, percent of fixations, and percent of dwell time across the display. This is configurable through the "Type (1 = Duration, 2= Count, 3 = Count Density, 4 = Duration Density)" option of the Output/Analysis -> Fixation Map preference settings. If a duration or duration-density type is selected, the height of the Gaussian is weighted by the duration of the individual fixations; for a count-based or a count density fixation map, the height of the Gaussian is the same for every fixation. The map activity is averaged based on trial count pooled across participants (i.e., a map based on 1 trial that has 1 fixation will have a same fixation output as a map based on 10 trials, each trial with 1 fixation at the same location). The title of the fixation map indicates the type of fixation map created, the total number of trials and fixations contributing to the output, and the maximum per-trial-average value for the type of map chosen. The legend of the map indicates how long or how often participants have looked across the map. By default, the frequently fixated areas are painted in red whereas the less-fixated areas are painted in green. The drawing colors and the transparency of the drawing can be configured through the preferences. A gray-scale version of the fixation map is also available if the "Enable

"Heat Map Mode" option is unchecked. This creates a see-through map, with the background image being most visible in those areas that were fixated most / longest.

The following (Figure 6-7) is a sample output of the four different fixation maps for the same trial. Note the difference between the duration/duration density maps and the fixation/fixation density maps: A - original fixations in the Spatial Overlay View; B - the duration-based fixation map; C - the density distribution of the fixation durations (i.e., proportion of trial dwell time on each area of the display); D - the count-based fixation map; and E - the density distribution of the fixation counts (i.e., how frequently each area of display area has been visited).



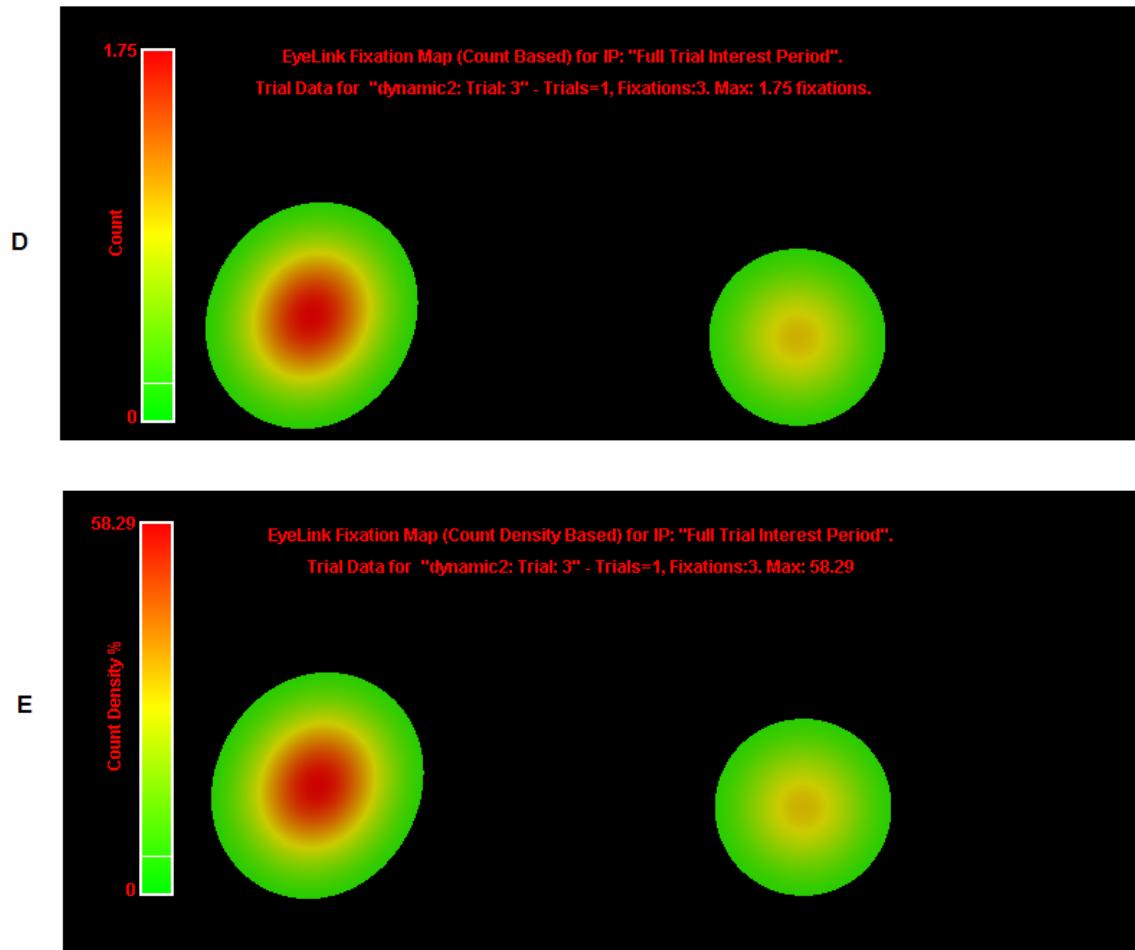
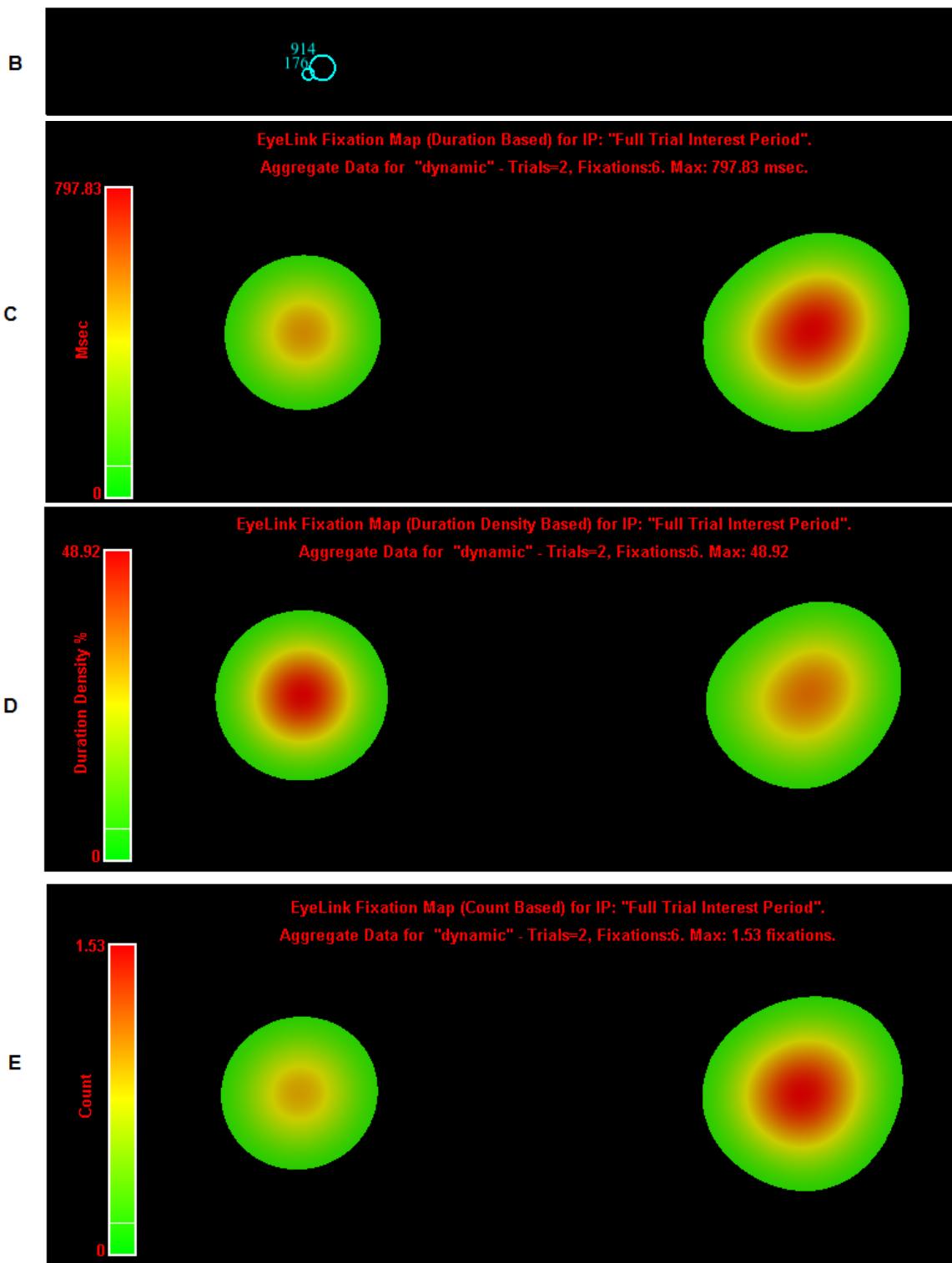


Figure 6-7. Types of Fixation Map

The count density and duration density maps, visualizing the proportion of fixation duration and fixation count relative to the trial total, may produce different outputs from the count and duration maps when the absolute trial duration or fixation count differ greatly across trials. The following example (Figure 6-8) illustrates the difference between the duration and duration density maps, and between the fixation count and count density maps. Panels A and B - original fixations in the Spatial Overlay View in two trials – note the difference in the total fixation number and total trial duration between the two trials; C - the duration-based fixation map; D - the density distribution of the fixation durations; E - the count-based fixation map; and F - the density distribution of the fixation counts.





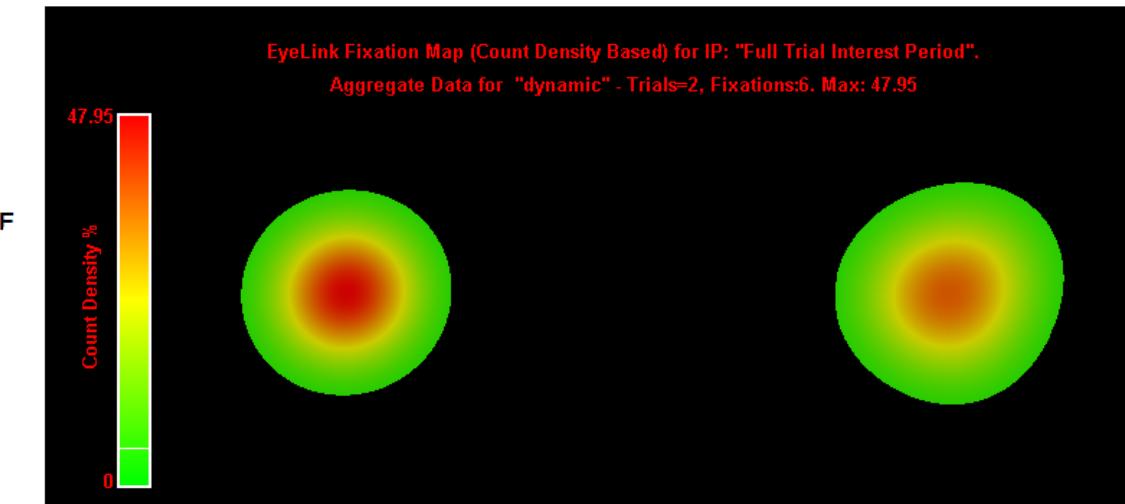


Figure 6-8. Types of Fixation Map

A single fixation map is useful for the purpose of identifying which parts of the display the participant or participants focused their gaze on; the legend displays colors that correspond to the peak and lowest activation values. However, fixation activities across two different fixation maps cannot be directly compared if the scales of the two maps are very different. To make such a comparison, users may set an intended peak activity value in the "Fixed Maximum Value" field of the preference settings. By default (with a value of -1 in the "Fixed Maximum Value" field), the peak value displayed in the legend will be the actual maximum per-trial-average value for the map. If a user-defined peak value is set, the drawing of the fixation map will be adjusted according to this new scale. A black line is drawn on the heatmap scale to indicate the actual maximum activation of the heatmap (if that value is less than the fixed maximum). A white line is drawn on the heatmap scale to indicate the "Low Activity % Cut-off" when the setting is greater than 0 and the "Fixed Minimum Value" set in the preferences. This low activity cutoff feature ignores areas on the map with an activation value lower than 10% (default) of the peak value. If the low activity cutoff value is set to 0, the whole display is colored.

Panel A of Figure 6-9 shows the original fixations in a trial. Panel B shows the fixation-count based map using the default "Fixed Maximum Value" (-1) and "Low Activity % Cut-off" (10% - the white line position). Panel C shows the same trial but with a different "Fixed Maximum Value" (4) - the actual peak value in the map is indicated by a black line. Panel D illustrates the output using a "Fixed Maximum Value" of 2.0 (which is the same as the actual peak value), a "Fix Minimum Value" of 0.5 (which is higher than the default 10% cutoff value, i.e., 0.2 fixation), and the "Clip Map Below Fixed Minimum" option checked. Notice that areas below the fixed minimum value are clipped (and therefore not colored).



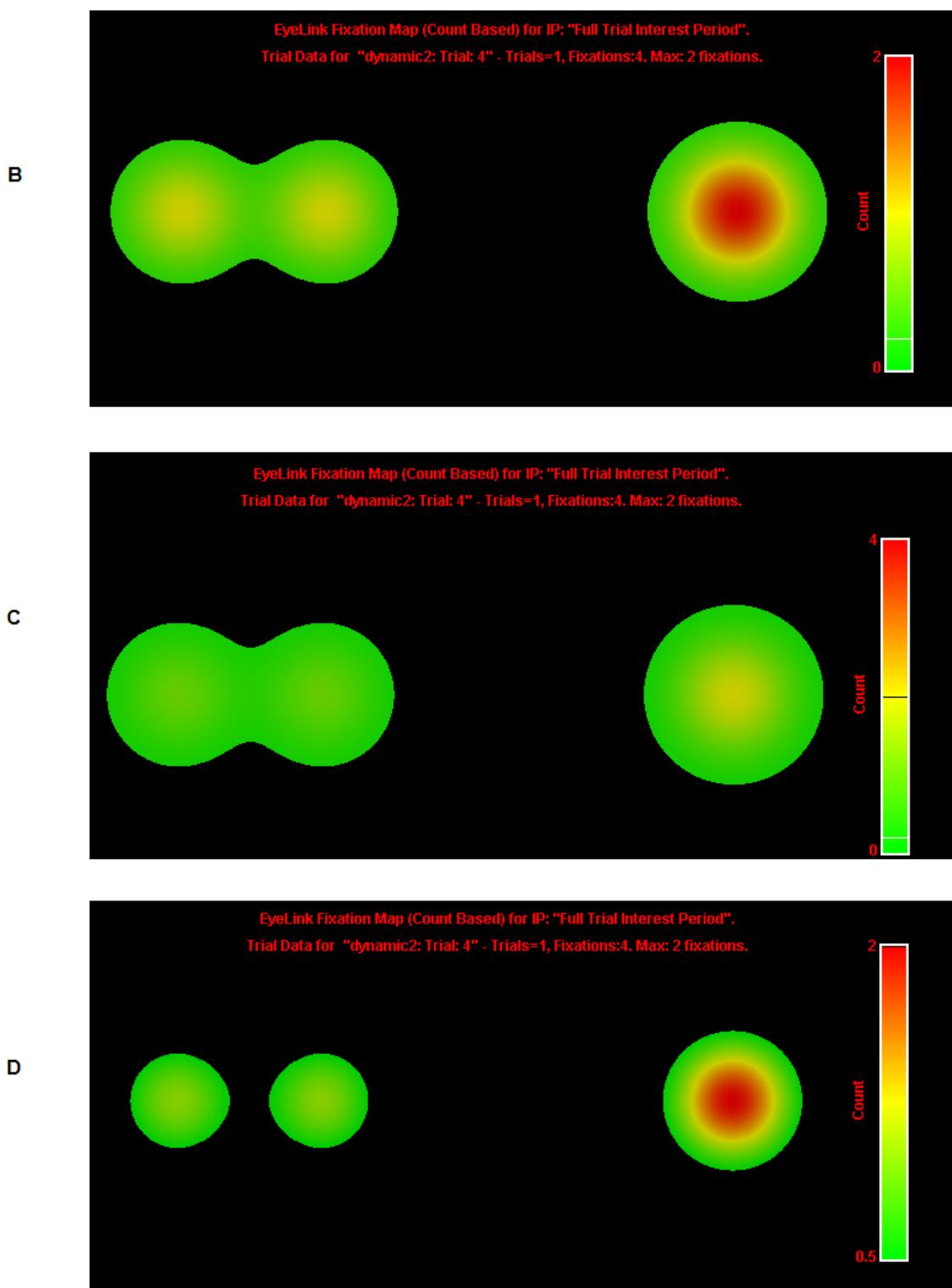


Figure 6-9. Adjusting the Scale of the Fixation Map

6.2.1 Difference Fixation Map

While individual fixation maps can be created for each trial group, some users may be interested in visualizing the difference in fixation pattern between groups directly on a single map. Version 2.4 of Data Viewer allows users to create a difference fixation map between two trials or trial groups (assuming they have the same recording resolution). In the top-left tree view panel, hold down the Ctrl key and select two trials or trial groups that you wish to compare. Click the right mouse, and choose “Create Difference Fixation Map” option. The following example illustrates a difference heat map in a pro-saccade task where the subject maintained a fixation in the center of the screen and then saccaded to a target that appeared either on the left or right side of the screen. Panels A and B show the original fixation data—red and blue fixations are from the trials in which the saccade target appeared on the left and right side of the screen respectively. Panel C is the difference fixation map between the two groups of trials.

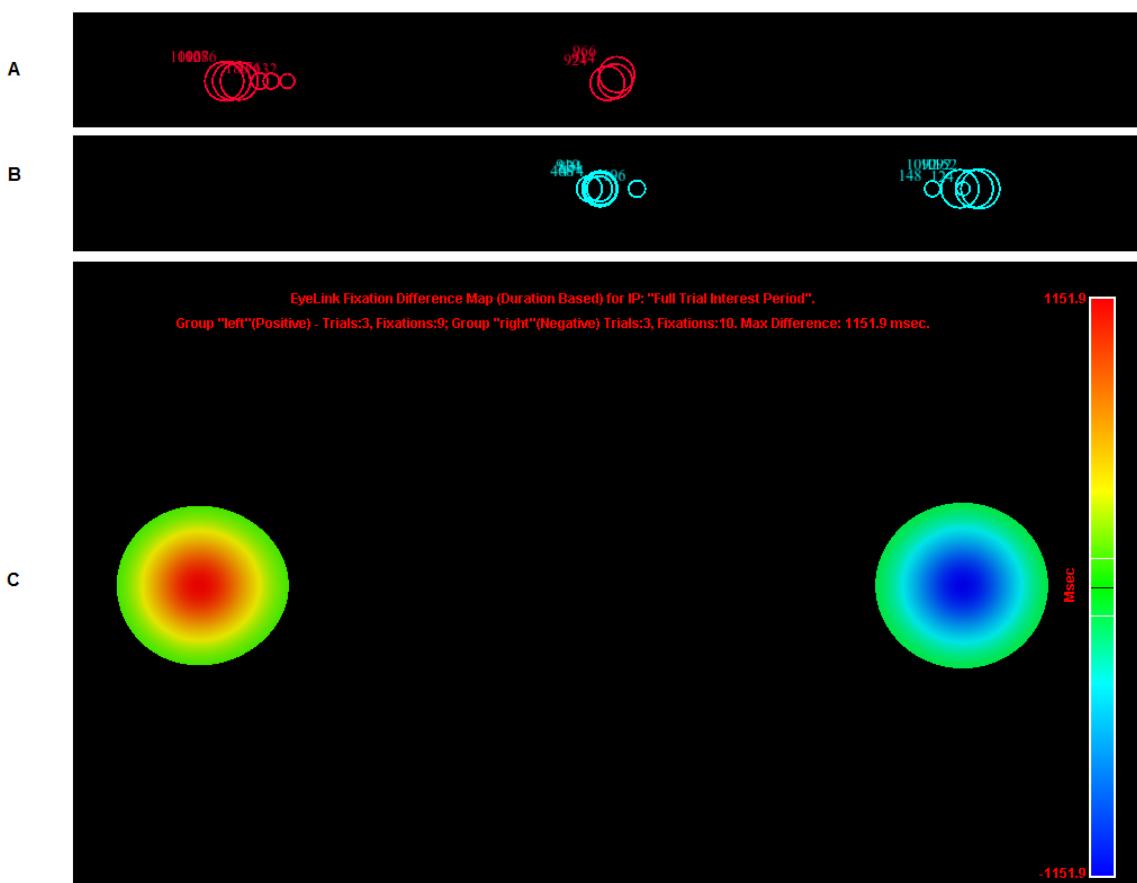


Figure 6-10. Example Difference Fixation Map

To create the difference heat map, Data Viewer first generates a separate activation map for each of the two groups, and subtracts the activation values between the two maps. The maximum difference in fixation duration is then identified between the two maps. This value is used to create a symmetrical color scale with the values ranging from negative maximum duration to positive maximum duration. Areas where one group fixates more will be associated with a positive difference value and painted in green-yellow-red color

gradient; areas where the other group fixates more will be associated with a negative difference value and painted in green-cyan-blue color scale. The title of the difference heatmap indicates which trial group is associated with a positive difference value and which group is associated with a negative difference value. A default low activity cut-off value (10%) is used on both sides of the scale (marked with a white line in the scale) so that no coloring is applied when the difference is small. The color map will then be painted on top of the background stimulus.

Please note that the difference map created by Data Viewer is intended for qualitative visualization of the difference in fixation pattern between trials or trial groups, it is not intended to provide any statistical tests of the differences.

6.2.2 Dynamic Heat Map

Version 2.4 of Data Viewer supports dynamic heat map presentation in the Animation Playback View. To create a dynamic heat map, first set a trial grouping so that all trials using the same stimulus (e.g., the same video clip or image) are included in the same trial group. Then enable the “Aggregate Mode” (⊕) so that all the data within the trial grouping are displayed in the same window. Now toggle on the “Enable Dynamic Heatmap in Aggregate Mode” button (heatmap) in the toolbar to see the real-time rendering of the dynamic heat map when the trial playback progresses. (Note: A recent video card with OpenGL 3.0 support is required for the dynamic heat map presentation. If Data Viewer detects an unsupported video card, it will automatically disable the heat map mode and draw the gaze cursors instead in the Animation View.) To see the raw gaze data alongside the dynamic heat map, simply enable the “Show Gaze Cursor when in Heat Map Mode” option in the “Fixation Map” preferences.

Similar to the static fixation map in the Spatial Overlay View, the dynamic heat map is generated by calculating pixel intensity for all points on the screen. The intensity at a given point is again weighted by a Gaussian distribution determined by the relative distance to a gaze position. While the static heat map uses the parsed fixation data, dynamic heat map accumulates gaze samples from multiple subjects/trials within a fixed temporal window (centering on the current playback position and splitting the duration equally forward and backward). This temporal window is used to smooth the heat map transition between video frames. Shorter window durations tend to show rapidly appearing and disappearing hot spots whereas longer window durations may result in a distorted presentation as it may include too much past and future data in the rendering. The default temporal window size is 300 milliseconds. Users can adjust “Heat Map Window Duration” field in the “Fixation Map” preferences if necessary.

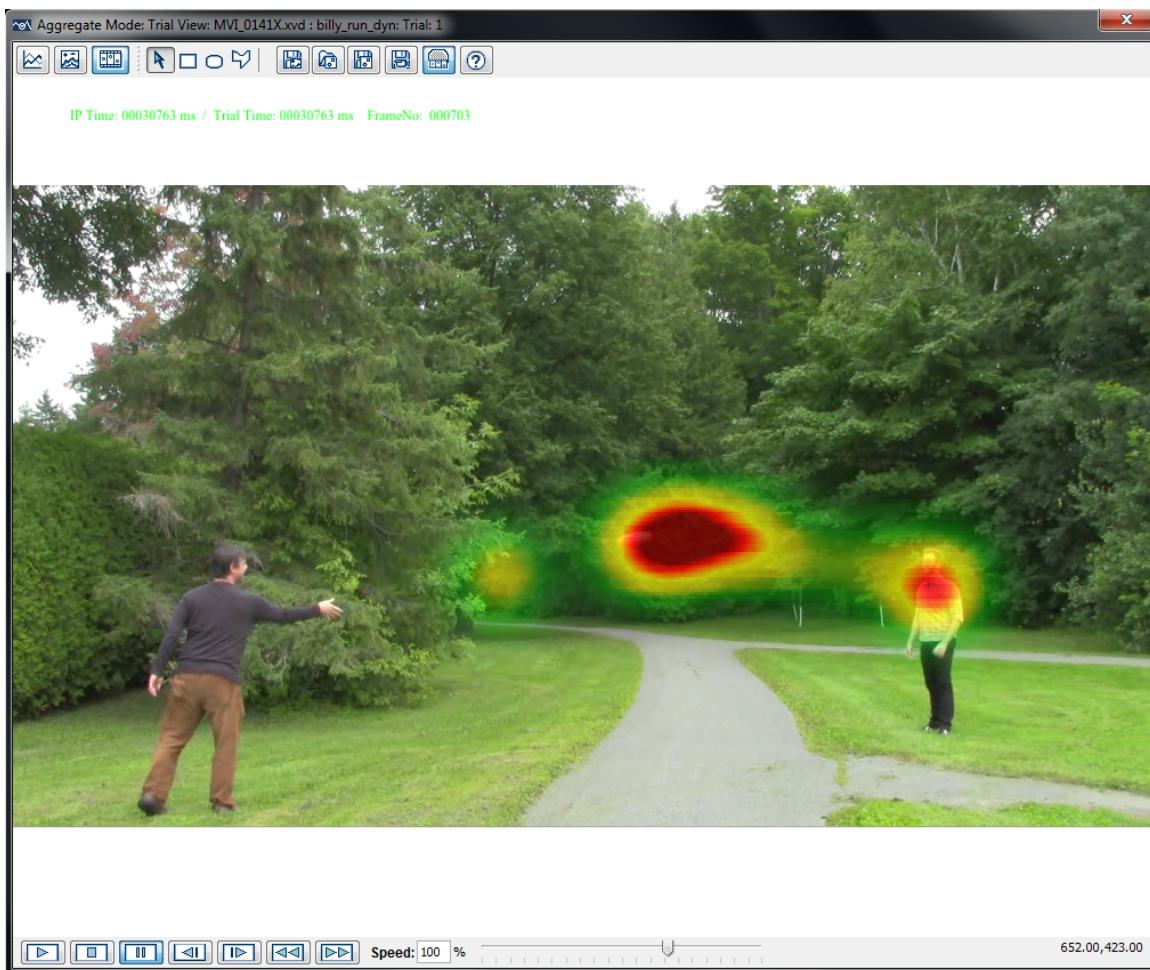


Figure 6-11. Example Dynamic Heat Map when Participants ($N = 14$) Viewing a Video Clip of Playing Frisbee. The temporal window is 300 ms and the max duration is fixed to 60 ms.

After the pixel intensity is calculated for all points on the screen (accumulating gaze samples within the temporal window), the pixel intensity is mapped to a color scale so that a heat map is painted on top of the background image/video frames. Because the fixation pattern will vary as the stimulus presentation unwinds, the peak value of the gaze duration will vary across different playback positions. As a result, the automatic peak value in the static fixation map cannot be used here as this makes the interpretation of data difficult (it is impossible to perform a direct comparison of viewing pattern between frames if the heat maps are painted in different color scales). Instead a “Fixed Maximum Value” must be established in the Fixation Map preferences for the dynamic heat map rendering - the default is set to 60 milliseconds for a Window Duration of 300 milliseconds (the Fixed Maximum Value should be bigger if a larger Window Duration is used). Obviously, the maximum value will vary from one stimulus set to another and as a result, users are expected to come up with an appropriate fixed maximum value accordingly.

6.3 Managing Reaction Time Definitions

Another important application of the trial condition variables is for managing reaction-time definitions for all the trials in the same experimental condition. A typical trial recording could be ended in several ways, such as a button response, a saccade event, a fixation event, or a special message. To obtain an accurate reaction time (RT) measure, the EyeLink Data Viewer relies on a set of reaction time definitions to parse the start and end events for RT calculation. The reaction time manager allows users to configure the way in which the trial starts and ends for each condition of the experimental design. Once a set of RT definitions has been created and applied, the RT start and end event information is available in both the Trial View Window and the Inspector Window.

6.3.1 Reaction Time Manager

The Reaction Time Manager is used to create, edit, or delete reaction time definitions for different experimental conditions. Users can set parameters of a trial end event and specify condition values that must be matched for the RT definition to be applied to a given trial.

To configure reaction time definition,

- 1) From the menus, choose:
Analysis → Reaction Time Manager

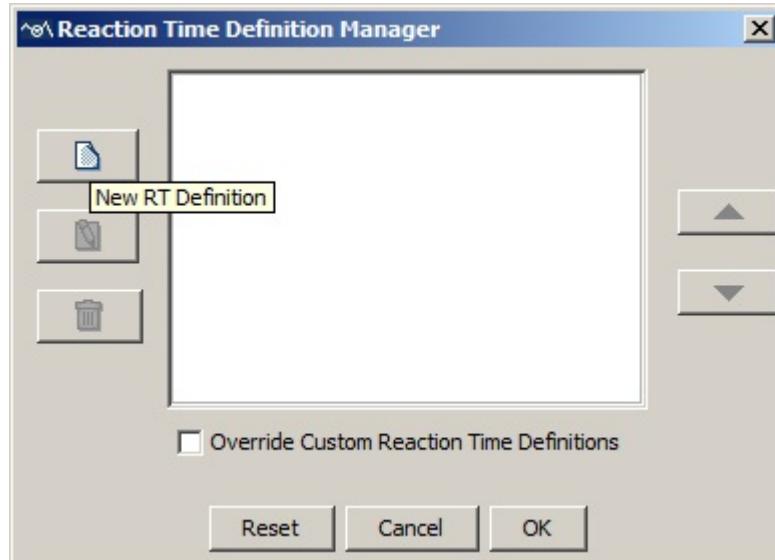


Figure 6-12. Reaction Time Definition Manager

In the Reaction Time Manager dialog (see Figure 6-12), users can create a new reaction time (RT) definition by clicking the New RT Definition button  on the left, edit an existing RT definition by clicking on the  button, and remove an RT definition by clicking on the  button.

Users who have already had custom reaction time messages defined in the EDF file need to decide whether the custom RT messages from the EDF file or any new RT definitions created here should take precedence when both of them are applicable for a particular trial. If "Override Custom Reaction Time Definitions" box is checked, the new RT definitions created through the Reaction Time Definition Manager will take precedence; otherwise, the custom RT messages written in the EDF file will be used.

- 2) Click the New  button. In the Reaction Time Definition Editor dialog (General Tab; see Figure 6-13)
 - a. Enter a label for the current RT definition in the Label edit box.
 - b. Select the type of RT end event from the End Event Type combo box.
 - c. In the Trial Condition Qualifiers group box, select the trial condition variables and enter the intended values for the current RT definition (DO NOT include quotes for text strings). Please note that the Trial Condition Qualifiers settings are optional. If values are specified for some of the variables, the RT definition will only be applied to those trials whose variable values match the ones specified.

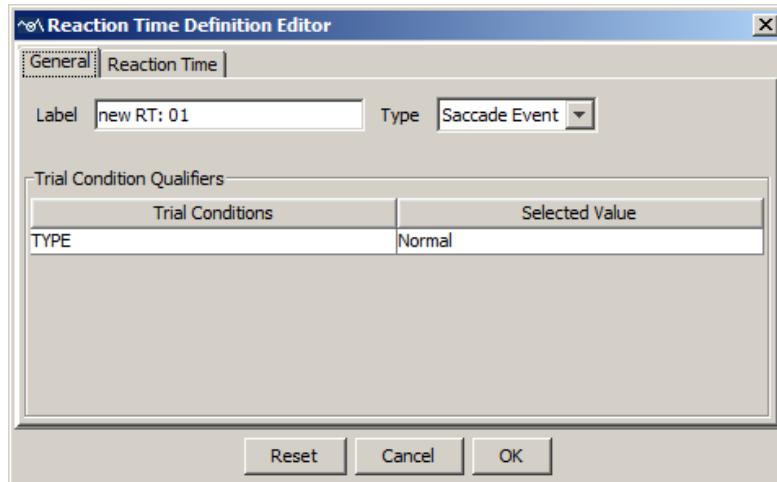


Figure 6-13. Reaction Time Definition Editor (General Tab)

- 3) Select the Reaction Time tab (see Figure 6-14).

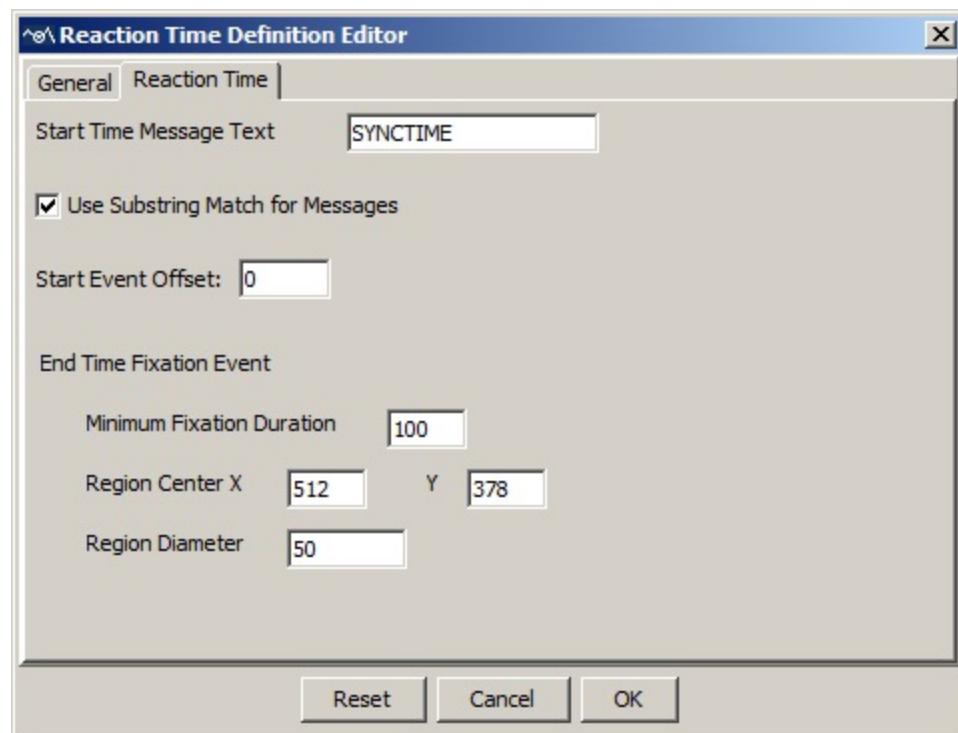


Figure 6-14. Reaction Time Definition Editor (Reaction Time Tab)

The layout of the Reaction Time tab depends on the type of end event you selected in the General tab. One common feature, though, is the configuration of the start time message. In the Start Time Message Text edit box, type in the intended message string (the default is "SYNCTIME"). The "Use Substring Match for Messages" option, if checked (default), searches for any string that contains the message text specified here. If this option is unchecked, the message string should be exactly like the one specified. For example, "SYNCTIME_SIGNAL" will not be accepted if the specified text is "SYNCTIME" and the "Use Substring Match for Messages" option is unchecked. Users can also provide a customized "Start Event Offset" value so that the reaction time period does not start right on the time of the message event (a negative number in milliseconds means that the reaction time period starts earlier than the matching event whereas a positive number means that the reaction time period starts later than the matching event).

Button Event:

This will treat a particular button press/release as the reaction time end event. Select the intended button ID from the Button Number combo box and choose the button state (button press or release).

Input Event:

This will treat a particular input event as the reaction time end event. Set the intended Input Number for the End Time Input Event.

Message Event:

This will treat the first occurrence of a matching message as the end event for reaction time calculation. In the “End Time Message Text” edit box, type in the message string (DO NOT include quotes for text strings).

Fixation Event:

This will end the trial by the appearance of a specific fixation. In the edit boxes, fill in the minimum fixation duration (in milliseconds) required, as well as the *xy* coordinates of the center of the fixation region and the diameter of the region.

Saccade Event:

This will end the trial by the occurrence of a specific saccade. Users can choose to set a minimum saccadic amplitude (in degrees of visual angle) required, as well as the *xy* coordinates of a region center and the diameter of the saccade region into which the qualifying saccade should fall. If these parameters are left blank then the first saccade following the Start Time message will be the qualifying saccade.

- 4) Once all of the desired RT definitions have been set, arrange the order of the definitions by using the ▲ and ▼ buttons in the Reaction Time Definition Manager dialog. This operation is important only when more than one RT definition can be met for a single trial—Data Viewer will apply the first matching Reaction Time definitions in the list. Therefore, if you have both specific RT definitions (those are qualified by “Trial Condition Qualifiers”) and general definitions, always put the specific definitions before the general ones.
- 5) Click OK to close the Reaction Time Manager dialog. This will apply the reaction definitions to all trials. If there are lots of trials in a viewing session, this may take some time to finish.
- 6) RT definitions that are no longer required or are not appropriate, can be removed by clicking on the “Delete Selected RT Definition” button on the Reaction Time Definition Manager dialog box.

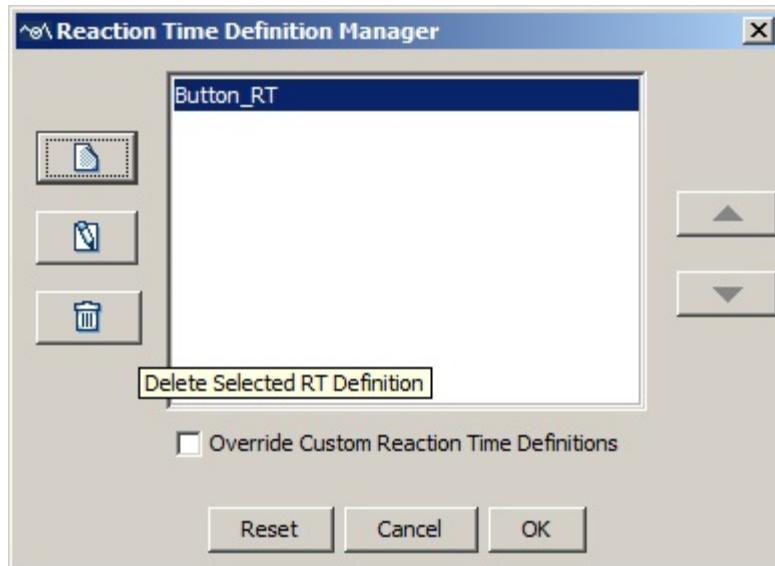


Figure 6-15. Deleting Reaction Time Definitions

6.3.2 Viewing Reaction Time Information

If the reaction time events are applied, such information is available for viewing in the Trial View Window (see Figure 6-16). In the Spatial Overlay View, a red RT symbol is displayed near the end event. In the Temporal Graph View, a green line is drawn at the time when the start time message is presented and a red line is drawn at the time when the end event occurs (to see these graphics, make sure that the Display RT Graphics field in the Data Views Preferences is checked; see section 8.6).

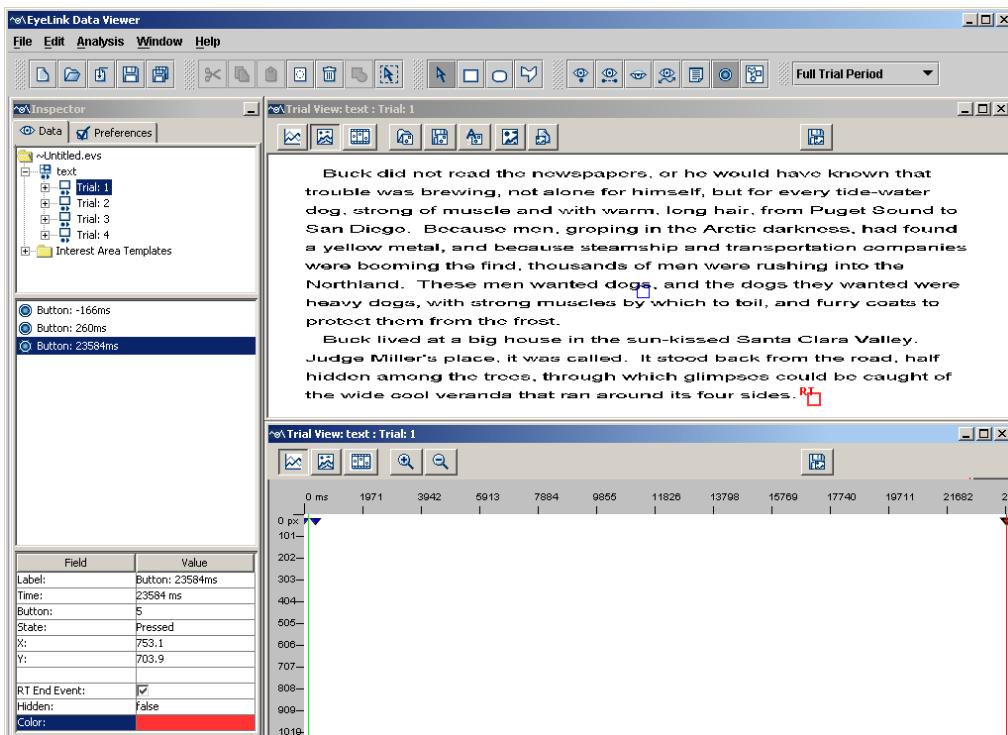


Figure 6-16. Reaction Time Graphics in Both the Spatial Overlay View and the Temporal Graph View of the Trial View Window

In the event list of the Inspector Window, select the end event that meets the reaction time definition for the selected trial. The RT End Event field of that event is automatically checked. This field will be unchecked and reaction time calculation will be updated if the user decides to choose another event as the RT end event by checking the same field of the newly selected event.

6.4 Interest Periods

In addition to reaction-time definitions, users may also selectively view and perform analysis on data within a specific period of time within a trial (Interest Period). For example, users may want to examine the eye data between two important markup messages; for a trial with multi-page manipulation, analysis may be performed separately for the period of each page presentation. Data Viewer allows users to create interest periods based on messages, button events, input events, or duration. In order to facilitate interest period creation, when programming an experiment, users should mark up possible interest periods with messages or other important events such as button presses. If different stimuli are shown in each of the interest periods, users should also make sure the integration messages that are used to load images, text, or draw simple graphics be recorded within the scope of the intended interest period; otherwise gaze data will be overlaid on top of wrong images.

6.4.1 Creating Interest Periods

To create an interest period,

- 1) Click the “Interest Period List” combo box at the far-right hand of the application menu bar and select the “Edit ...”.
- 2) Similar to the reaction time manager dialog, users can create a new interest period by clicking the New Interest Period  button on the left, edit an existing interest period by clicking on the Edit Selected Interest Period  button, and remove an interest period by clicking on the Delete Selected Interest Period  button. Users can make a copy of the selected interest periods in the Interest Period Editor by clicking on the Duplicate Selected Interest Period  button. Data Viewer also supports exporting and importing of interest periods across viewing sessions. For example, users may create intended interest periods for one session, and then export the interest periods into a property file by clicking on the "Export the Interest Period" button . For all future viewing sessions that involve EDF files with the necessary messages/button presses/input values that fit the interest period definitions, creation of the interest periods can be automated by importing the

previously saved property file (by clicking on the "Import the Interest Period" button ).

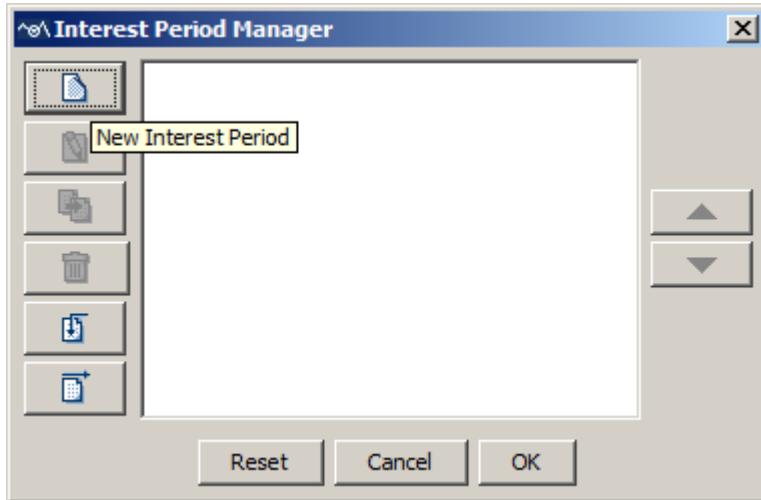


Figure 6-17. Interest Period Manager

- 3) Click the New Interest Period  button. In the following Interest Period Editor dialog, enter a label for the current interest period in the "Interest Period Name" edit box. The following steps explain in detail how to configure the IP Start Event Settings and IP End Event Settings of the new interest period to be created.
- 4) In the IP Start Event Settings box, users need to specify the Interest Period Start Event Type, and the Start Event Offset (msec). The start event of an interest period can be a message (clicking on the "EDF Message" radio button) or an input event (clicking on the "Input" radio button).
 - If the start event is a message, enter the message string in the "Message Text" field (case-sensitive; DO NOT include quotes for the text string). If this field is left empty, this will be the start of the trial recording. A "Use Substring Match for Messages" option is available for the message event type. If checked (default), Data Viewer searches for any string that contains the message text specified here. If this option is unchecked, the message string should be exactly like the one specified. For example, "SYNCTIME_SIGNAL" will not be accepted if the specified text is "SYNCTIME" and the "Use Substring Match for Messages" option is unchecked.
 - If the start event is an input event, enter a value in the "Input Value" field and choose the proper Input Event Value Format - "Decimal", "Binary", or "Hex".

For both the message and input start event type, users can specify the "Start Event Offset (msec)"—a time offset that can be used when the interest period does not start right on the time of the message or button event. A negative number in milliseconds should be used when the interest period starts earlier than the

matching event, and a positive number should be used when the interest period starts later than the matching event.

- 5) Users can similarly specify the event type and offset value in the IP End Event Settings box. The end event type of an interest period can be an EDF message, input event, button event, or fixed duration.
 - EDF Message - This will treat the first occurrence of a matching message as the end event for the interest period. Enter the desired message string in the "Message Text" field (case sensitive, with no quotes for the text string). Check the "Use Substring Match for Messages" option if you would like Data Viewer to search for any string that contains the message text specified here. Otherwise please have this option unchecked if the message string should be exactly like the one specified.
 - Input - This will treat a particular input event as the interest period end event. Enter a value in the "Input Value" field and choose a proper Input Event Value Format - "Decimal", "Binary", or "Hex".
 - Button - This will treat a particular button press/release as the interest period end event. Select the intended button ID from the Button Number combo box and choose the desired button action (pressed or released).
 - Duration - The interest period can also be based on a duration following the detection of the start message (e.g., 10 seconds following the "SYNCTIME" message). In the "IP Duration (msec)" edit box, enter the desired duration of the interest period – a value of 0 creates an interest period from the matching start event to the end of the trial. Version 3.1 of Data Viewer allows users to create multiple consecutive duration-based interest periods by checking the "Create Multiple Consecutive IPs" box on the right side and entering the desired number in the "Total Number of IPs" box. These options are only available when creating new interest periods but not when editing existing ones.

For the EDF message, input, or button end event type, users can specify the "End Event Offset (msec)"—a time offset to be used when the interest period does not end right on the time of the message, input, or button event. A negative number in milliseconds should be used when the interest period ends earlier than the matching event, and a positive number should be used when the interest period ends later than the matching event.

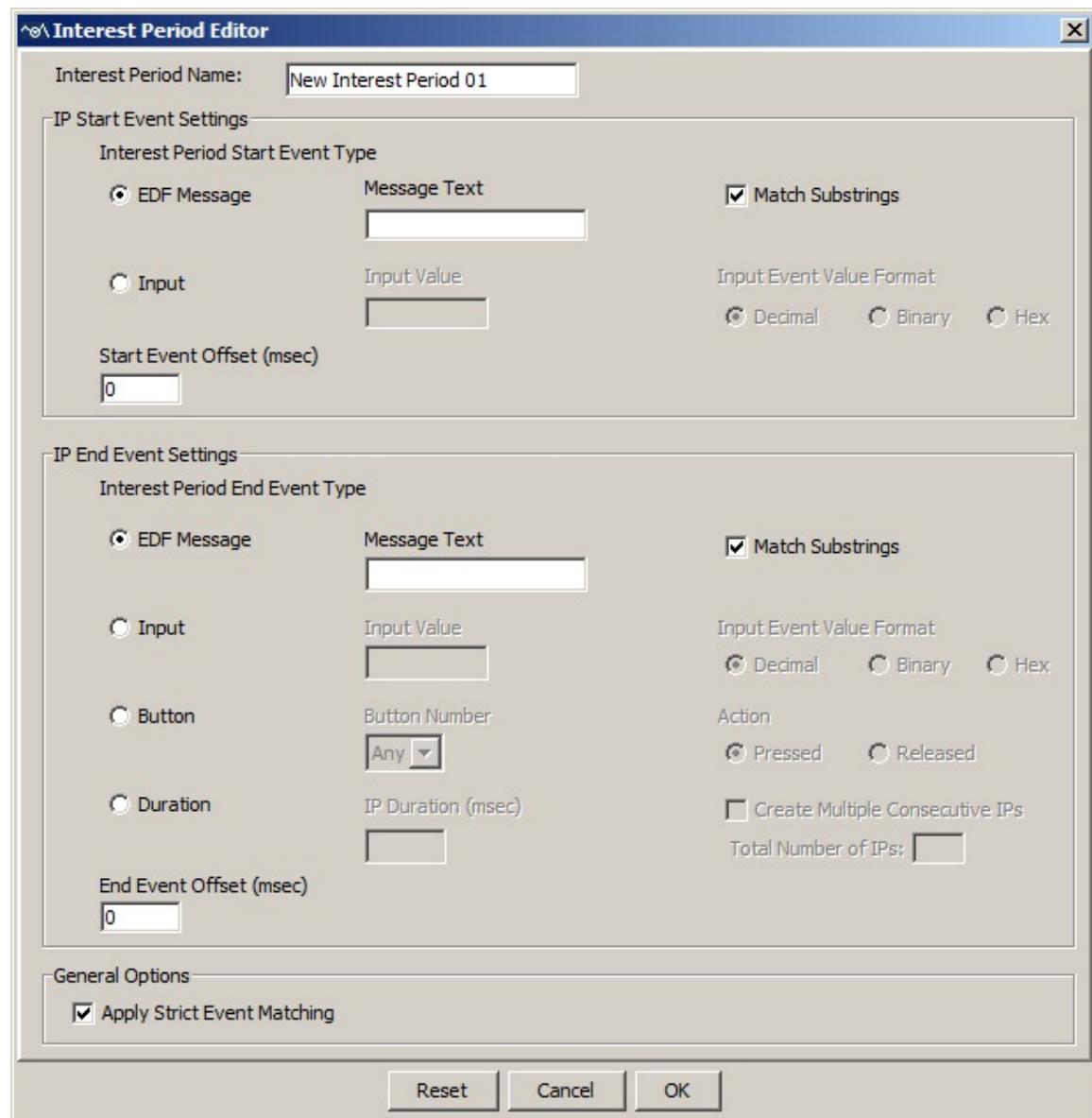


Figure 6-18. Interest Period Editor

- 6) At the bottom of the Interest period editor, there is a general option of “Apply Strict Event Matching”. If this option is enabled, a strict match of the start event and end event is required for the interest period creation. That is, a valid interest period will only be created when a matching event is found for both the start event and end event in the trial; otherwise an empty interest period will be created for the trial. If the option is unchecked, Data Viewer will use the start time of the trial as the start of the interest period if no matching start event is identified in the trial, and use the end time of the trial as the end of the interest period if no matching end event is found.
- 7) Click OK to close the Interest Period Editor dialog. This will apply the interest period for all trials.

6.4.2 Using Interest Periods

The newly-created interest periods are added to the existing interest period list, which includes two default interest periods—“Full Trial Period” and “Reaction Time Period”. The Full Trial Period corresponds to the entire trial recording. If Reaction Time definitions have been created in the current viewing session (through “Analysis -> Reaction Time Manager”), Reaction Time Period corresponds to the trial segment between the start and end of the reaction time. If no reaction time definition is created or no valid reaction time definition is found in a trial, the “Reaction Time Period” is the same as the “Full Trial Period”.

Users can navigate between different interest periods by selecting the desired interest period from the list. For each interest period, only those events falling within that period are shown in the Spatial Overlay, Temporal Graph Views, and in the event list of the Inspector Window. In addition, for all of the following output reports (trial, fixation, saccade, interest area, sample, aggregate event statistics and aggregate interest area reports), only those events and data within the selected interest period (custom-defined interest period, or the default—“Full Trial Period” or “Reaction Time Period”) are exported. If the “Create Output Report for All Custom Interest Periods” option on the output dialog box is checked, data export will include all custom interest periods created in the viewing session (the “Full Trial Period” or “Reaction Time Period” is included only if it is the currently-selected interest period).

The property table of the trial nodes provides feedback on the interest period selected. It displays the times of the interest period (“Interest Period Start” and “Interest Period End”) as well as whether a matching event is identified for the start and end of the interest period (“Interest Period Start Matched” and “Interest Period End Matched”). Such feedback is also available as individual variables (IP_LABEL, IP_START_TIME, IP_END_TIME, IP_START_EVENT_MATCHED, and IP_END_EVENT_MATCHED) in the output reports.

Applying an interest period will filter out all events that are not within the scope of the selected interest period. This may also affect the eye events that overlap with the start/end of the interest period. If the "Trimmed Spanned Fixation Duration" setting of the "Data Filters" preference is enabled, the duration, start time, and end time of the fixations that overlap with the start or end of the interest period will be trimmed accordingly.

6.5 Trial Report

Trial reports summarize the performance of individual trials. If you want to look at a segment of data from each recording trial instead of the default full trial period, please make sure that you have created and selected a proper interest period or reaction time definition before creating a trial report.

6.5.1 Creating a Trial Report

To obtain a trial report,

1) From the application menus, choose:

Analysis -> Reports -> Trial Report

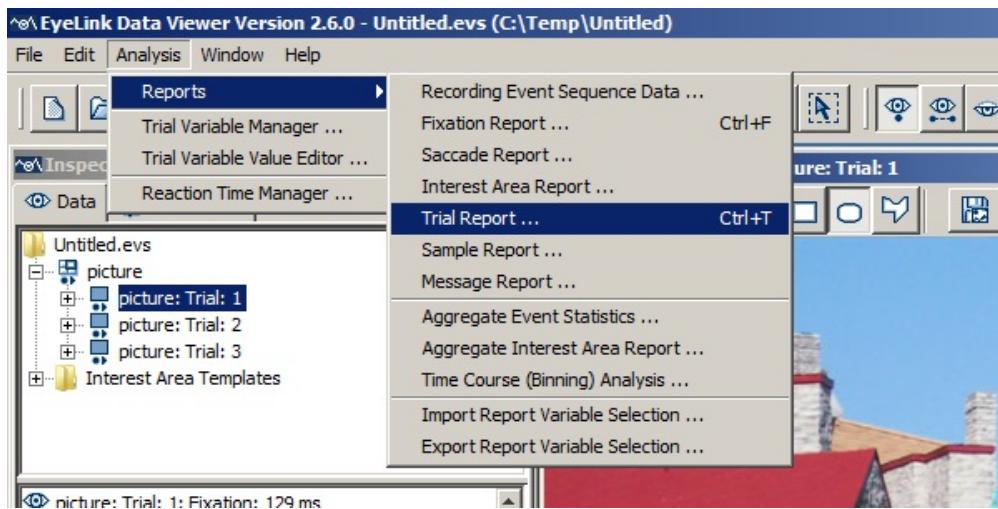


Figure 6-19. Creating a Trial Report.

- 2) In the following output report dialog, select the variables in the list of available output variables (left panel) and press ">>" to enter the variables into the list of selected output variables. You can also drag the selected variables and drop them to the intended position in the selected variables list.

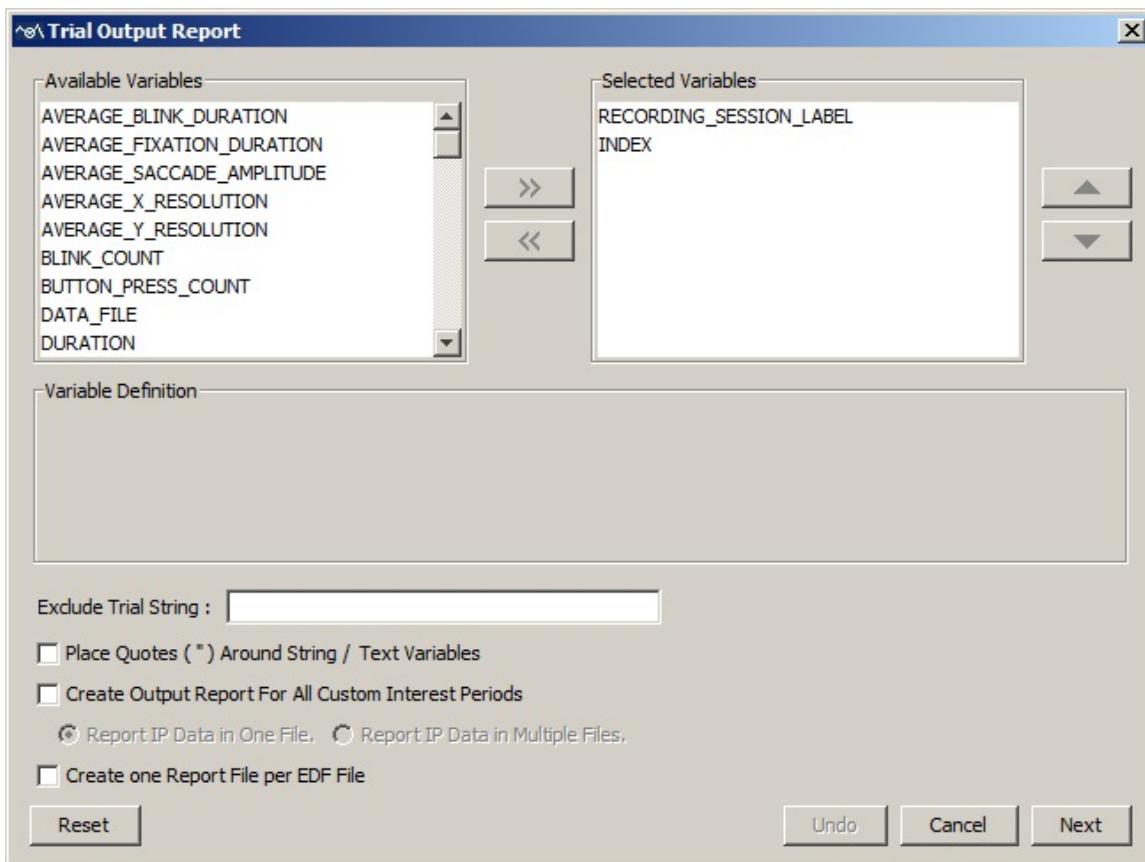


Figure 6-20. Variables Used in the Trial Report.

- To remove variables from the output list, simply select the variables and press <<. You can also drag the selected variables and drop them back to the Available Variables list.
- To change the order in which the variables are listed, simply select one variable and use the ▲ or ▼ button to move it to the desired position. Repeat this step until all the chosen variables are in the right position. You can also select the variable(s) and then drag and drop them to the intended position.
- Data Viewer supports exporting and importing of variable selection across viewing sessions. For example, users may go through each of the output reports to configure the selection of variables in an intended order, then export the variable selection into a property file by clicking “Analysis -> Reports -> Export Report Variable Selection”. For future viewing sessions, the variable selection in the reports can be achieved by importing the previously saved property file by choosing “Analysis -> Reports -> Import Report Variable Selection” (except for user-defined variables if they are used differently across experiments).

3) Once all the desired variables have been entered into the output list, press the Next button.

4) In the Save dialog box, browse to the directory in which you want to save the output report. The default output directory can be configured through "General Preferences".

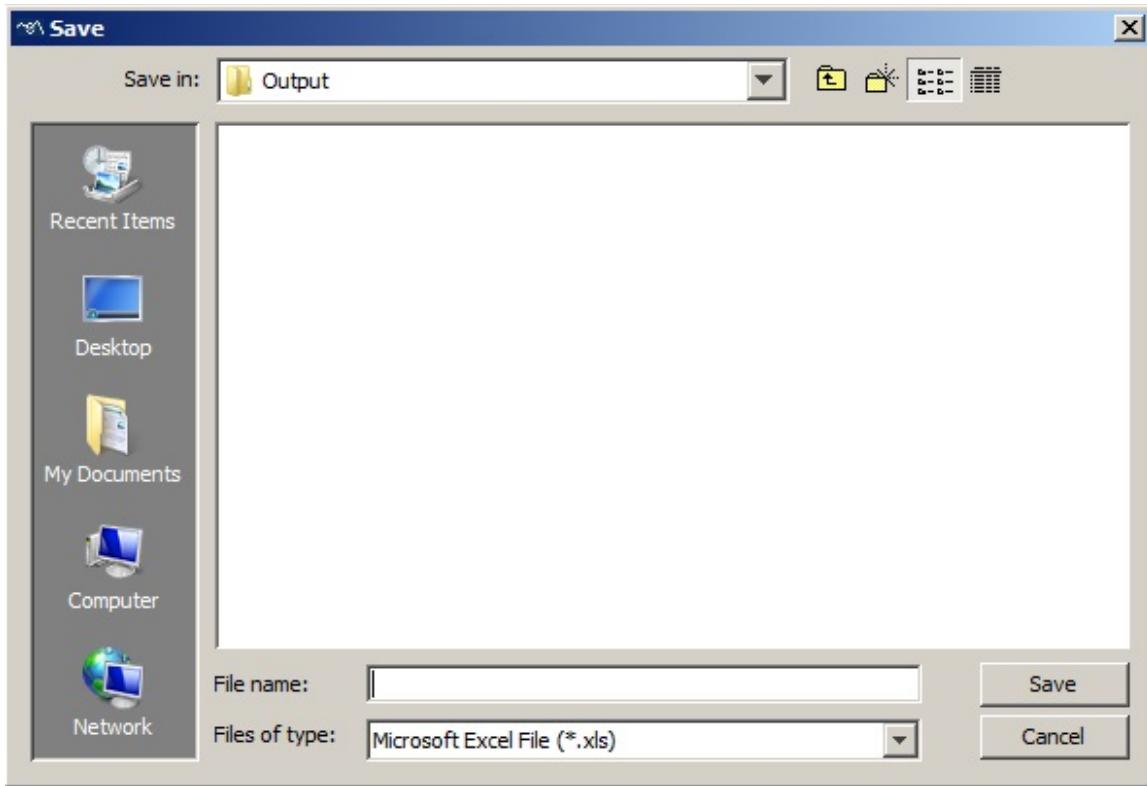


Figure 6-21. Saving the Output Report.

5) In the File name text box, type in the name for the document and choose the appropriate file extension. Note: if the output report file extension set to "All Files" and the file name does not contain an extension, the file name is appended with a ".txt" by default.

6) Press the "Save" button.

Note: The saved trial report is a tab-delimited text file, despite the default file extension is .xls on Windows. Occasionally the file formatting may be confused by the quotation marks in the report variables. Instead of opening the file by double clicking on the .xls file directly, try starting Microsoft Excel first and then clicking "File -> Open" (choose the "Delimited" option in the Text Import Wizard, click "Next". Keep the default settings for "Delimiters" options, and then click "Next" and "Finish").

6.5.2 Variables in the Trial Report

The following variables are listed in the trial report. Outputs for those variables marked with an "*" will change if a different interest period is used.

Field	Contents
RECORDING SESSION LABEL	Label of the data file.
* AVERAGE_BLINK_DURATION	Average duration (in milliseconds) of all blinks in the trial within the currently-selected interest period.
* AVERAGE_FIXATION_DURATION	Average duration (in milliseconds) of all fixations in the trial within the currently-selected interest period.
* AVERAGE_SACCADE_AMPLITUDE	Average size (in degrees of visual angle) of all saccades in the trial within the currently-selected interest period.
AVERAGE_X/Y_RESOLUTION	Average horizontal/vertical angular resolution (in screen pixels per degree) for the trial.
* BLINK_COUNT	Total number of blinks in the trial within the currently-selected interest period.
* BUTTON_PRESS_COUNT	Total number of button presses in the trial within the currently-selected interest period.
DATA_FILE	File name of the EDF data file.
DURATION	Duration of the eye tracker recording for the current trial (i.e., duration between the “START” event and the “END” event of a recording segment). This duration is not affected by any interest period or reaction time period filtering.
END_TIME	Timestamp when the trial recording ends (in milliseconds since EyeLink tracker was activated; i.e., EDF file time).
EYE_USED	Records which eye's data (LEFT or RIGHT) was used to create this report.
* FIXATION_COUNT	Total number of fixations in the trial within the currently-selected interest period.
FIXATION_DURATION_MAX	The longest fixation duration (in milliseconds) in the trial.
FIXATION_DURATION_MAX_TIME	Start time (in milliseconds since EyeLink tracker was activated; i.e., EDF file time) of the fixation with the longest fixation duration in the trial.
FIXATION_DURATION_MIN	The shortest fixation duration (in milliseconds) in the trial.
FIXATION_DURATION_MIN_TIME	Start time (in milliseconds since EyeLink

	tracker was activated; i.e., EDF file time) of the fixation with the shortest fixation duration in the trial.
IA_COUNT	Reports total number of unique interest areas in the trial.
INDEX	Sequential order of the trial in the recording.
* INPUT_COUNT	Number of input events that occur during the trial within the currently-selected interest period.
INTEREST_AREA_FIXATION_SEQUENCE	Temporal order in which interest areas were fixated in the current trial. Please note that this sequence calculation differs from RUN_COUNT in two aspects: 1) this variable takes null values (when no interest area is fixated) into account and represents them with a 0 value in the list; 2) For fixations into overlapping interest areas (if "Include Fixation in Single IA" preference is not enabled), INTEREST_AREA_FIXATION_SEQUENCE only takes the first interest area for each fixation and doesn't consider other overlapping interest areas. RUN_COUNT is calculated by summing up the individual runs across all interest areas (which can contain overlaps and don't count nulls).
INTEREST_AREA_SET	Setting of the interest area ("Custom Interest Area Set" if interest areas are loaded/created and "Empty Interest Area Set" if not).
* IP_DURATION	Duration of the interest period in milliseconds.
IP_END_EVENT_MATCHED	Whether an event that matches the end of the selected interest period has been found in the current trial.
* IP_END_TIME	End time (in milliseconds since EyeLink tracker was activated) of the interest period.
IP_INDEX	The index (starting from 1) of interest period created by the user. For the Full-Trial period or Reaction-Time Period, a

	missing value is given as they are not created by the user.
IP_LABEL	Label of the current interest period selected in the viewing session.
IP_START_EVENT_MATCHED	Whether an event that matches the start of the selected interest period has been found in the current trial.
* IP_START_TIME	Start time (in milliseconds since EyeLink tracker was activated) of the interest period.
MEDIAN_FIXATION_DURATION	Median duration (in milliseconds) of all fixations in the trial within the currently-selected interest period.
MEDIAN_SACCADE_AMPLITUDE	Median size (in degrees of visual angle) of all saccades in the trial within the currently-selected interest period.
* MESSAGE_COUNT	Total number of messages in the trial within the currently-selected interest period.
* PUPIL_SIZE_MAX	Largest pupil size in arbitrary units in the trial recording within the currently-selected interest period. Note that PUPIL_SIZE_MAX, PUPIL_SIZE_MEAN, and PUPIL_SIZE_MIN fields will output a missing value if samples are not loaded into a viewing session (see Data Loading Preferences).
*PUPIL_SIZE_MAX_TIME	EDF Time (EDF file time in milliseconds since EyeLink tracker was activated) of the sample with maximum pupil size. Note that this field will output a missing value if samples are not loaded into a viewing session (see Data Loading Preferences).
*PUPIL_SIZE_MAX_X	Gaze X position at PUPIL_SIZE_MAX_TIME. Note that this field will output a missing value if samples are not loaded into a viewing session (see Data Loading Preferences) or the eye is in a blink.
*PUPIL_SIZE_MAX_Y	Gaze Y position at PUPIL_SIZE_MAX_TIME. Note that this

	field will output a missing value if samples are not loaded into a viewing session (see Data Loading Preferences) or the eye is in a blink.
* PUPIL_SIZE_MEAN	Average pupil size in arbitrary units in the trial. Note that this field will output a missing value if samples are not loaded into a viewing session (see Data Loading Preferences) or the eye is in a blink.
* PUPIL_SIZE_MIN	Smallest pupil size in arbitrary units in the trial. Note that this field will output a missing value if samples are not loaded into a viewing session (see Data Loading Preferences) or the eye is in a blink.
* PUPIL_SIZE_MIN_TIME	EDF Time (in milliseconds since EyeLink tracker was activated; i.e., EDF file time) of the sample with minimum pupil size. Note that this field will output a missing value if samples are not loaded into a viewing session (see Data Loading Preferences) or the eye is in a blink.
* PUPIL_SIZE_MIN_X	Gaze X position at PUPIL_SIZE_MIN_TIME. Note that this field will output a missing value if samples are not loaded into a viewing session (see Data Loading Preferences) or the eye is in a blink.
* PUPIL_SIZE_MIN_Y	Gaze Y position at PUPIL_SIZE_MIN_TIME. Note that this field will output a missing value if samples are not loaded into a viewing session (see Data Loading Preferences) or the eye is in a blink.
¶ REACTION_TIME	Configurable response time determined by the Reaction Time Definition associated with the trial. This variable returns a '.' if the trial does not have an RT end event.
¶ RT_DEFINITION_LABEL	Label of the RT definition ("." if undefined). "CUSTOM_RT" if the RT definition is a custom one.
¶ RT_EVENT_BUTTON_ID	If the RT end event is the press/release of a button, records the button ID; otherwise, records ".".
¶ RT_EVENT_END_TIME	End time (in milliseconds since EyeLink

	tracker was activated, i.e., in EDF time) of the end event. If end event is not an eye event (fixation or saccade event), this variable is equal to RT_EVENT_START_TIME.
¶ RT_EVENT_INDEX	Sequential order of the end event (index is based on all events of that particular event type); -1 when NO_MATCH.
¶ RT_EVENT_INPUT	If the reaction time end event is the INPUT event defined, reports the new INPUT value; otherwise, a missing value “.” is reported.
¶ RT_EVENT_MESSAGE_TEXT	Reports the message text of the end event. If the end event is not a message event, reports “.”.
¶ RT_EVENT_POSITION_X/Y	Reports the X/Y coordinates of the fixation or saccade end event and reports “.” for a button, input, or message end event.
¶ RT_EVENT_START_TIME	Start time (in milliseconds since EyeLink tracker was activated, i.e., in EDF time) of the end event.
¶ RT_EVENT_TYPE	The type of the end event (BUTTON, INPUT, FIXATION, SACCADE, MESSAGE, or NO_MATCH) for the Reaction Time Definition associated with the trial.
¶ RT_START_TIME	Start time (in milliseconds since EyeLink tracker was activated; i.e., EDF file time) of RT definition for a trial.
* RUN_COUNT	Total runs of fixations (two consecutive fixations in the same interest area belong to the same run) in the trial within the currently-selected interest period.
* SACCADE_COUNT	Total number of saccades in the trial within the currently-selected interest period.
* SAMPLE_COUNT	Total number of samples in the trial within the currently-selected interest period.
* SD_SACCADE_AMPLITUDE	Standard deviation of the amplitude (in degrees of visual angle) across all saccades in the trial within the currently-selected interest period.
* SD_FIXATION_DURATION	Standard deviation of the duration (in

	milliseconds) across all fixations in the trial within the currently-selected interest period.
START_TIME	Timestamp when the trial recording starts (in milliseconds since EyeLink tracker was activated; i.e., EDF file time).
TRIAL_LABEL	Label of the trial.
VISITED_INTEREST_AREA_COUNT	Reports total number of unique interest areas visited in the trial (i.e., RUN_COUNT without replacement).

Besides these default variables, additional trial variables will be listed if they have been defined in the EDF file or created during the viewing session (see section 6.1.1 on trial variable manager).

6.5.3 Using Trial Report

Please note that in the above table, outputs for all of the variables marked with an “*” will change if different interest periods are used. For example, the value of these variables in a Trial Report run with a Reaction Time Period set may be different from the values in a Trial Report run with Full Trial Period set, as the former will only include a subset of the data in the report. Therefore, please make sure that you have the right Interest Period selected when creating your own reports (see figure below; see also section 6.4.2). In those trials with no reaction time defined, missing values (“.”) will be recorded for those variables marked with a “¶” sign. Please also note that event counts only include visible events.

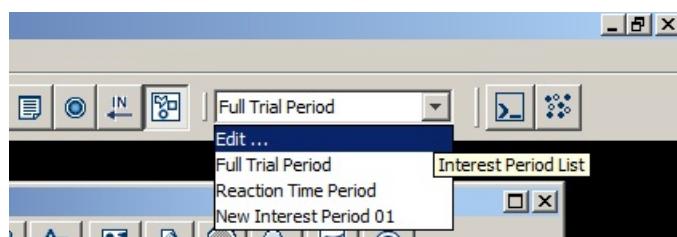


Figure 6-22. Using Interest Period for Event Filtering

There are three possible time periods for a trial report: 1) recording period, 2) reaction-time period, and 3) interest period. The recording period (START_TIME, END_TIME, and DURATION) of a trial starts from the “START” message in the EDF file and ends on the “END” message. This is fixed for a recording trial, regardless of how the user sets the interest period filters.

If a valid reaction time definition is found for one trial, the RT_START_TIME is the time of the RT start message (e.g., time of “SYNCTIME” message),

RT_EVENT_END_TIME, and RT_EVENT_START_TIME are the start and end time of the RT event (fixation, saccade, button, input, or message). Reaction time (REACTION_TIME) is calculated as the difference between RT_START_TIME and RT_EVENT_START_TIME. Please note that the RT_EVENT_END_TIME and RT_EVENT_START_TIME will be the same when a button, input, or message is used as the RT end event, but will be different when a fixation or saccade is defined as the end event. If the user does not create a reaction time definition or no valid reaction time definition is found for one trial, REACTION_TIME, RT_EVENT_END_TIME, and RT_EVENT_START_TIME, and other variables related to reaction-time definition will have missing values (“.”) whereas RT_START_TIME will be the same as the trial recording start time (START_TIME).

The interest period variables will have different values depending on the settings used in the interest period filter (see Figure 6-22). If the interest period filter is set to “Full Trial Period”, the start (IP_START_TIME), end (IP_END_TIME), and duration (IP_DURATION) of the interest period will be same as those for the recording period (i.e., START_TIME, END_TIME, and DURATION). If the interest period filter is set to “Reaction Time Period”, the start, end, and duration of the interest period will be same as those for the reaction time period. If a user has created their own interest period (see section 6.4.1) and that interest period is used to filter events, the output report will do summary statistics (variables marked with “*” in the above table) for only those events falling within that period.

6.5.4 Configuring the Trial Report

Data Viewer allows users to configure the trial report (and similarly other reports). A few options are available in the “Trial Output Report” dialog box:

- Users can exclude some trials by entering a string in the “Exclude Trial String” edit box. This string should be one message or part of a message within the trial recording (see section 7.1 on defining the start and end of a trial) that uniquely defines the subset of trials to be excluded.
- To enable correct loading of string/text variables into some statistics software, Data Viewer provides an option of adding a pair of quotation marks for those variables.
- If the “Create Output Report for All Custom Interest Periods” option is enabled, the Trial Report will output data across all custom interest periods created in the viewing session—the “Full Trial Period” or “Reaction Time Period” data is only included in the report if it is the currently-selected interest period. Users can save the data from multiple interest periods into a single file or into multiple individual files.
- If the “Create One Report File Per EDF File” option is checked, Data Viewer will create one report file for each of the EDF files loaded into the viewing session.

Note: If the “Exclude from Reports” property of a trial or trial group is checked, data from that trial/trial group will not be included in the trial report (and other reports).

6.6 Fixation Report

Fixation reports provide information about fixation events. Each row of the report represents a single fixation. Depending on the variables selected for output, each row can contain information on the previous fixation and/or saccade, as well as the next fixation and/or saccade.

6.6.1 Obtaining a Fixation Report

To obtain a fixation report,

- 1) From the application menu, choose:
Analysis -> Reports -> Fixation Report

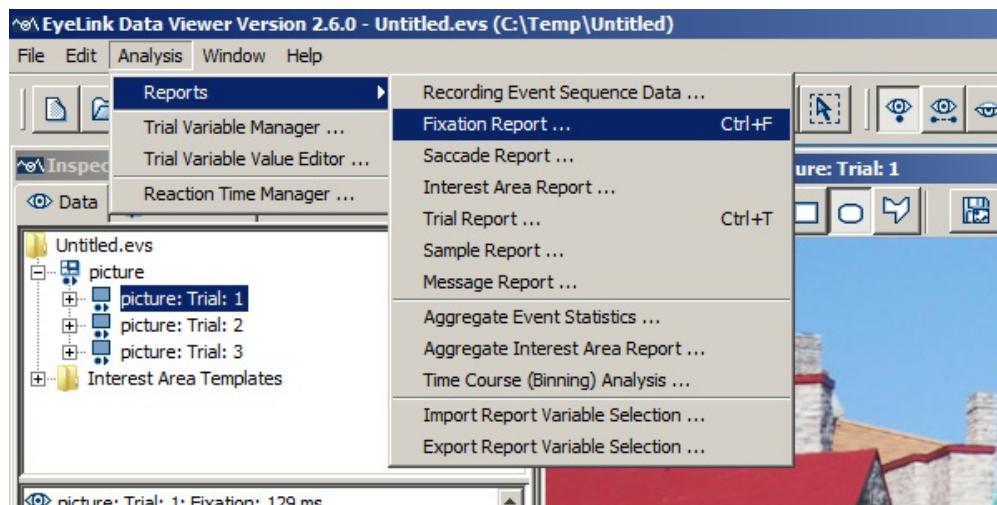


Figure 6-23. Creating a Fixation Report.

- 2) In the following output report dialog, select the variables in the list of available output variables (left panel) and press ">>" to enter the variables into the list of selected output variables. You can also drag the selected variables and drop them to the intended position in the selected variables list.

- To remove variables from the output list, simply select the variables and press <<. You can also drag the selected variables and drop them back to the Available Variables list.
- To change the order in which the variables are listed, simply select one variable and use the ▲ or ▼ button to move it to the desired position. Repeat this step until all variables are in the right position. You can also select the variable(s) and then drag and drop them to the intended position.

- Data Viewer supports exporting and importing of variable selection across viewing sessions. For example, users may go through each of the output reports to configure the selection of variables in an intended order, and then export the variable selection into a property file by clicking “Analysis -> Reports -> Export Report Variable Selection”. For all future viewing sessions, the variable selection in the reports can be achieved by importing the previously saved property file (through “Analysis -> Reports -> Import Report Variable Selection”).

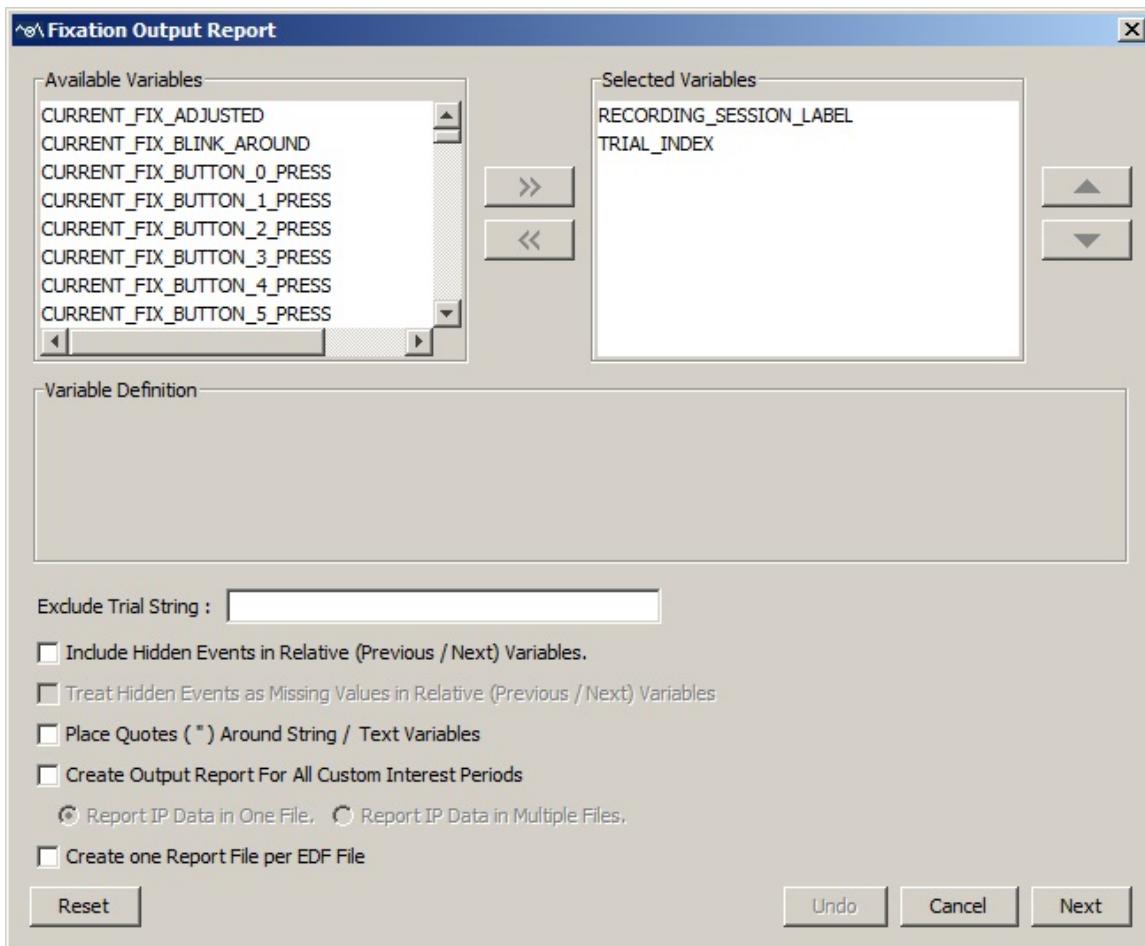


Figure 6-24. Variables in a Fixation Report.

- 3) Once all the desired variables have been entered into the output list, press the Next button.
- 4) In the Save dialog box, browse to the directory in which you want to save the output report. The default output directory can be configured through "General Preferences".

5) In the File name text box, enter the name for the document and choose the appropriate file extension. Note, if the output report file extension is set to "All Files" and the file name does not contain an extension, the file name is appended with a ".txt" by default.

6) Press the "Save" button.

6.6.2 Variables in the Fixation Report

The fixation report includes the following variables. Please note that the values of all variables marked with a “¶” symbol are calculated relative to TRIAL_START_TIME, and therefore will be different depending on whether a valid reaction time is found in the trial (see section 6.5.3 on discussion of three time periods used in Data Viewer).

Field	Contents
RECORDING_SESSION_LABEL	Label of the data file.
CURRENT_FIX_ADJUSTED	Whether the current fixation has been adjusted manually.
CURRENT_FIX_BLINK_AROUND	Whether there is a blink preceding or following the current fixation. Possible values are “AFTER” (a blink follows the current fixation), “BEFORE” (a blink precedes the current fixation), “BOTH” (the current fixation is flanked by a preceding and a following blink), or “NONE” (no blink appears around the current fixation).
CURRENT_FIX_BUTTON_0_PRESS ... CURRENT_FIX_BUTTON_8_PRESS	Trial time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") if a specific button (0 - 8) has been pressed during or after fixation. If no button press is made from the start of the current fixation to the start of next fixation, missing value “.” is assigned.
CURRENT_FIX_DURATION	Duration of the current fixation.
¶CURRENT_FIX_END	Trial time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") when the current fixation ends.
¶CURRENT_FIX_END_OTHER	Trial time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") when the current fixation ends (for the other eye in a binocular recording).
CURRENT_FIX_INDEX	The position of the current fixation in the trial. Index numbers range from 1 to n, where n is the total number of fixations in the trial.
CURRENT_FIX_INPUT_EVENT	A list used to store new input events (time and

S	event code) that occur during the current fixation.
CURRENT_FIX_INTEREST_AREAS	A list of the interest area IDs that the current fixation falls into.
CURRENT_FIX_INTEREST_AREA_DATA	A list containing the data (interest area type, dynamic/static interest area, and coordinate data) of the interest area to which the current fixation is assigned.
CURRENT_FIX_INTEREST_AREA_DWELL_TIME	Total amount of fixation dwell time (in msec) on the interest area to which the current fixation belongs.
CURRENT_FIX_INTEREST_AREA_FIX_COUNT	Total number of fixations on the interest area to which the current fixation belongs.
CURRENT_FIX_INTERESTAREA_GROUP	Group label for the interest area to which the current fixation is assigned.
CURRENT_FIX_INTEREST_AREA_ID	The ID of the interest area in which the current fixation falls.
CURRENT_FIX_INTEREST_AREA_INDEX	The index of the interest area in which the current fixation falls. This measure is the same as the CURRENT_FIX_INTEREST AREA_ID except when there are multiple interest areas with the same ID, or interest area IDs didn't start from 1.
CURRENT_FIX_INTEREST_AREA_LABEL	The label of the interest area to which the current fixation is assigned.
CURRENT_FIX_INTEREST_AREA_PIXEL_AREA	Pixel area of the interest area to which the current fixation is assigned.
CURRENT_FIX_INTEREST_AREA_RUN_ID	The ordinal sequence of the current run ¹ of fixation(s) made towards the current interest area. If the current interest area does not have a previous run of fixation(s) on it, this variable will have a value of 1.
CURRENT_FIX_INTEREST_AREA_X_OFFSET	Horizontal offset of the current fixation relative to the center of the interest area. If the fixation falls into multiple interest areas, returns the offset value relative to the first relevant interest area only. Returns a missing value (.) for freehand interest areas.
CURRENT_FIX_INTEREST_AREA_Y_OFFSET	Vertical offset of the current fixation relative to the center of the interest area. If the fixation falls into multiple interest areas, returns the offset value relative to the first relevant interest area only. Returns a missing value (.) for freehand interest

	areas.
CURRENT_FIX_IS_RT_END	Whether the current fixation is the end event of the RT definition.
¶ CURRENT_FIX_LABEL	Label of the current fixation.
CURRENT_FIX_MSG_COUNT ²	Number of visible messages associated with the current fixation event ¹ . This number will not exceed the “Maximum Message Variables for Eye Event” set in the Output/Analysis Preference Settings.
CURRENT_FIX_MSG_TEXT_# ²	Text string for messages associated with the current fixation ¹ . There will be as many of these as the value set in the “Maximum Message Variables for Eye Event” property of the Output/Analysis preferences.
¶ CURRENT_FIX_MSG_TIME_# ²	Trial time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the message ¹ . There will be as many of these as the value set in the “Maximum Message Variables for Eye Event” property of the Output/Analysis preferences.
CURRENT_FIX_NEAREST_INTEREST_AREA	Nearest interest area the current fixation is assigned to. If the fixation falls within multiple interest areas, the assignment is based on the shortest distance to the center of an interest area. If the fixation doesn't fall within any interest areas, the assignment is based on the shortest distance to the closest edge of an interest area.
CURRENT_FIX_NEAREST_INTEREST_AREA_DISTANCE	Distance (in degrees of visual angle) between the current fixation point and the center of the nearest interest area to the current fixation.
CURRENT_FIX_NEAREST_INTEREST_AREA_LABEL	Label for the nearest interest area to the current fixation.
CURRENT_FIX_PUPIL	Average pupil size during the current fixation.
CURRENT_FIX_REFIX_INTEREST_AREA	Whether this trial has a previous fixation in a different run ¹ that had the same interest area as the current fixation. If so, the CURRENT_FIX_INDEX value of the very first fixation in that interest area is reported. If not, 0 is reported.
CURRENT_FIX_REFIX_PREV_INTEREST_AREA	Whether this trial has a previous fixation in an IA with higher IA ID than current fix IA ID (see run ¹ definition).

CURRENT_FIX_RUN_DWELL_TIME	Total amount of dwell time (in msec) in the current run ¹ of fixations.
CURRENT_FIX_RUN_INDEX	Ordinal sequence of the current fixation in the current run ¹ of fixations. The first fixation in this run has a RUN_INDEX of 1 and the second one has RUN_INDEX value of 2, and so on.
CURRENT_FIX_RUN_SIZE	Number of fixations within the current run ¹ .
¶ CURRENT_FIX_START	Trial time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") when the current fixation starts.
¶ CURRENT_FIX_START_OTHER	Trial time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") when the current fixation starts (on the other eye in a binocular recording).
CURRENT_FIX_TRIAL_SPAN	Whether the fixation starts before the trial starts and ends after the trial starts, or starts before the trial ends and ends after the trial ends.
CURRENT_FIX_X	X coordinate of the current fixation.
CURRENT_FIX_X_OTHER	X coordinate of the current fixation (of the other eye in a binocular recording).
CURRENT_FIX_X_RESOLUTION	Horizontal pixel-per-degree resolution for the current fixation.
CURRENT_FIX_Y	Y coordinate of the current fixation.
CURRENT_FIX_Y_OTHER	Y coordinate of the current fixation (of the other eye in a binocular recording).
CURRENT_FIX_Y_RESOLUTION	Vertical pixel-per-degree resolution for the current fixation.
	Note: Similar analyses are done for the previous fixation (variables beginning with PREVIOUS_FIX) and for the next fixation (variables beginning with NEXT_FIX).
DATA_FILE	File name of the recording.
EYE_USED	Records which eye's data (LEFT or RIGHT) is used in the current report.
IP_END_EVENT_MATCHED	Whether an event that matches the end of the selected interest period has been found in the current trial.
IP_END_TIME	End time (in milliseconds since EyeLink tracker was activated; i.e., EDF file time) of the interest period.
IP_INDEX	The index (starting from 1) of interest period created by the user. For the Full-Trial period or

	Reaction-Time Period, a missing value is given as they are not created by the user.
IP_LABEL	Label of the current interest period selected in the viewing session.
IP_START_EVENT_MATCHED	Whether an event that matches the start of the selected interest period has been found in the current trial.
IP_START_TIME	Start time (in milliseconds since EyeLink tracker was activated; i.e., EDF file time) of the interest period.
LAST_BUTTON_PRESSED	ID of the pressed button.
¶LAST_BUTTON_PRESS_TIME	Trial time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") when the last button is pressed.
LAST_BUTTON_RELEASED	ID of the last released button.
¶LAST_BUTTON_RELEASED_TIME	Trial time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") when the last button is released.
¶LAST_BUTTON_TIME	Trial time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") when the last button is pressed or released.
NEXT_FIX_ANGLE, PREVIOUS_FIX_ANGLE	Angle between the horizontal plane and the line connecting the current fixation and the next/previous fixation (see Figure 5-2).
NEXT_FIX_DIRECTION, PREVIOUS_FIX_DIRECTION	Direction (Left, Right, Top, Bottom), relative to the current fixation, in which the next/previous fixation is located.
NEXT_FIX_DISTANCE, PREVIOUS_FIX_DISTANCE	Distance between the current fixation and the next/previous fixation in degrees of visual angle.
NEXT_SAC_AMPLITUDE	Amplitude of the following saccade in degrees of visual angle.
NEXT_SAC_ANGLE	Angle between the horizontal plane and the direction of the next saccade (see Figure 5-2).
NEXT_SAC_AVG_VELOCITY	Average velocity of the next saccade.
NEXT_SAC_BLINK_DURATION	Duration (in milliseconds) of the blink found within the next saccade. If no blink event occurred, a missing value is given.
NEXT_SAC_BLINK_END	End time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the blink found within the previous saccade event. If no blink event occurred, a missing value is given.
NEXT_SAC_BLINK_START	Start time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the

	blink found within the previous saccade. If no blink event occurred, a missing value is given.
NEXT_SAC_CONTAINS_BLINK	Whether the next saccade contains blink(s).
NEXT_SAC_DIRECTION	Direction (Left, Right, Top, Bottom), relative to the current fixation, in which the next saccade is aiming. Note a missing value will be reported if the NEXT_SAC_AMPLITUDE is less than 0.5 degree.
NEXT_SAC_DURATION	Duration of the next saccade in milliseconds.
NEXT_SAC_END_INTEREST AREAS	Interest areas in which the end point of the next saccade falls.
NEXT_SAC_END_INTEREST_A REA_ID	The ID of the interest area to which the end point of the next saccade is assigned.
NEXT_SAC_END_INTEREST_A REA_INDEX	Interest area to which the end point of the next saccade is assigned. This measure is the same as the NEXT_SAC_END_INTEREST_AREA_ID except when there are multiple interest areas with the same ID, or when interest area IDs didn't start from 1.
NEXT_SAC_END_INTEREST_A REA_LABEL	Label for the interest area to which the end position of the next saccade is assigned.
¶NEXT_SAC_END_TIME	Trial time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") when the next saccade ends.
NEXT_SAC_END_X	X coordinate of the end point for the next saccade.
NEXT_SAC_END_X_RESOLUTION	Horizontal angular resolution (in screen pixels per degree) at the end of the saccade. If samples are loaded into the viewing session, this takes the horizontal resolution of the last sample in the saccade; otherwise, the horizontal resolution of the next fixation is used.
NEXT_SAC_END_Y	Y coordinate of the end point for the next saccade.
NEXT_SAC_END_Y_RESOLUTION	Vertical angular resolution (in screen pixels per degree) at the end of the saccade. If samples are loaded into the viewing session, this takes the vertical resolution of the last sample in the saccade; otherwise, the vertical resolution of the next fixation is used.
NEXT_SAC_INDEX	Ordinal index of the next saccade.
NEXT_SAC_INPUT_EVENTS	A list used to store new input events (time and event code) that occur during the next saccade.
NEXT_SAC_IS_RT_END	Whether the next saccade is the end event of the reaction time definition.

¶NEXT_SAC_LABEL	Label of the next saccade.
NEXT_SAC_MSG_COUNT ²	Number of visible messages associated with the next saccade event ¹ . This number will not exceed the "Maximum Message Variables for Eye Event" set in the Output/Analysis Preference Settings.
NEXT_SAC_MSG_TEXT ²	Text string of the messages associated with the next saccade ¹ .
¶NEXT_SAC_MSG_TIME ²	Trial time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the message ¹ .
NEXT_SAC_NEAREST_END_INTEREST_AREA	Nearest interest area to which the end point of the next saccade is assigned.
NEXT_SAC_NEAREST_END_INTEREST_AREA_LABEL	Label for the nearest interest area to which the end point of the next saccade is assigned.
NEXT_SAC_NEAREST_START_INTEREST_AREA	Nearest interest area to which the start point of the next saccade is assigned.
NEXT_SAC_NEAREST_START_INTEREST_AREA_LABEL	Label for the nearest interest area to which the start point of the next saccade is assigned.
NEXT_SAC_PEAK_VELOCITY	Peak values of gaze velocity (in visual degrees per second) of the next saccade. The peak velocity calculation depends on whether the samples are loaded in the viewing session.
NEXT_SAC_START_INTEREST AREAS	Interest areas in which the start point of the next saccade falls.
NEXT_SAC_START_INTEREST AREA_ID	The ID of the interest area to which the start point of the next saccade is assigned.
NEXT_SAC_START_INTEREST AREA_INDEX	Index of the Interest area to which the start point of the next saccade is assigned. This measure is the same as the NEXT_SAC_START_INTEREST AREA_ID except when there are multiple interest areas with the same ID, or interest area IDs didn't start from 1.
NEXT_SAC_START_INTEREST AREA_LABEL	Label for the interest area to which the start position of the next saccade is assigned.
¶NEXT_SAC_START_TIME	Trial time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") when the next saccade ends.
NEXT_SAC_START_X	X coordinate of the start point for the next saccade.
NEXT_SAC_START_X_RESOLUTION	Horizontal angular resolution (in screen pixels per degree) at the start of the saccade. If samples are loaded into the viewing session, this takes the horizontal resolution of the first sample in the

	saccade; otherwise, the horizontal resolution of the current fixation is used.
NEXT_SAC_START_Y	Y coordinate of the start point for the next saccade.
NEXT_SAC_START_Y_RESOLUTION	Vertical angular resolution (in screen pixels per degree) at the start of the saccade. If samples are loaded into the viewing session, this takes the vertical resolution of the first sample in the saccade; otherwise, the vertical resolution of the current fixation is used.
	Note: Similar analyses are done for the previous saccade (variables beginning with PREVIOUS_SAC).
TRIAL_FIXATION_TOTAL	Total number of fixations in a trial within the currently-selected interest period.
TRIAL_INDEX	Sequential order of the trial in the recording.
TRIAL_LABEL	Label of the trial.
TRIAL_SACCADE_TOTAL	Total number of saccades in the trial within the currently selected interest period.
¶ TRIAL_START_TIME	The start time (in milliseconds since EyeLink tracker was activated; i.e., EDF file time) of the trial. If a valid reaction time is found in the trial, TRIAL_START_TIME will be set to the start time of the reaction time definition instead.
VIDEO_FRAME_INDEX_END	Index of the video frame that was visible at the end of the eye event.
VIDEO_FRAME_INDEX_START	Index of the video frame that was visible at the start of the eye event. Note that all “VIDEO_” variables are applicable to SceneLink recordings or some Experiment Builder recordings only. For SceneLink recordings, please check out the “Data Loading” Preference Settings.
VIDEO_NAME_END	Name of the video frame that was visible at the end of the eye event.
VIDEO_NAME_START	Name of the video frame that was visible at the start of the eye event.

In addition to these default variables, other user-defined variables are also listed if they have been defined in the EDF file (see section 7.2.1 on creating trial variable labels) or created during the viewing session (see section 6.1.1 on using the trial variable manager).

Please note that output for the variables depends on the setting of the interest period filter (see section 6.4.2 or Figure 6-22)—only those fixation and saccade events falling within

the active interest period will be reported. If the "Trimmed Spanned Fixation Duration" setting of the "Data Filter" preference is enabled, the duration, start time, and end time of the fixations that overlap with the start or end of the interest period will be trimmed accordingly. If a valid reaction time definition is found in a trial, the TRIAL_START_TIME will be set as the start as the reaction time definition; otherwise this will be set as the start of trial recording (see section 6.5.3 on discussion of three time periods used in Data Viewer). As a result, the values of CURRENT_FIX_END and CURRENT_FIX_START, which are calculated relative to TRIAL_START_TIME, will be different depending on whether a valid reaction time definition is found for the trial.

Note 1: A run of fixations refers to a group of consecutive fixations that are directed towards the same interest area. Thus, for example, if the interest areas of 10 fixations are: A A B A A A C A E D, the run count will be 7. The following table summarizes the values for some relevant variables.

Variables	A	A	B	A	A	A	C	A	E	D
Run (not listed in the variable list)	1	1	2	3	3	3	4	5	6	7
CURRENT_FIX_INDEX	1	2	3	4	5	6	7	8	9	10
CURRENT_FIX_INTEREST_A REA_INDEX	1	1	2	1	1	1	3	1	5	4
CURRENT_FIX_INTEREST_A REA_FIX_COUNT	6	6	1	6	6	6	1	6	1	1
CURRENT_FIX_INTEREST_A REA_RUN_ID	1	1	1	2	2	2	1	3	1	1
CURRENT_FIX_REFIX_INTER- EST AREA	0	0	0	1	1	1	0	1	0	0
CURRENT_FIX_REFIX_PREV_- INTEREST_AREA	0	0	0	1	1	1	0	1	0	1
CURRENT_FIX_RUN_INDEX	1	2	1	1	2	3	1	1	1	1
CURRENT_FIX_RUN_SIZE	2	2	1	3	3	3	1	1	1	1

Note ²: Messages written in the EDF file will be associated with an event closest in time. So, for a fixation report, the message could appear during the preceding saccade (PREVIOUS_SAC_MSG_#) or the following saccade (NEXT_SAC_MSG_#). In very rare cases, the message can be written to both saccade and fixation events if the message was written out after the last sample of a fixation (or saccade) but before the first sample of the following saccade (or fixation).

6.6.3 Configuring the Fixation Report

Data Viewer allows users to configure the fixation report (and, in a similar fashion, the saccade report). A few options are available in the “Fixation Output Report” dialog box:

- Users can exclude some trials by entering a string in the “Exclude Trial String” edit box. This string should be one message or part of a message within the trial recording (see section 7.1 on defining the start and end of a trial) that uniquely defines the subset of trials to be excluded.
- The fixation report (and similarly the saccade report) allows the inclusion of hidden events in the relative event variables [PREVIOUS_ and NEXT_]. This can be done by clicking the “Include Hidden Events in Relative Variables” check box. If the hidden events in relative variables are included in the analysis, then the additional check box is available to specify whether or not to treat these hidden events as missing data in these relative variables.
- To enable the alternative formatting and easy loading of string/text variables into some statistics software packages with strict requirements, Data Viewer provides an option of adding a pair of quotation marks for those variables.
- If the “Create Output Report for All Custom Interest Periods” option is enabled, the Fixation Report will output data across all custom interest periods created in the viewing session—the “Full Trial Period” or “Reaction Time Period” data is only included in the report if it is the currently-selected interest period. Users can save the data from multiple interest periods into a single file or into multiple individual files.
- If the “Create One Report File Per EDF File” option is checked, Data Viewer will create one report file for each of the EDF files loaded into the viewing session.

Note: If the “Exclude from Reports” property of a trial or trial group is checked, data from that trial/trial group will not be included in the fixation report (and other reports).

6.7 Saccade Report

Saccade reports provide information about saccade events in the data file. Each row of the report represents a single saccade event. Depending on the variables selected for output, each row can contain information on the previous fixation and/or saccade, as well as the next fixation and/or saccade.

6.7.1 Creating a Saccade Report

To create a saccade report choose:

Analysis → Reports → Saccade Report

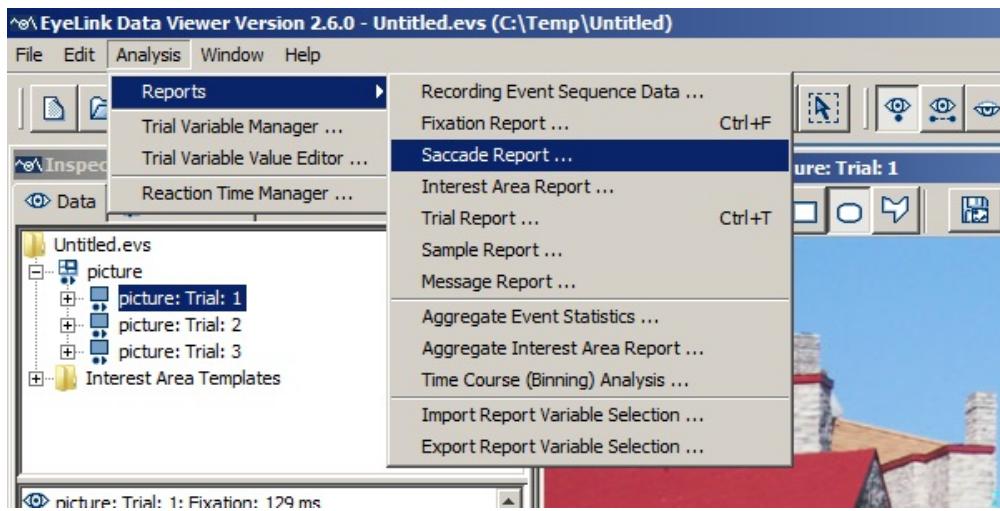


Figure 6-25. Creating a Saccade Report.

6.7.2 Variables in the Saccade Report

Currently, the saccade report includes the following saccade-related information: index, label, start time, end time, start x / y coordinates, end x / y coordinates, duration, amplitude, angle, direction, average velocity, peak velocity, interest areas at the start and end of the event, and message events that occurred during the saccade. It also contains the following information on the previous fixation and the next fixation: angle, blink around, direction, distance, duration, start time, end time, pupil size, trial span, the interest area in which the fixation is located, the nearest interest area, and whether the fixation has been selected for analysis. In addition, the report contains labels of the data file, data file, and individual trials, as well as other user-defined variables (see section 6.6.2 Variables in the Fixation Report for the complete list of variables and their meanings).

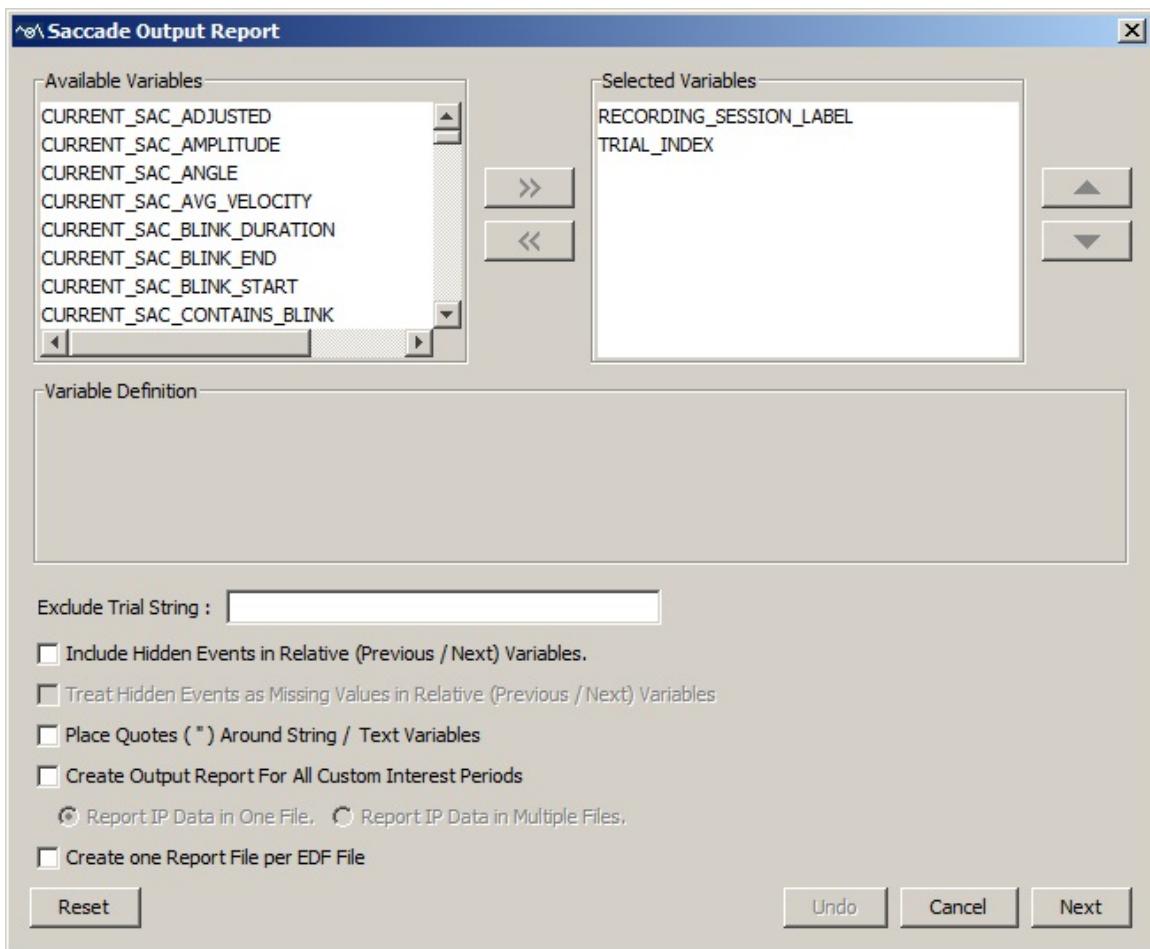


Figure 6-26. Variables in a Saccade Report.

6.8 Interest Area Report

Interest area reports provide information concerning each interest area in a trial. Each row of the report represents an interest area, arranged in an ascending order of the interest area ID.

6.8.1 Obtaining an Interest Area Report

To obtain an interest area report,

1) From the application menus, choose:

Analysis -> Reports -> Interest Area Report

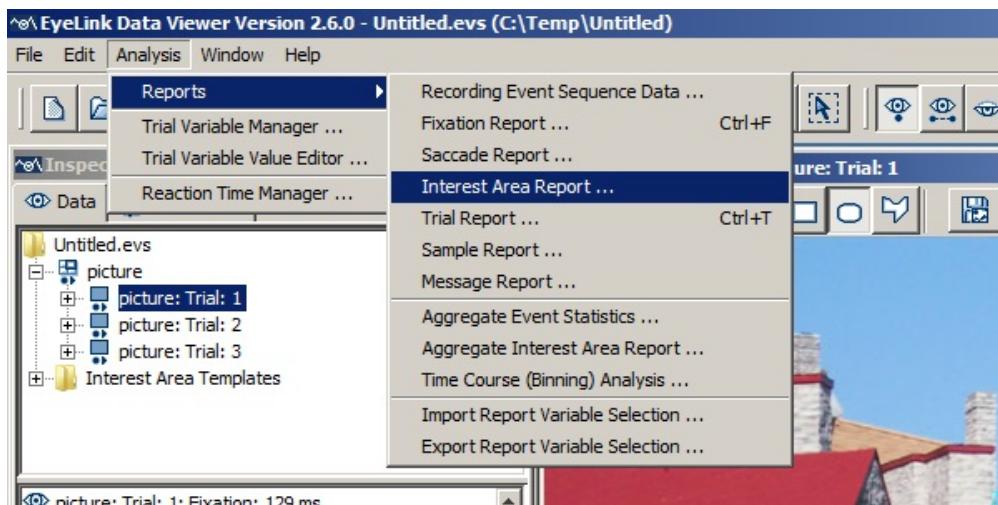


Figure 6-27. Creating an Interest Area Report.

2) In the following output report dialog, select the variables in the list of available output variables (left panel) and press ">>" to enter the variables into the list of selected output variables. You can also drag the selected variables and drop them to the intended position in the selected variables list.

- To remove variables from the output list, simply select the variables and press <<. You can also drag the selected variables and drop them back to the Available Variables list.
- To change the order in which the variables are listed, simply select one variable and use the ▲ or ▼ button to move it to the desired position. Repeat this step until all variables are in the right position. You can also select the variable(s) and then drag and drop them to the intended position.
- Data Viewer supports exporting and importing of variable selection across viewing sessions. For example, users may go through each of the output reports to configure the selection of variables in an intended order, then export the variable selection into a property file by clicking “Analysis -> Reports -> Export Report Variable Selection”. For all future viewing sessions, the variable selection in the reports can be automated by importing the previously saved property file (through “Analysis -> Reports -> Import Report Variable Selection”).

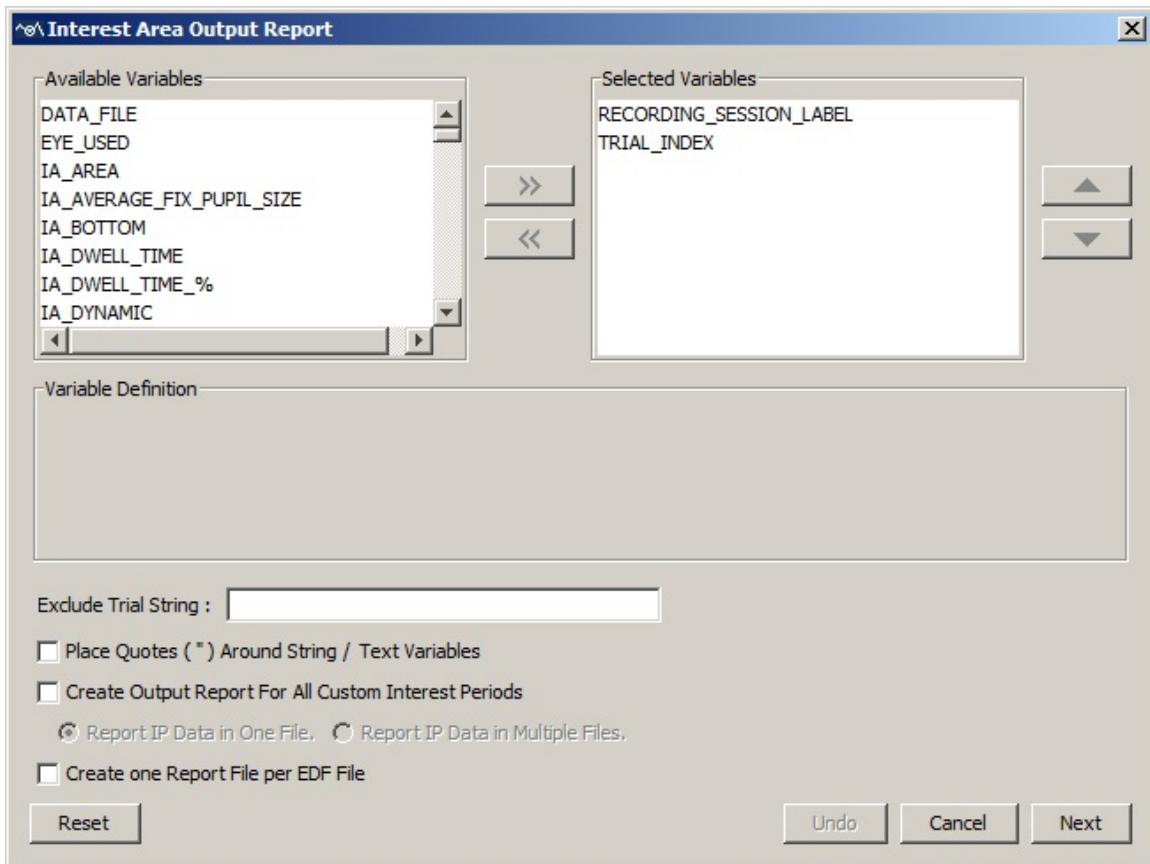


Figure 6-28. Variables in an Interest Area Report.

- 3) Once all the desired variables have been entered into the output list, press the Next button.
- 4) In the Save dialog box, browse to the directory in which you want to save the output report. The default output directory can be configured through "General Preferences".
- 5) In the File name text box, enter the name for the document and choose the appropriate file extension. Note, if the output report file extension is set to "All Files" and the file name does not contain an extension, the file name is appended with a ".txt" by default.
- 6) Press the "Save" button.

Data Viewer allows users to configure the interest area report. Users can exclude some trials by entering a string in the "Exclude Trial String" edit box. This string should be one message or part of a message within the scope of the trial recording that uniquely defines that subset of trials to be excluded. In addition, to enable correct loading of string/text

variables in some statistics software, the Viewer also has an option of adding a pair of quotation marks for such variables.

6.8.2 Variables in the Interest Area Report

Currently, the interest area report provides information for the following variables. Please note that the values of all variables marked with a “**T**” sign are calculated relative to TRIAL_START_TIME, and therefore will be different depending on whether a valid reaction time is found in the trial. Output for most variables in this report will change if a different interest period is used.

Field	Contents
RECORDING_SESSION_LABEL	Label of the data file.
DATA_FILE	File name of the recording.
EYE_USED	Records which eye's data (LEFT or RIGHT) was used to create the report.
IA_AREA	Pixel area for the current interest area.
IA_AVERAGE_FIX_PUPIL_SIZE	Average pupil size across all fixations in the interest area.
IA_BOTTOM	Y coordinate of the lower-right corner of a rectangular or elliptical interest area (“.” For a freehand interest area).
IA_DWELL_TIME	The sum of the duration across all fixations that fell in the current interest area.
IA_DWELL_TIME_%	Percentage of trial time spent on the current interest area (IA_DWELL_TIME /TRIAL_DWELL_TIME, the latter is the summed duration of all fixations within the trial interest period).
IA_DYNAMIC	Whether the current interest area is a dynamic one (true or false).
IA_END_TIME	Time (relative to the start of the current interest period) when the last instance of the current interest area ends. This variable is applicable to dynamic interest areas only.
IA_FIRST_FIXATION_DURATION	Duration of the first fixation event that was within the current interest area.
IA_FIRST_FIXATION_INDEX	Ordinal sequence of the first fixation that was within the current interest area.
IA_FIRST_FIXATION_PREVIOUS_FIX_IA	The ID of the interest area for the fixation immediately preceding the first fixation on the current interest area.
IA_FIRST_FIXATION_PREVIOUS_IAREAS	Reports a list of the IDs of all interest areas that were fixated prior to the first fixation on the

	current interest area. The most recently visited interest area appears at the beginning of list.
IA_FIRST_FIXATION_RUN_IND_EX	The number of runs of fixations that have occurred when a first fixation is made to an interest area. The current run is also included in the tally.
¶ IA_FIRST_FIXATION_TIME	Start time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the first fixation to enter the current interest area.
IA_FIRST_FIXATION_VISITED_IA_COUNT	This reports the number of different interest areas visited so far before the first fixation is made to the current interest area.
IA_FIRST_FIXATION_X	The X position of the first fixation event within the current interest area.
IA_FIRST_FIXATION_Y	The Y position of the first fixation event within the current interest area.
IA_FIRST_FIX_PROGRESSIVE	Checks whether later interest areas have been visited before the first fixation enters the current interest area. 1 if NO higher IA ID in earlier fixations before the first fixation in the current interest area; 0 otherwise. This measure is useful in reading to check whether the first run of fixations in this interest area is in fact first-pass fixations.
IA_FIRST_RUN_DWELL_TIME	Dwell time of the first run (i.e., the sum of the duration of all fixations in the first run of fixations within the current interest area). Note that this measure does not include the duration of the saccades. You could retrieve the total time of the first run in an interest area by subtracting IA_FIRST_RUN_START_TIME from IA_FIRST_RUN_END_TIME. These two variables correspond to the start time of the first fixation and the end time of the last fixation, respectively.
¶ IA_FIRST_RUN_END_TIME	End time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the first run of fixations in the current interest area.
IA_FIRST_RUN_FIXATION_%	Percentage of all fixations in a trial falling in the first run of the current interest area.
IA_FIRST_RUN_FIXATION_COUNT	Number of all fixations in a trial falling in the first run of the current interest area.
IA_FIRST_RUN_LANDING_POSITION	Number of pixels from the horizontal position of the first fixation during the first run on the current

	interest area to the left edge of the interest area. For the right-to-left languages (see the "Left to Right Reading" setting in the Output/Analysis preferences), this is calculated as the pixel difference between the horizontal position of the first fixation during the first run and the right edge of the interest area. If "Report Distance in" (Output/Analysis preferences) is set to "Degrees", the angular distance (in degrees of visual angle) is reported.
IA_FIRST_RUN_LAUNCH_SITE	Number of pixels from the horizontal position of the fixation immediately preceding the first run on the current interest area to the left edge of the interest area. For the right-to-left languages (see the "Left to Right Reading" setting in the Output/Analysis preferences), this is calculated as the pixel difference between the horizontal position of the fixation immediately preceding the first run and the right edge of the interest area. If "Report Distance in" (Output/Analysis preferences) is set to "Degrees", the angular distance (in degrees of visual angle) is reported.
¶ IA_FIRST_RUN_START_TIME	Start time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the first run of fixations in the current interest area.
IA_FIRST_SACCADE_AMPLITUDE	Amplitude (in degrees of visual angle) of the first saccade entering into the current interest area.
IA_FIRST_SACCADE_ANGLE	Angle between the horizontal plane and the direction of the first saccade entering into the current interest area.
¶ IA_FIRST_SACCADE_END_TIME	End time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the saccade that first landed within the current interest area.
IA_FIRST_SACCADE_INDEX	Ordinal index of the saccade in a trial which first landed within the current interest area.
¶ IA_FIRST_SACCADE_START_TIME	Start time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the saccade that first landed within the current interest area.
IA_FIXATION_%	Percentage of all fixations in a trial falling in the current interest area.
IA_FIXATION_COUNT	Total number of fixations falling in the interest

	area.
IA_FSA_COUNT	The number of fixations, with (fixation N) starting in the current row of interest area and (fixation N + fixation_skip_count) ending in the current column of interest area. Please see section 6.8.3.1 "Fixation Sequence Analysis" for detailed explanation of this variable.
IA_FSA_DURATION	The summed duration for all fixations, with (fixation N) starting in the current row of interest area and (fixation N + fixation_skip_count) ending in the current column of interest area. Please see section 6.8.3.1 "Fixation Sequence Analysis" for detailed explanation of this variable.
IA_GROUP	Group label for the current interest area.
IA_ID	Ordinal ID of the current interest area.
IA_INSTANCE_COUNT	The total number of individual instances of the current dynamic interest area.
IA_LABEL	Label for the current interest area.
IA_LAST_FIXATION_DURATION	Duration of the last fixation event that was within the current interest area.
IA_LAST FIXATION RUN	Index of run that the last fixation is in.
¶IA_LAST_FIXATION_TIME	Start time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the last fixation to enter the current interest area.
IA_LAST_FIXATION_X	The X position of the last fixation event that was within the current interest area.
IA_LAST_FIXATION_Y	The Y position of the last fixation event that was within the current interest area.
IA_LAST_RUN_DWELL_TIME	Dwell time of the last run (i.e., the sum of the duration of all fixations in the last run of fixations within the current interest area).
¶IA_LAST_RUN_END_TIME	End time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the last run of fixations in the current interest area.
IA_LAST_RUN_FIXATION_%	Percentage of all fixations in a trial falling in the last run in the current interest area.
IA_LAST_RUN_FIXATION_COUNT	Number of all fixations in a trial falling in the last run in the current interest area.
IA_LAST_RUN_LANDING_POSITION	Number of pixels from the horizontal position of the first fixation during the last run on the current interest area to the left edge of the interest area. For the right-to-left languages (see the "Left to

	"Right Reading" setting in the Output/Analysis preferences), this is calculated as the pixel difference between the horizontal position of the first fixation during the last run and the right edge of the interest area. If "Report Distance in" (Output/Analysis preferences) is set to "Degrees", the angular distance (in degrees of visual angle) is reported.
IA_LAST_RUN_LAUNCH_SITE	Number of pixels from the horizontal position of the fixation immediately preceding the last run on the current interest area to the left edge of the interest area. For the right-to-left languages (see the "Left to Right Reading" setting in the Output/Analysis preferences), this is calculated as the pixel difference between the horizontal position of the fixation immediately preceding the last run and the right edge of the interest area. If "Report Distance in" (Output/Analysis preferences) is set to "Degrees", the angular distance (in degrees of visual angle) is reported.
¶IA_LAST_RUN_START_TIME	Start time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the last run of fixations in the current interest area.
IA_LAST_SACCADE_AMPLITUDE	Amplitude (in degree of visual angle) of the last saccade entering into the current interest area.
IA_LAST_SACCADE_ANGLE	Angle between the horizontal plane and the direction of the last saccade entering into the current interest area.
¶IA_LAST_SACCADE_END_TIME	End time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the last saccade that landed within the current interest area.
IA_LAST_SACCADE_INDEX	Ordinal index of the last saccade in a trial that landed within the current interest area.
¶IA_LAST_SACCADE_START_TIME	Start time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the last saccade that landed within the current interest area.
IA_LEFT	X coordinate of the upper-left corner of a rectangular or elliptical interest area ("." For a freehand interest area).
IA_LEGAL	IA_LEGAL for an interest area N will be equal to

	1 only if the first fixation in interest area N was preceded at some point earlier in the trial by a fixation in interest area (N-1). IA_LEGAL will be 0 if the first fixation in interest area N was not preceded at some point earlier in the trial by a fixation in interest area (N-1). This variable is relevant for experiments that run in a contingent display paradigm, as it ensures that readers could see the target area before actually fixating it.
IA_LEGAL_IMMEDIATE	IA_LEGAL_IMMEDIATE for an interest area N will be equal to 1 only if the first fixation in interest area N was immediately preceded by a fixation in interest area (N-1). IA_LEGAL_IMMEDIATE will be 0 if the first fixation in interest area N was not immediately preceded by a fixation in interest area (N-1). This variable is relevant for experiments that run in a contingent display paradigm, as it ensures that readers could see the target area before actually fixating it.
IA_MAX_FIX_PUPIL_SIZE	Maximum pupil size among all fixations in the interest area. Note this measure does not represent the maximum pupil size within a fixation – rather it is the largest CURRENT_FIX_PUPIL_SIZE value for fixations in the IA, and CURRENT_FIX_PUPIL_SIZE represents the average pupil size during that fixation.
IA_MIN_FIX_PUPIL_SIZE	Minimum pupil size among all fixations falling within the interest area. Note this measure does not represent the minimum pupil size within a fixation.
IA_POINTS	List of points for a freehand interest area (otherwise “.” is reported).
IA_REGRESSION_IN	Whether the current interest area received at least one regression from later interest areas (e.g., later parts of the sentence). 1 if interest area was entered from a higher IA_ID (from the right in English); 0 if not.
IA_REGRESSION_IN_COUNT	Number of times interest area was entered from a higher IA_ID (from the right in English).
IA_REGRESSION_OUT	Whether regression(s) was made from the current interest area to earlier interest areas (e.g., previous parts of the sentence) prior to leaving that interest

	area in a forward direction. 1 if a saccade exits the current interest area to a lower IA_ID (to the left in English) before a later interest area was fixated; 0 if not.
IA_REGRESSION_OUT_COUNT	Number of times interest area was exited to a lower IA_ID (to the left in English) before a higher IA_ID was fixated in the trial.
IA_REGRESSION_OUT_FULL	Whether regression(s) was made from the current interest area to earlier interest areas (e.g., previous parts of the sentence). 1 if a saccade exits the current interest area to a lower IA_ID (to the left in English); 0 if not. Note that IA_REGRESSION_OUT only considers first-pass regressions whereas IA_REGRESSION_OUT_FULL considers all regressions, regardless whether later interest areas have been visited or not.
IA_REGRESSION_OUT_FULL_COUNT	Number of times interest area was exited to a lower IA_ID (to the left in English).
IA_REGRESSION_PATH_DURATION	The summed fixation duration from when the current interest area is first fixated until the eyes enter an interest area with a higher IA_ID.
IA_RIGHT	X coordinate of the lower-right corner of a rectangular or elliptical interest area ("." For a freehand interest area).
IA_RUN_COUNT	Number of times the Interest Area was entered and left (runs).
IA_SECOND_FIXATION_DURATION	Duration of the second fixation in IA, regardless of run.
IA_SECOND_FIXATION_RUN	Index of run that the second fixation is in.
¶IA_SECOND_FIXATION_TIME	Time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the second fixation in IA, regardless of run.
IA_SECOND_FIXATION_X	The X position of the second fixation event that was within the current interest area.
IA_SECOND_FIXATION_Y	The Y position of the second fixation event that was within the current interest area.
IA_SECOND_RUN_DWELL_TIME	Dwell time for the second run (i.e. the sum of the duration across all fixations of the second run of fixations within the current interest area).
¶IA_SECOND_RUN_END_TIME	End time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the second run of fixations in the current interest area.

IA_SECOND_RUN_FIXATION_%	Percentage of all fixations in a trial falling in the second run of the current interest area.
IA_SECOND_RUN_FIXATION_COUNT	Number of all fixations in a trial falling in the second run in the current interest area.
IA_SECOND_RUN_LANDING_POSITION	Number of pixels from the horizontal position of the first fixation during the second run on the current interest area to the left edge of the interest area. For the right-to-left languages (see the "Left to Right Reading" setting in the Output/Analysis preferences), this is calculated as the pixel difference between the horizontal position of the first fixation during the second run and the right edge of the interest area. If "Report Distance in" (Output/Analysis preferences) is set to "Degrees", the angular distance (in degrees of visual angle) is reported.
IA_SECOND_RUN_LAUNCH_SI TE	Number of pixels from the horizontal position of the fixation immediately preceding the second run on the current interest area to the left edge of the interest area. For the right-to-left languages (see the "Left to Right Reading" setting in the Output/Analysis preferences), this is calculated as the pixel difference between the horizontal position of the fixation immediately preceding the second run and the right edge of the interest area. If "Report Distance in" (Output/Analysis preferences) is set to "Degrees", the angular distance (in degrees of visual angle) is reported.
IA_SECOND_RUN_START_TIME	Start time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the second run of fixations in the current interest area.
IA_SELECTIVE_REGRESSION_PATH_DURATION	Duration of fixations and refixations of the current interest area before the eyes enter an interest area with a higher ID.
IA_SKIP	An interest area is considered skipped (i.e., IA_SKIP = 1) if no fixation occurred in first-pass reading.
IA_SPILLOVER	The duration of the first fixation made on 'interest area (N+1)' after leaving 'interest area N' in first pass.
IA_START_TIME	Time (relative to the start of the current interest period) when the first instance of the current

	interest area starts. This variable is applicable to dynamic interest areas only.
IA THIRD FIXATION DURATION	Duration of the third fixation in IA, regardless of run.
IA THIRD FIXATION RUN	Index of run that the third fixation is in.
¶IA THIRD FIXATION TIME	Time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the third fixation in IA, regardless of run.
IA THIRD FIXATION X	The X position of the third fixation event that was within the current interest area.
IA THIRD FIXATION Y	The Y position of the third fixation event that was within the current interest area.
IA THIRD RUN DWELL TIME	Dwell time for third run (i.e. the sum of the duration across all fixations in the third run of fixations within the current interest area).
¶IA THIRD RUN END TIME	End time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the third run of fixations in the current interest area.
IA THIRD RUN FIXATION %	Percentage of all fixations in a trial falling in the third run of the current interest area.
IA THIRD RUN FIXATION COUNT	Number of all fixations in a trial falling in the third run in the current interest area.
IA THIRD RUN LANDING POSITION	Number of pixels from the horizontal position of the first fixation during the third run on the current interest area to the left edge of the interest area. For the right-to-left languages (see the "Left to Right Reading" setting in the Output/Analysis preferences), this is calculated as the pixel difference between the horizontal position of the first fixation during the third run and the right edge of the interest area. If "Report Distance in" (Output/Analysis preferences) is set to "Degrees", the angular distance (in degrees of visual angle) is reported.
IA THIRD RUN LAUNCH SITE	Number of pixels from the horizontal position of the fixation immediately preceding the third run on the current interest area to the left edge of the interest area. For the right-to-left languages (see the "Left to Right Reading" setting in the Output/Analysis preferences), this is calculated as the pixel difference between the horizontal position of the fixation immediately preceding the third run and the right edge of the interest area. If

	"Report Distance in" (Output/Analysis preferences) is set to "Degrees", the angular distance (in degrees of visual angle) is reported.
¶IA THIRD RUN START TIME	Start time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the third run of fixations in the current interest area.
IA_TOP	Y coordinate of the upper-left corner of a rectangular or elliptical interest area ("." For a freehand interest area).
IA_TYPE	Type of interest area (rectangular, elliptical, or freehand).
IP_END_EVENT_MATCHED	Whether an event that matches the end of the selected interest period has been found in the current trial.
IP_END_TIME	End time (in milliseconds since EyeLink tracker was activated; i.e., EDF file time) of the interest period.
IP_INDEX	The index (starting from 1) of interest period created by the user. For the Full-Trial period or Reaction-Time Period, a missing value is given as they are not created by the user.
IP_LABEL	Label of the current interest period selected in the viewing session.
IP_START_EVENT_MATCHED	Whether an event that matches the start of the selected interest period has been found in the current trial.
IP_START_TIME	Start time (in milliseconds since EyeLink tracker was activated; i.e., EDF file time) of the interest period.
REPORTING_METHOD	Whether a fixation-based or sample-based calculation is used in creating the interest area report. The reporting method can be configured through "Output/Analysis Preference -> Perform Sample-based Calculation". See section "5.10.25 Output Reports and Preferences" for information on the difference between sample and fixation-based calculations.
TRIAL_DWELL_TIME	Dwell time (i.e., summation of all fixation durations) for the trial within the currently-selected interest period.
TRIAL_FIXATION_COUNT	Total number of fixations in the trial within the currently-selected interest period.

TRIAL_IA_COUNT	Reports the total number of interest areas found in the trial.
TRIAL_INDEX	Sequential order of the trial in the recording.
TRIAL_LABEL	Label of the trial.
¶ TRIAL_START_TIME	The start time (in milliseconds since EyeLink tracker was activated; i.e., EDF file time) of the trial. If a valid reaction time is found in the trial, TRIAL_START_TIME will be set to the start time of the reaction time definition instead.
TRIAL_TOTAL_VISITED_IA_COUNT	Reports total number of unique interest areas visited in the trial.

Besides these default variables, additional trial variables will be listed if they have been defined in the EDF file (see trial variable labels) or created during the viewing session (see trial variable manager).

6.8.3 Using Interest Area Report

The output in the interest area report depends on the setting of the interest period filter (see section 6.4.2 or Figure 6-22)—only fixation and saccade events falling within the active interest period will be reported. If a valid reaction time definition is found in a trial, the TRIAL_START_TIME will be set as the start as the reaction time definition; otherwise this will be set as the start of trial recording (see section 6.5.3 on discussion of three time periods used in Data Viewer). As a result, the values of all those variables marked with a “¶” symbol, which are calculated relative to TRIAL_START_TIME, will be different depending on whether a valid reaction time is found in the trial. If the "Trimmed Spanned Fixation Duration" setting of the "Data Filter" preference is enabled, the duration, start time, and end time of the fixations that overlap with the start or end of the interest period will be trimmed accordingly.

Some variables in the interest area report may be influenced by outlier fixations that do not belong to any interest area. For example, the presence of an outlier fixation may break the run of fixations on a particular interest area and therefore shortens the measure of IA_FIRST_RUN_DWELL_TIME and increases the IA_RUN_COUNT value. Therefore, if "run"-related measures are important, users may want to ensure that all fixations are assigned to a particular interest area before creating an interest area report. Users can either manually move the position of those outlier fixations or, more conveniently, enable the "Use Nearest Interest Area for Outlier Fixations" option of the Output/Analysis preference settings.

Interest area reports are designed to support analysis of data from different research paradigms and, therefore, users will typically only need to use a small number of variables in one output. **If you have lots of interest areas in a trial, including IA_FSA_COUNT and IA_FSA_DURATION in the output report may cause Data**

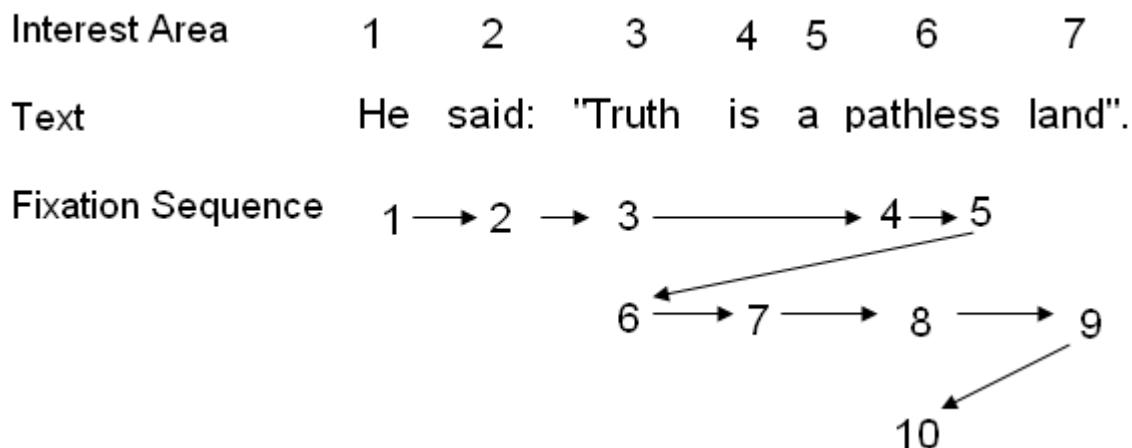
Viewer to take a very long time to generate the report. A progress dialog (see Figure 6-29) will be displayed while creating the report. Users may abort the process by pressing the “Cancel” button.



Figure 6-29. Progress Dialog Box Displayed when Creating the Interest Area Report

6.8.3.1 Fixation Sequence Analysis

The variables IA_FSA_COUNT and IA_FSA_DURATION are used for fixation sequence analysis (i. e., examination of the frequency of saccades directed from the current interest area to all interest areas). If there are N interest areas in a trial, this will generate N columns in the output report, with column labels being IA_FSA_COUNT_1 to IA_FSA_COUNT_N for counts and IA_FSA_DURATION_1 to IA_FSA_DURATION_N for duration outputs. Each column in the output file reports the number of fixations coming to one particular interest area from each of all possible interest areas. Each row reports number of fixations starting from the current interest area and ending at each of the interest areas (when “Fixation Skip Count” in the Output/Analysis preference settings is set to 1).



IA_ID		IA_FSA_COUNT_1	IA_FSA_COUNT_2	IA_FSA_COUNT_3	IA_FSA_COUNT_4	IA_FSA_COUNT_5	IA_FSA_COUNT_6	IA_FSA_COUNT_7
	IA_LABEL	He	said:	"Truth	Is	a	pathless	Land".
1	He	0	1	0	0	0	0	0
2	said:	0	0	1	0	0	0	0
3	'Truth	0	0	0	1	0	1	0
4	is	0	0	0	0	0	1	0
5	a	0	0	0	0	0	0	0

6	pathless	0	0	1	0	0	1	1
7	land?.	0	0	0	0	0	1	0

The above example illustrates the use of fixation sequence analysis. See interest area #6 (“pathless”) for example. It received four fixations in total. These fixations came from interest area #3 (Fixation 4), #6 (Fixation 5), #4 (Fixation 8), and #7 (Fixation 10). This is reported in the column “IA_FSA_COUNT_6”. There are three fixations starting from interest area #6: Fixation 5 (to IA #6), Fixation 6 (to IA #3), and Fixation 9 (to IA #7). This is reported in the row with IA_ID being 6 (“pathless”).

Please note that users should also check the setting for “Fixation Skip Count” in the Output/Analysis preference settings. The fixation skip count defines the number (should be an integer no less than 1) of fixations to skip when looking for the next interest area to use in the fixation sequence analysis variables of the Interest Area report. The default setting is 1 and uses the next available fixation for the sequence analysis (from the current interest area to all interest area). A value of 2 uses the fixation following the next one for the analysis, and so on.

6.8.3.2 Regression Analysis

A lot of the variables in the interest area report are intended for regression analysis, particularly in reading research. The following example illustrates the use of the interest area report in the regression analysis.

IA_ID	1	2	3	4	5	6	7
IA_LABEL	He	said:	“Truth	Is	a	Pathless	Land”.
IA_DWELL_TIME	F1	F2	F3 + F6	F7	0	F4 + F5 + F8 + F10	F9
IA_FIXATION_COUNT	1	1	2	1	0	4	1
IA_RUN_COUNT	1	1	2	1	.	3	1
IA_FIRST_FIXATION_INDEX	1	2	3	7	.	4	9
IA_FIRST_FIXATION_RUN_INDEX	1 [1]	2 [1, 2]	3 [1, 2, 3]	6 [1, 2, 3, 6, 3, 4]	.	4 [1, 2, 3, 6]	8 [1, 2, 3, 6, 3, 4, 6, 7]
IA_FIRST_FIXATION_VISITED_IA_COUNT	0 []	1 [1]	2 [1, 2]	4 [1, 2, 3, 6]	.	3 [1, 2, 3]	5 [1, 2, 3, 6, 4]
IA_FIRST_FIX_PROGRESSIVE	1	1	1	0	.	1	1
IA_FIRST_FIXATION_DURATION	F1	F2	F3	F7	.	F4	F9
IA_FIRST_RUN	F1	F2	F3	F7	.	F4 + F5	F9

DWELL TIME							
IA_SECOND_FIXATION_DURATION	.	.	F6	.	.	F5	.
IA_SECOND_FIXATION_RUN	.	.	2	.	.	1	.
IA_SECOND_RUN_DWELL_TIME	.	.	F6	.	.	F8	.
IA_REGRESSION_IN	0	0	1	0	.	1	0
IA_REGRESSION_IN_COUNT	0	0	1	0	.	1	0
IA_REGRESSION_OUT	0	0	0	0	.	1	1
IA_REGRESSION_OUT_COUNT	0	0	0	0	.	1	1
IA_REGRESSION_PATH_DURATION	F1	F2	F3	F7	.	F4 + F5 + F6 + F7 + F8	F9 + F10
IA_SELECTIVE_REGRESSION_PATH_DURATION	F1	F2	F3	F7	.	F4 + F5 + F8	F9

Take interest area #6 (“pathless”) for example. IA_REGRESSION_PATH_DURATION includes the first pass fixations on the interest area (F4 + F5), time spent in previous parts of the sentence following regressive eye movements (F6 + F7), and time due to refixations coming from the left before the eyes move past the interest area (F8). The calculation of IA_SELECTIVE_REGRESSION_PATH_DURATION only includes the first run fixation on the interest area (F4+F5) and the refixations on the interest area (F8) before the eyes enter next interest area with a higher IA_ID (“land”).

IA_FIRST_FIX_PROGRESSIVE checks whether later interest areas have been visited before the first fixation enters the current interest area. Therefore, this variable would be 0 for the interest area “is” because it was fixated on Fixation 7 while Fixations 4 and 5 were on a later part of the sentence (“pathless”). IA_REGRESSION_OUT checks whether at least one regression was made from the current interest area to previous parts of the sentence prior to leaving that interest area in a forward direction. Therefore, the transition from F5 → F6 makes this flag true for the interest area #6 (labeled as “pathless”). IA_REGRESSION_IN checks whether a given interest area received at least one regression from later parts of the sentence. Therefore, this is true for both interest areas #3 “truth” (F5 → F6) and #6 “pathless” (F9 → F10).

6.8.4 Configuring the Interest Area Report

See section 6.5.4 “Configuring the Trial Report” for a review of these identical configuration settings.

6.9 Sample Report

Sample reports provide information concerning each sample in a trial. The sample report option will not be available if the samples are not loaded into a viewing session. As in the other reports, the sample report only outputs samples that fall within the active interest period for the trial.

6.9.1 Loading Samples into a Viewing Session

The sample report option will only be available from the Analysis menu if samples are loaded into the viewing session. To make sure sample data will be available in a viewing session, please first check the data loading preferences before importing EDF files.

- 1) Before loading any EDF files, please go to "Start -> Programs -> SR Research -> EyeLink -> Data Viewer" to start the software.
- 2) Once the application starts up, click the "Preferences" tab and go to "Data Loading" preferences. Make sure the "Load Samples" option is checked. If you want this changes to be persistent over future viewing sessions, you may save this as the default setting by selecting the topmost preference tree node, right-clicking and selecting "Save Properties as Defaults".
- 3) Now, start loading in the EDF files.

6.9.2 Creating a Sample Report

To create an output report for samples,

- 1) From the application menus, choose:
Analysis -> Reports -> Sample Report

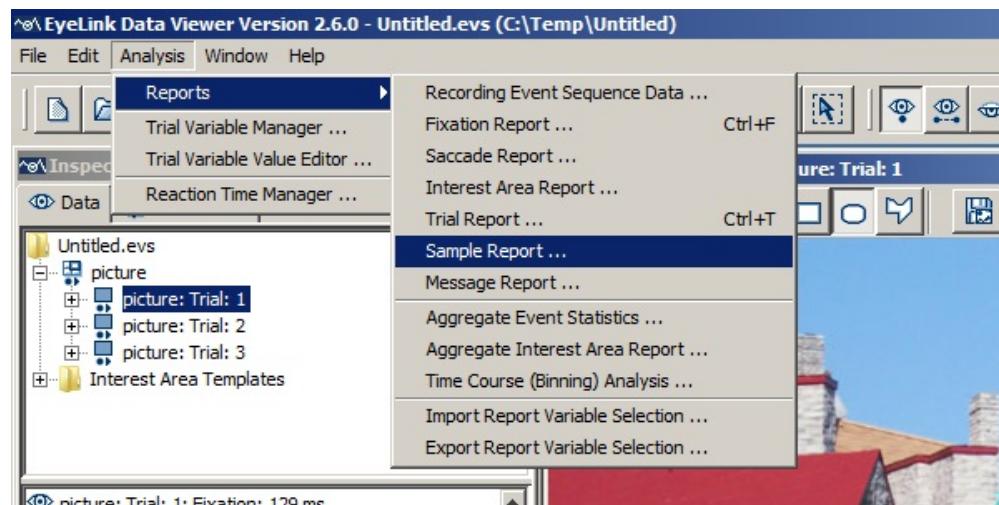


Figure 6-30. Creating a Sample Report.

2) In the following output report dialog, select the variables in the list of available output variables (left panel) and press ">>" to enter the variables into the list of selected output variables. You can also drag the selected variables and drop them to the intended position in the selected variables list.

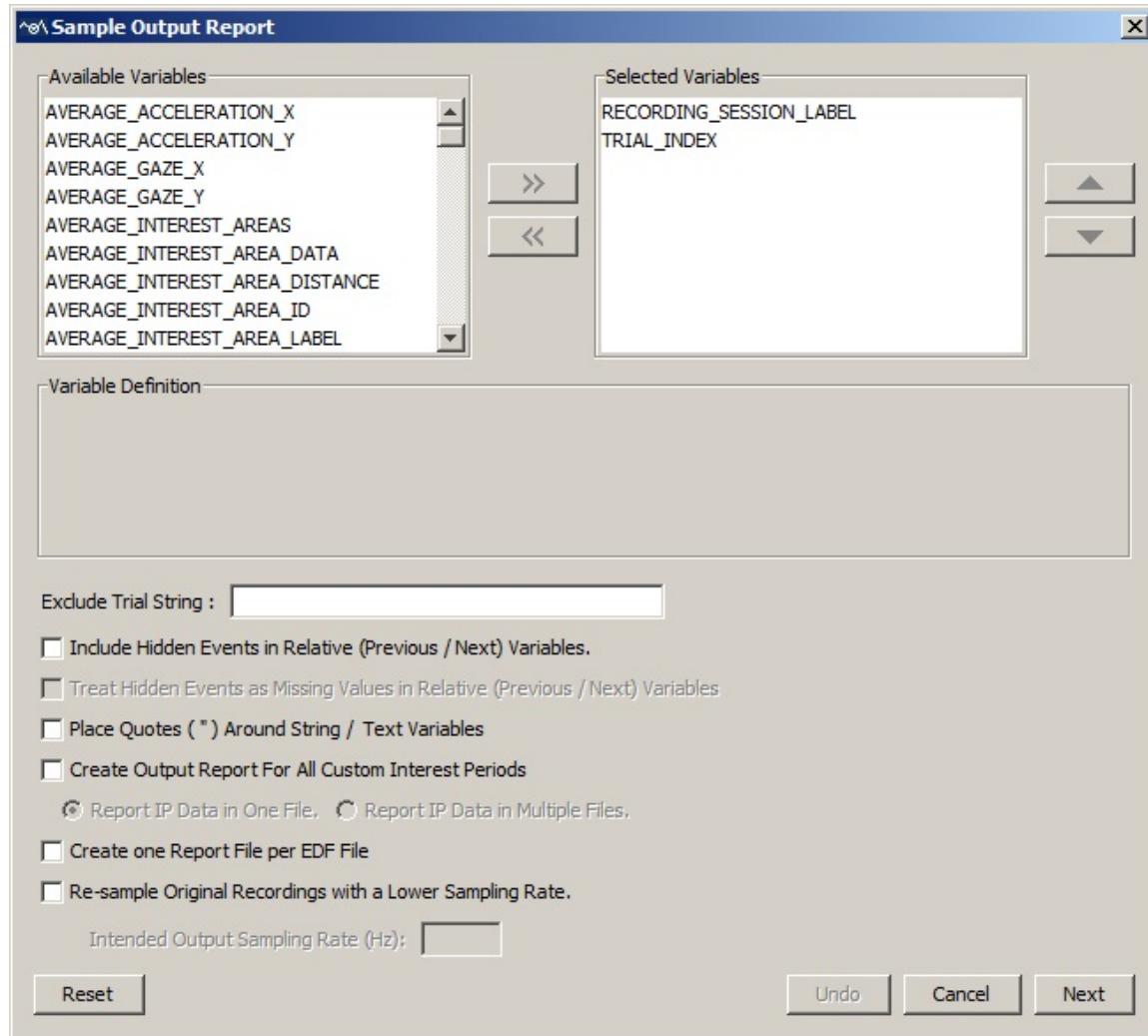


Figure 6-31. Variables in a Sample Report.

- To remove variables from the output list, simply select the variables and press <<. You can also drag the selected variables and drop them back to the Available Variables list.
- To change the order in which the variables are listed, simply select one variable and use the ▲ or ▼ button to move it to the desired position. Repeat this step until all variables are in the right position. You can also select the variable(s) and then drag and drop them to the intended position.
- Data Viewer supports exporting and importing of variable selection across viewing sessions. For example, users may go through each of the output reports to configure the selection of variables in an intended order, then export the variable

selection into a property file by clicking “Analysis -> Reports -> Export Report Variable Selection”. For all future viewing sessions, the variable selection in the reports can be automated by importing the previously saved property file (through “Analysis -> Reports -> Import Report Variable Selection”).

- 3) Once all the desired variables have been entered into the output list, press the Next button.
- 4) In the Save dialog box, browse to the directory in which you want to save the output report. The default output directory can be configured through "General Preferences".
- 5) In the File name text box, enter the name for the document and choose the appropriate file extension. Note, if the output report file extension is set to "All Files" and the file name does not contain an extension, the file name is appended with a ".txt" by default.
- 6) Press the "Save" button.
Note: Depending on the size of the EDF file(s), generating this report may take a long time.

6.9.3 Variables in the Sample Report

Currently, the sample output report provides output for the following variables:

Field	Contents
RECORDING_SESSION_LABEL	Label of the data file.
AVERAGE_ACCELERATION_X	Acceleration value (in degree/second/second) along the x axis averaged across both eyes ¹ .
AVERAGE_ACCELERATION_Y	Acceleration value (in degree/second/second) along the y axis averaged across both eyes ¹ .
AVERAGE_GAZE_X	Gaze coordinate along the x axis averaged across both eyes ¹ .
AVERAGE_GAZE_Y	Gaze coordinate along the y axis averaged across both eyes ¹ .
AVERAGE_INTEREST AREAS	List of interest areas in which the current sample (averaged across both eyes) falls.
AVERAGE_INTEREST_AREA DATA	Reports as a list the data (interest area type, dynamic/static interest area, and coordinate data) of the interest area in which the current sample (averaged across both eyes) falls.
AVERAGE_INTEREST_AREA_DISTANCE	Distance (in degrees of visual angle) between the current sample (averaged across both eyes) and the center of the interest area in which the

	sample falls. For a freehand interest area, this reports the distance to the bound's center (the center of the bounding rectangle for the freehand interest area).
AVERAGE_INTEREST_AREA_ID	ID of the interest area in which the current sample (averaged across both eyes ¹) falls.
AVERAGE_INTEREST_AREA_LABEL	Label of the interest area in which the current sample (averaged across both eyes ¹) falls.
AVERAGE_INTEREST_AREA_PIXEL_AREA	Pixel area of the interest area in which the current sample (averaged across both eyes) falls.
AVERAGE_IN_BLINK	This will be true when both LEFT_IN_BLINK and RIGHT_IN_BLINK are true, false when both LEFT_IN_BLINK and RIGHT_IN_BLINK are false, and a missing value(.) when the two don't match. For monocular recordings with the Cyclopean Mode option enabled (Output/Analysis preferences), it uses the blink status of the tracked eye (LEFT_IN_BLINK or RIGHT_IN_BLINK). The output of this variable may be affected by the "Blink Correction for Pupil Size Calculations" settings in the "Data Filters" preferences.
AVERAGE_IN_SACCADE	This will be true when both LEFT_IN_SACCADE and RIGHT_IN_SACCADE are true, false when both LEFT_IN_SACCADE and RIGHT_IN_SACCADE are false, and a missing value(.) when the two don't match. For monocular recordings with the Cyclopean Mode option enabled (Output/Analysis preferences), it uses the saccade status of the tracked eye (LEFT_IN_SACCADE or RIGHT_IN_SACCADE).
AVERAGE_PUPIL_SIZE	Pupil size of the current sample across two eyes.
AVERAGE_VELOCITY_X	Velocity value (in degrees/second) along the x axis averaged across both eyes ¹ .
AVERAGE_VELOCITY_Y	Velocity value (in degrees/second) along the y axis averaged across both eyes ¹ .
DATA_FILE	File name of the EDF data file.
EYE_TRACKED	Reports which eye (left, right, both) is tracked for the current trial.
HTARGET_DISTANCE ²	Distance between the head target and eye camera

	(in millimeters) for an EyeLink Remote recording. Returns a missing value if the head target was missing or if the data was recorded with a non-Remote eye tracker.
HTARGET_FLAGS ²	Flags used to indicate the head target tracking status ('.....' if target tracking is ok; otherwise error code) for an EyeLink Remote recording. Returns a missing value if the data was recorded with non-Remote eye tracker.
HTARGET_X ²	X position of the head target in camera coordinates for an EyeLink Remote recording. Returns a missing value if the head target was missing or if the data was recorded with a non-Remote eye tracker.
HTARGET_Y ²	Y position of the head target in camera coordinates for an EyeLink Remote recording. Returns a missing value if the head target was missing or if the data was recorded with a non-Remote eye tracker.
IP_DURATION	Duration of the interest period in milliseconds.
IP_END_EVENT_MATCHED	Whether an event that matches the end of the selected interest period has been found in the current trial.
IP_END_TIME	End time (in milliseconds since EyeLink tracker was activated) of the interest period.
IP_INDEX	The index (starting from 1) of interest period created by the user. For the Full-Trial period or Reaction-Time Period, a missing value is given as they are not created by the user.
IP_LABEL	Label of the current interest period selected in the viewing session.
IP_START_EVENT_MATCHED	Whether an event that matches the start of the selected interest period has been found in the current trial.
IP_START_TIME	Start time (in milliseconds since EyeLink tracker was activated) of the interest period.
LEFT_ACCELERATION_X	Acceleration value (in degree/second/second) of the left eye along the x axis.
LEFT_ACCELERATION_Y	Acceleration value (in degree/second/second) of the left eye along the y axis.
LEFT_FIX_INDEX	Ordinal sequence of the fixation in the trial to which the left-eye sample belongs.

LEFT_GAZE_X	Left eye gaze coordinate along the x axis.
LEFT_GAZE_Y	Left eye gaze coordinate along the y axis.
LEFT_INTEREST AREAS	List of interest areas in which the left-eye sample falls.
LEFT_INTEREST_AREA_DATA	Reports the data (interest area type, dynamic/static interest area, and coordinate data) of the interest area in which the left-eye sample falls.
LEFT_INTEREST_AREA_DISTANCE	Distance (in degrees of visual angle) between the current left-eye sample and the center of the interest area in which the sample falls.
LEFT_INTEREST_AREA_ID	Index of the interest area in which the left-eye sample falls.
LEFT_INTEREST_AREA_LABEL	Label of the interest area in which the left-eye sample falls.
LEFT_INTEREST_AREA_PIXEL_AREA	Pixel area of the interest area in which the left-eye sample falls.
LEFT_IN_BLINK	Whether the left eye is in a blink (1 if true, 0 if false). The output of this variable may be affected by the “Blink Correction for Pupil Size Calculations” settings in the “Data Filters” preferences.
LEFT_IN_SACCADE	Whether the left eye is in a saccade (1 if true, 0 if false).
LEFT_PUPIL_SIZE	Left eye pupil size of the current sample.
LEFT_SACCADE_INDEX	Ordinal sequence of the saccade in the trial to which the left-eye sample belongs.
LEFT_VELOCITY_X	Velocity value (in degree/second) of the left eye along the x axis.
LEFT_VELOCITY_Y	Velocity value (in degree/second) of the left eye along the y axis.
RESOLUTION_X	Horizontal angular resolution (in screen pixels per degree) for the sample.
RESOLUTION_Y	Vertical angular resolution (in screen pixels per degree) for the sample.
RIGHT_ACCELERATION_X	Acceleration value (in degree/second/second) of the right eye along the x axis.
RIGHT_ACCELERATION_Y	Acceleration value (in degree/second/second) of the right eye along the y axis.
RIGHT_FIX_INDEX	Ordinal sequence of the fixation in the trial to which the right-eye sample belongs.
RIGHT_GAZE_X	Right eye gaze coordinate along the x axis.

RIGHT_GAZE_Y	Right eye gaze coordinate along the y axis.
RIGHT_INTEREST AREAS	List of interest areas in which the right-eye sample falls.
RIGHT_INTEREST_AREA_DATA	Reports the data (interest area type, dynamic/static interest area, and coordinate data) of the interest area in which the right-eye sample falls.
RIGHT_INTEREST_AREA_DISTA NCE	Distance (in degrees of visual angle) between the current right-eye sample and the center of the interest area in which the sample falls.
RIGHT_INTEREST_AREA_ID	ID of the interest area in which the right-eye sample falls.
RIGHT_INTEREST_AREA_LABEL	Label of the interest area in which the right-eye sample falls.
RIGHT_INTEREST_AREA_PIXEL _AREA	Pixel area of the interest area in which the right-eye sample falls.
RIGHT_IN_BLINK	Whether the right eye is in a blink (1 if true, 0 if false). The output of this variable may be affected by the “Blink Correction for Pupil Size Calculations” settings in the “Data Filters” preferences.
RIGHT_IN_SACCADE	Whether the right eye is in a saccade (1 if true, 0 if false).
RIGHT_PUPIL_SIZE	Right eye pupil size of the current sample.
RIGHT_SACCADE_INDEX	Ordinal sequence of the saccade in the trial to which the right-eye sample belongs.
RIGHT_VELOCITY_X	Velocity value (in degree/second) of the right eye along the x axis.
RIGHT_VELOCITY_Y	Velocity value (in degree/second) of the right eye along the y axis.
SAMPLE_BUTTON	If the EyeLink button box is pressed, this records the ID of the EyeLink button number.
SAMPLE_INDEX	The index of the sample in the trial.
SAMPLE_INPUT	The input value for the current sample.
SAMPLE_MESSAGE	Message text printed out during the current sample. Multiple messages associated with the current sample are delimited by a semicolon (;).
TARGET_ACCELERATION_X	Acceleration value (in degree/second/second) of the target along the x axis.
TARGET_ACCELERATION_Y	Acceleration value (in degree/second/second) of the target along the y axis.
TARGET_VELOCITY_X	Velocity value (in degree/second) of the target

	along the x axis.
TARGET_VELOCITY_Y	Velocity value (in degree/second) of the target along the y axis.
TARGET_VISIBLE	Whether the target is visible during the current sample. To support the retrieval of target position from a sample report, the target position data must be written according in the appropriate format (see section "Protocol for EyeLink Data to Viewer Integration -> Target Position Commands").
TARGET_X	Target position on X axis (in screen pixel coordinates). To support the retrieval of target position from a sample report, the target position data must be written according in the appropriate format (see section "Protocol for EyeLink Data to Viewer Integration -> Target Position Commands").
TARGET_Y	Target position on Y axis (in screen pixel coordinates). To support the retrieval of target position from a sample report, the target position data must be written according in the appropriate format (see section "Protocol for EyeLink Data to Viewer Integration -> Target Position Commands").
TIMESTAMP	The time stamp of the sample (in milliseconds since EyeLink tracker was activated).
TRIAL_INDEX	Sequential order of the trial in the recording.
TRIAL_LABEL	Label of the trial.
¶ TRIAL_START_TIME	The start time (in milliseconds since EyeLink tracker was activated; i.e., EDF file time) of the trial. If a valid reaction time is found in the trial, TRIAL_START_TIME will be set to the start time of the reaction time definition instead.
VIDEO_FRAME_INDEX	Index of the video frame that was visible at the sample time. Note that all "VIDEO_" variables are applicable to SceneLink recordings or some Experiment Builder recordings only. For SceneLink recordings, please check out the "Data Loading" Preference Settings.
VIDEO_NAME	Name of the video frame that was visible at the sample time.

Note ¹: If one eye has valid data whereas the other eye has a missing value or was not recorded at all, the “AVERAGE_**” data in the Sample Report will be based on the good eye if the “Cyclopean Mode” option (in the Output/Analysis Preferences) is checked. If this is not checked, then a missing value is reported if no valid data is available from either eye. This option has no effect when both eyes have valid or missing data.

Note ²: Please note that HTARGET_DISTANCE, HTARGET_X, HTARGET_Y, and HTARGET_FLAGS outputs are intended for a qualitative indication of subject head position in the camera coordinates. If you need quantitative data output for the head movements and rotation angle, you will need an independent head tracker.

In addition, other user-defined trial variable labels will also be listed. Please note that the data output in the sample report depends on the setting of the interest period filter (see 6.4.2 or Figure 6-22)—only those samples, fixation and saccade events falling within the active interest period will be reported. If a valid reaction time definition is found in a trial, the ¶ TRIAL_START_TIME variable will be set as the start of the reaction time definition; otherwise this will be set as the start of trial recording (see 6.5.3 on discussion of three time periods used in Data Viewer).

6.9.4 Configuring the Sample Report

Data Viewer allows users to configure the sample report. A few options are available in the “Sample Output Report” dialog box:

- Users can exclude some trials by entering a string in the “Exclude Trial String” edit box. This string should be one message or part of a message within the trial recording (see section 7.1 on defining the start and end of a trial) that uniquely defines the subset of trials to be excluded.
- The sample report allows the inclusion of hidden events in the relative event variables [LEFT_SACCADE_INDEX, LEFT_FIX_INDEX, RIGHT_SACCADE_INDEX, RIGHT_FIX_INDEX]. This can be done by clicking the “Include Hidden Events in Relative Variables” check box.
- To enable correct loading of string/text variables into some statistics software, Data Viewer provides an option of adding a pair of quotation marks for those variables.
- If the “Create One Report File Per EDF File” option is checked, Data Viewer will create one report file for each of the EDF files loaded into the viewing session.
- Version 2.6 of the Data Viewer software allows users to create a shorter sample report by enabling the “Re-sample Original Recordings with a Lower Sampling Rate” option. Users can then fill out the “Intended Output Sampling Rate (Hz):” edit box.

Note: If the “Exclude from Reports” property of a trial or trial group is checked, data from that trial/trial group will not be included in the sample report (and other reports).

6.10 Message Report

Message reports provide information concerning the messages written in each trial as well as the eye movement events to which the messages are associated. As with the other reports, message report only outputs messages that fall within the active interest period for the trial.

6.10.1 Creating a Message Report

To create an output report for messages,

- 1) From the application menus, choose:
Analysis -> Reports -> Message Report

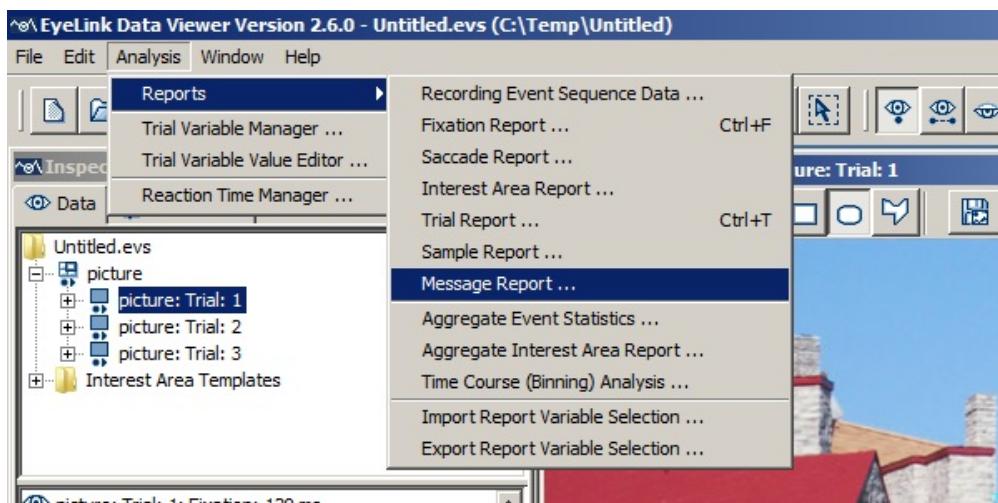


Figure 6-32. Creating a Message Report.

- 2) In the following output report dialog, select the variables in the list of available output variables (left panel) and press ">>" to enter the variables into the list of selected output variables. You can also drag the selected variables and drop them to the intended position in the selected variables list.

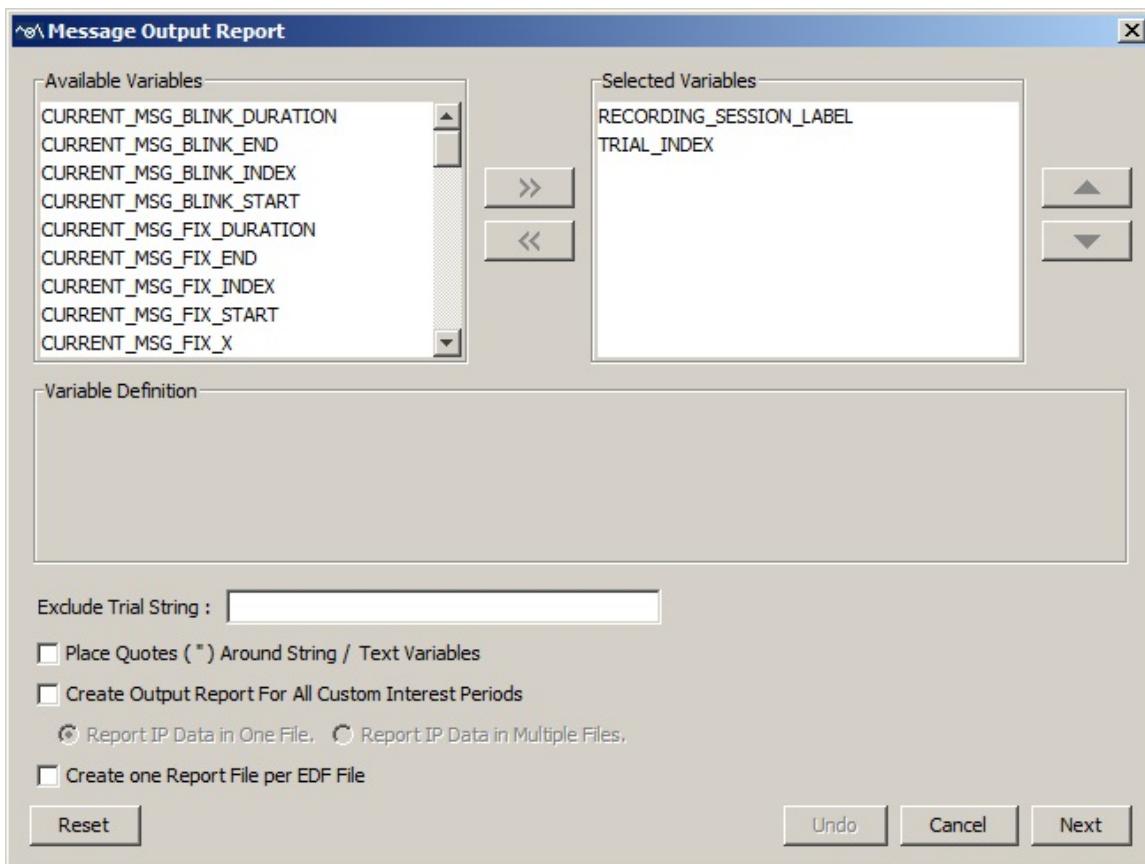


Figure 6-33. Variables in a Message Report.

- To remove variables from the output list, simply select the variables and press <<. You can also drag the selected variables and drop them back to the Available Variables list.
- To change the order in which the variables are listed, simply select one variable and use the ▲ or ▼ button to move it to the desired position. Repeat this step until all variables are in the right position. You can also select the variable(s) and then drag and drop them to the intended position.
- Data Viewer supports exporting and importing of variable selection across viewing sessions. For example, users may go through each of the output reports to configure the selection of variables in an intended order, then export the variable selection into a property file by clicking “Analysis -> Reports -> Export Report Variable Selection”. For all future viewing sessions, the variable selection in the reports can be achieved by importing the previously saved property file (through “Analysis -> Reports -> Import Report Variable Selection”).

3) Once all the desired variables have been entered into the output list, press the Next button.

4) In the Save dialog box, browse to the directory in which you want to save the output report. The default output directory can be configured through "General Preferences".

5) In the File name text box, enter the name for the document and choose the appropriate file extension. Note, if the output report file extension is set to "All Files" and the file name does not contain an extension, the file name is appended with a ".txt" by default.

6) Press the "Save" button.

Data Viewer also allows users to configure the message output report. Users can exclude some trials by entering a string in the "Exclude Trial String" edit box. This string should be one message or part of a message within the scope of the trial recording that uniquely defines that subset of trials to be excluded. In addition, to enable correct loading of string/text variables in some statistics software, the Viewer also has an option of adding a pair of quotation marks for such variables.

6.10.2 Variables in the Message Report

Currently, the following variables are included in the message output report. Please note that the values of all variables marked with a “¶” symbol are calculated relative to TRIAL_START_TIME, and therefore will be different depending on whether a valid reaction time is found in the trial (see section 6.5.3 on discussion of three time periods used in Data Viewer).

Field	Contents
RECORDING SESSION LABEL	Label of the data file.
CURRENT_MSG_BLINK_DURATION	Duration of the blink to which the message is associated.
¶CURRENT_MSG_BLINK_END	End time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the blink to which the message is associated.
CURRENT_MSG_BLINK_INDEX	Index of the blink to which the message is associated.
¶CURRENT_MSG_BLINK_START	Start time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the blink during which the message was written.
CURRENT_MSG_FIX_DURATION	Duration of the fixation to which the message is associated.
¶CURRENT_MSG_FIX_END	End time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the fixation to which the message is associated.
CURRENT_MSG_FIX_INDEX	Index of the fixation to which the message is

	associated.
¶ CURRENT_MSG_FIX_START	Start time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the fixation to which the message is associated.
CURRENT_MSG_FIX_X	X position of the fixation to which the message is associated.
CURRENT_MSG_FIX_Y	Y position of the fixation to which the message is associated.
CURRENT_MSG_INDEX	Index of the current message.
CURRENT_MSG_INTEREST_AREAS	List of interest areas in which the current eye position falls at the time the message is recorded.
CURRENT_MSG_INTEREST_AREA_ID	The ID of the interest area in which the current eye position falls when the message is recorded. If the message falls into multiple interest areas, the interest area with lowest ID will be used.
CURRENT_MSG_INTEREST_AREA_INDEX	The index of the interest area in which the current eye position falls when the message is recorded. This measure is the same as the CURRENT_MSG_INTEREST_AREA_ID except when there are multiple interest areas with the same ID, or interest area IDs didn't start from 1.
CURRENT_MSG_INTEREST_AREA_LABEL	Label for the interest area in which the current eye position falls when the message is recorded.
CURRENT_MSG_IS_RT_END	Whether the current message is the end event of a reaction-time definition.
CURRENT_MSG_IS_RT_START	Whether the current message is the start event of a reaction-time definition.
¶ CURRENT_MSG_LABEL	Label of the current message event.
CURRENT_MSG_SAC_AMPLITUDE	Amplitude (in degrees of visual angle) of the saccade to which the message is associated.
CURRENT_MSG_SAC_AVG_VELOCITY	Average velocity (in degrees/second) of the saccade to which the message is associated.
CURRENT_MSG_SAC_DURATION	Duration of the saccade to which the message is associated.
¶ CURRENT_MSG_SAC_END_TIME	End time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the saccade to which the message is associated.
CURRENT_MSG_SAC_END_X	X coordinate of the end point for the saccade to which the message is associated.
CURRENT_MSG_SAC_END_Y	Y coordinate of the end point for the saccade to which the message is associated.

CURRENT_MSG_SAC_INDEX	Index of the saccade to which the message is associated.
CURRENT_MSG_SAC_PEAK_VELOCITY	Peak velocity (in degrees/second) of the saccade to which the message is associated. The peak velocity calculation depends on whether the samples are loaded in the viewing session.
¶CURRENT_MSG_SAC_START_TIME	Start time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the saccade to which the message is associated.
CURRENT_MSG_SAC_START_X	X coordinate of the start point for the saccade to which the message is associated.
CURRENT_MSG_SAC_START_Y	Y coordinate of the start point for the saccade to which the message is associated.
CURRENT_MSG_TEXT	Text string of the current message.
¶ CURRENT_MSG_TIME	Trial time (in milliseconds relative to the start of the current trial "TRIAL_START_TIME") of the message.
CURRENT_MSG_X_POSITION	X position of the current message text. It may be a missing value if samples are not loaded in the viewing session.
CURRENT_MSG_Y_POSITION	Y position of the current message text. It may be a missing value if samples are not loaded in the viewing session.
DATA_FILE	File name of the EDF data file.
EYE_USED	Records which eye's data (LEFT or RIGHT) was used to create this report.
IP_DURATION	Duration of the interest period in milliseconds.
IP_END_EVENT_MATCHED	Whether an event that matches the end of the selected interest period has been found in the current trial.
IP_END_TIME	End time (in milliseconds since EyeLink tracker was activated) of the interest period.
IP_INDEX	The index (starting from 1) of interest period created by the user. For the Full-Trial period or Reaction-Time Period, a missing value is given as they are not created by the user.
IP_LABEL	Label of the current interest period selected in the viewing session.
IP_START_EVENT_MATCHED	Whether an event that matches the start of the selected interest period has been found in the current trial.

IP_START_TIME	Start time (in milliseconds since EyeLink tracker was activated) of the interest period.
TRIAL_INDEX	Sequential order of the trial in the recording.
TRIAL_LABEL	Label of the trial.
¶ TRIAL_START_TIME	The start time (in milliseconds since EyeLink tracker was activated; i.e., EDF file time) of the trial. If a valid reaction time is found in the trial, TRIAL_START_TIME will be set to the start time of the reaction time definition instead.

Note: Messages written in the EDF file will be associated with the eye event closest in time. In very rare cases, the message can be associated with both a saccade and fixation event if the message was written out after the last sample of a fixation (or saccade) but before the first sample of the following saccade (or fixation).

In addition, other user-defined trial variable labels will also be listed.

6.10.3 Configuring the Message Report

See section 6.5.4 “Configuring the Trial Report”.

6.11 Aggregate Event Statistics

The Aggregate Event statistics provide summary statistics for each trial group in the current interest period. If no trial grouping was performed in the viewing session, the report provides summary statistics for each of the EDF files loaded.

6.11.1 Creating an Aggregate Event Statistics Report

To create an Aggregate Event Statistics report,

- 1) From the application menus, choose:
Analysis -> Reports -> Aggregate Event Statistics

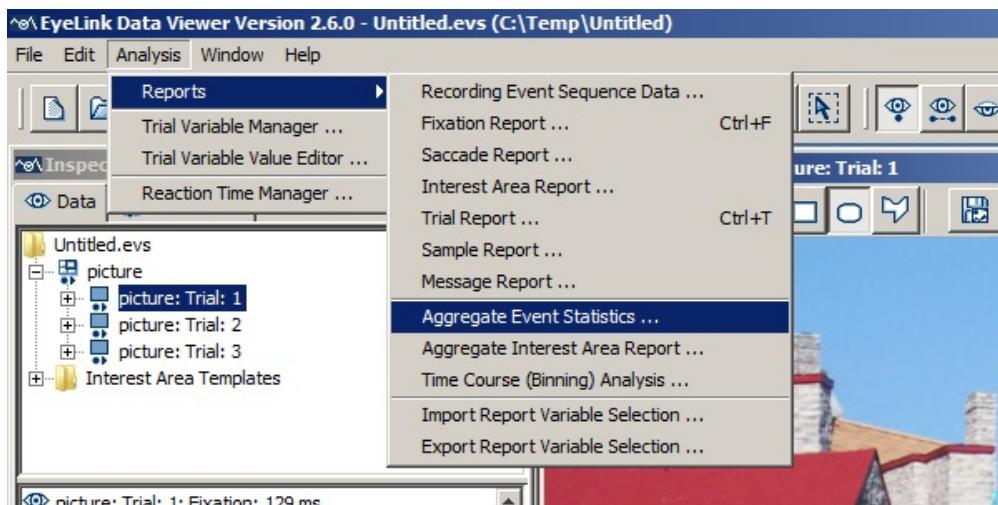


Figure 6-34. Creating an Aggregate Event Statistics Report.

- 2) In the following output report dialog, select the variables in the list of available output variables (left panel) and press ">>" to enter the variables into the list of selected output variables. You can also drag the selected variables and drop them to the intended position in the selected variables list.

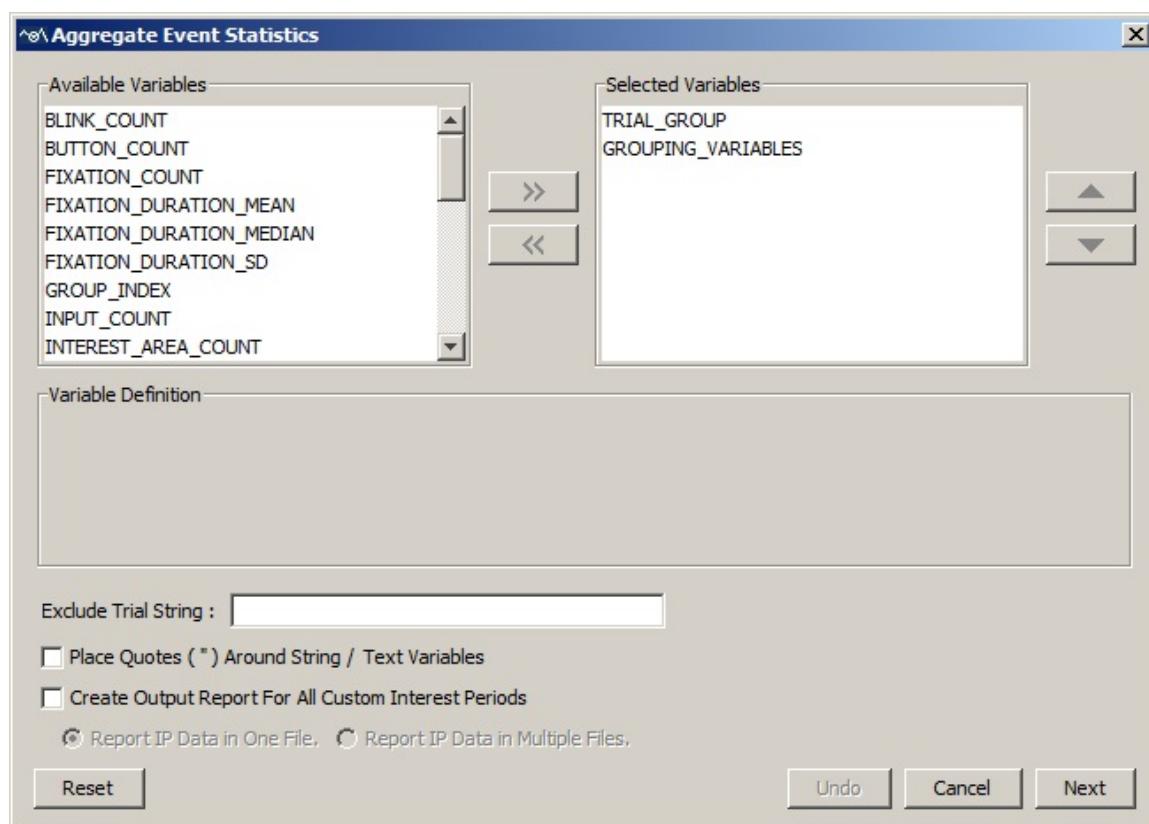


Figure 6-35. Variables in an Aggregate Event Statistics Report.

- To remove variables from the output list, simply select the variables and press <<. You can also drag the selected variables and drop them back to the Available Variables list.
- To change the order in which the variables are listed, simply select one variable and use the ▲ or ▼ button to move it to the desired position. Repeat this step until all variables are in the right position. You can also select the variable(s) and then drag and drop them to the intended position.
- Data Viewer supports exporting and importing of variable selection across viewing sessions. For example, users may go through each of the output reports to configure the selection of variables in an intended order, then export the variable selection into a property file by clicking “Analysis -> Reports -> Export Report Variable Selection”. For all future viewing sessions, the variable selection in the reports can be automated by importing the previously saved property file (through “Analysis -> Reports -> Import Report Variable Selection”).

- 3) Once all the desired variables have been entered into the output list, press the Next button.
- 4) In the Save dialog box, browse to the directory in which you want to save the output report. The default output directory can be configured through "General Preferences".
- 5) In the File name text box, enter the name for the document and choose the appropriate file extension. Note, if the output report file extension is set to "All Files" and the file name does not contain an extension, the file name is appended with a ".txt" by default.
- 6) Press the "Save" button.

6.11.2 Variables in the Aggregate Event Statistics Report

Currently, the following variables are included in the Aggregate Event Statistics output:

Field	Contents
TRIAL_GROUP	Name of the trial group (encoding the value(s) of the grouping variable(s) for the current trial group).
GROUPING_VARIABLES	Label(s) of the grouping variable(s) for the current viewing session.
BLINK_COUNT	Average number of blinks in a trial in the current interest period, calculated as the total number of blinks in the trial group divided by the number of trials in the group.
BUTTON_COUNT	Average number of button presses in a trial, calculated as the total number of button presses

	in the trial group divided by the number of trials in the group.
FIXATION_COUNT	Average number of fixations in a trial in the current interest period, calculated as the total number of fixations in the trial group divided by the number of trials in the group.
FIXATION_DURATION_MEAN	Average duration (in milliseconds) of all fixations in the trial group. This is calculated by summing up the duration of all fixations in the trial group divided by the total number of fixations in the group.
FIXATION_DURATION_MEDIAN	Median duration (in milliseconds) of all fixations in the trial group.
FIXATION_DURATION_SD	Standard Deviation (in milliseconds) of the duration across all fixations in the trial group.
GROUP_INDEX	Order of the trial group in the viewing session.
INPUT_COUNT	Average number of input events that occur in the trial group, calculated as the total number of input events in the trial group divided by the number of trials in the group.
INTEREST_AREA_COUNT	Average number of interest areas in the trial group, calculated as the total number of interest areas across all trials in the trial group divided by the number of trials.
IP_DURATION	Duration of the interest period (in milliseconds) averaged across all trials in the trial group.
IP_INDEX	The index (starting from 1) of interest period created by the user. For the Full-Trial period or Reaction-Time Period, a missing value is given as they are not created by the user.
IP_LABEL	Label of the current interest period selected in the viewing session.
PUPIL_SIZE	Average pupil size (in arbitrary units) across all non-blink samples in the trial group.
RUN_COUNT	Average number of fixation runs (two or more consecutive fixations in the same interest area belong to the same run) averaged over all trials in the current interest period. This is calculated as the average run count across all trials in the trial group.
SACCADE_AMPLITUDE_MEAN	Average size (in degrees of visual angle) of all saccades in the trial group. This is calculated by

	summing up the amplitude of all saccades in the trial group divided by the total number of saccades in the group.
SACCADE_AMPLITUDE_MEDIAN	Median size (in degrees of visual angle) of all saccades in the trial group.
SACCADE_AMPLITUDE_SD	Standard Deviation (in degrees of visual angle) of the amplitude of all saccades in the trial group.
SACCADE_COUNT	Average number of saccades in a trial, calculated as the total number of saccades in the trial group divided by the number of trials in the group.
SAMPLE_COUNT	Average number of samples in trials contained in the group, calculated as the total number of samples in the trial group divided by the number of trials in the group.
TRIALS_WITH_IAS_COUNT	Number of trials in the trial group that contain at least one interest area in the current interest period.
TRIAL_COUNT	Total number of trials in the trial group.
TRIAL_DURATION	Average duration (in milliseconds) of trial recording (between the START event and the END event) across all trials in the trial group.
VISITED_INTEREST_AREA_COU NT	Number of unique interest areas visited in the trial (calculated as the average count across all trials in the group).

Please note that the data output in the Aggregate Event Statistics depends on the setting of the interest period filter (see section 6.4.2 or Figure 6-22) —only events falling within the active interest period will be reported. Presently, all user-defined trial variables will report a missing value.

6.11.3 Configuring the Aggregate Event Statistics Report

To enable correct loading of string/text variables into some statistics software, Data Viewer provides an option of adding a pair of quotation marks for those variables.

Note: If the “Exclude from Reports” property of a trial or trial group is checked, data from that trial/trial group will not be included in the Aggregate Event Statistics report (and other reports).

6.12 Aggregate Interest Area Report

The Aggregate Interest Area Report provides information concerning each interest area in each trial group. If no trial grouping was performed in the viewing session, this will be a report for each interest area per each EDF file. This report assumes that trials in a trial group have the same interest area setup; if not, the interest area report will be based on the ID of the interest areas; the property of the interest areas will be drawn from the first instance found in the trial group.

6.12.1 Obtaining an Aggregate Interest Area Report

To create an Aggregate Interest Area Report,

- 1) From the application menus, choose:
Analysis -> Reports -> Aggregate Interest Area Report

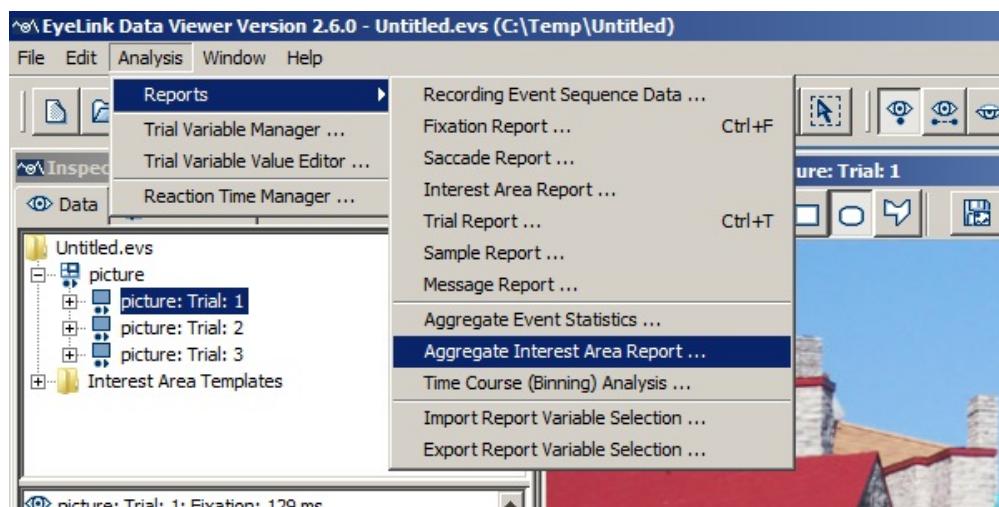


Figure 6-36. Creating an Aggregate Interest Area Report.

- 2) In the following output report dialog, select the variables in the list of available output variables (left panel) and press ">>" to enter the variables into the list of selected output variables. You can also drag the selected variables and drop them to the intended position in the selected variables list.

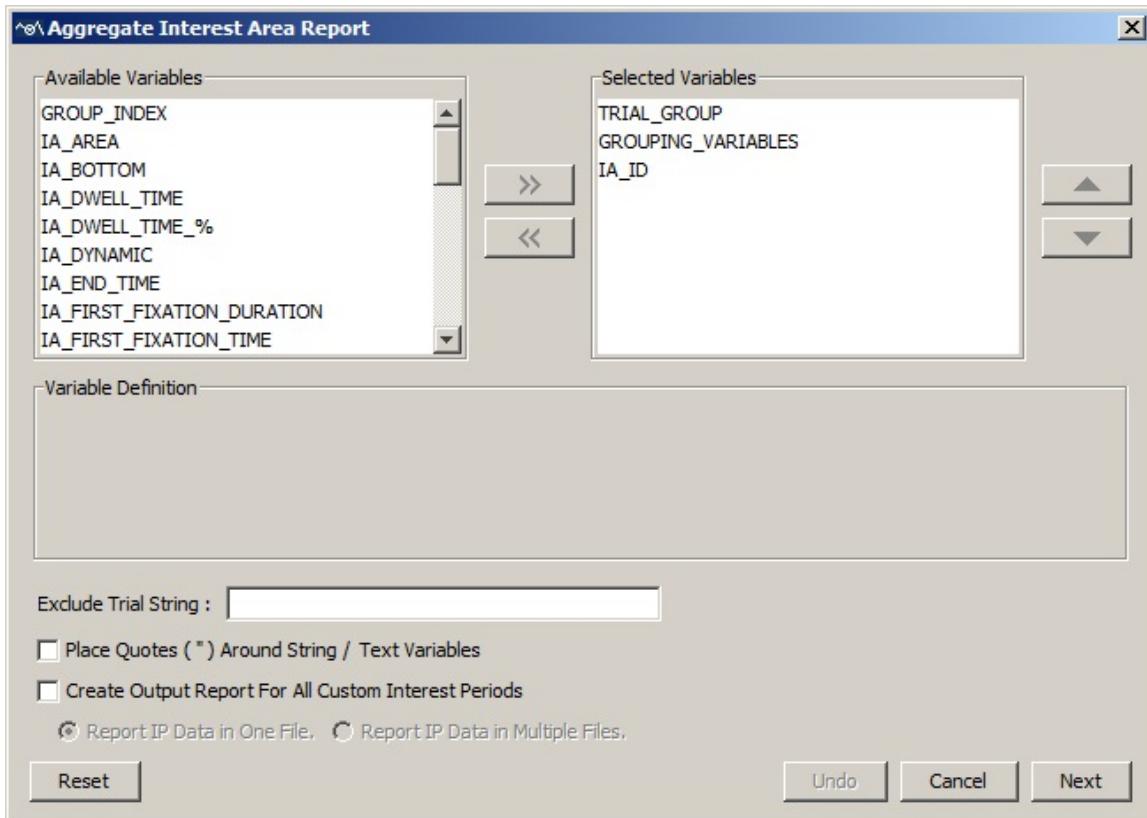


Figure 6-37. Variables in an Aggregate Interest Area Report.

- To remove variables from the output list, simply select the variables and press <<. You can also drag the selected variables and drop them back to the Available Variables list.
- To change the order in which the variables are listed, simply select one variable and use the ▲ or ▼ button to move it to the desired position. Repeat this step until all variables are in the right position. You can also select the variable(s) and then drag and drop them to the intended position.
- Data Viewer supports exporting and importing of variable selection across viewing sessions. For example, users may go through each of the output reports to configure the selection of variables in an intended order, then export the variable selection into a property file by clicking “Analysis -> Reports -> Export Report Variable Selection”. For all future viewing sessions, the variable selection in the reports can be automated by importing the previously saved property file (through “Analysis -> Reports -> Import Report Variable Selection”).

3) Once all the desired variables have been entered into the output list, press the Next button.

4) In the Save dialog box, browse to the directory in which you want to save the output report. The default output directory can be configured through "General Preferences".

5) In the File name text box, enter the name for the document and choose the appropriate file extension. Note, if the output report file extension is set to "All Files" and the file name does not contain an extension, the file name is appended with a ".txt" by default.

6) Press the "Save" button.

6.12.2 Variables in the Aggregate Interest Area Report

Currently, the following variables are included in the Aggregated Interest Area Report. Please note that the values of all variables marked with a “¶” symbol are calculated relative to TRIAL_START_TIME, and therefore will be different depending on whether a valid reaction time is found in the trial (see section 6.5.3 on discussion of three time periods used in Data Viewer).

Field	Contents
TRIAL_GROUP	Name of the trial group (encoding the value(s) of the grouping variable(s) for the current trial group).
GROUPING_VARIABLES	Label(s) of the grouping variable(s) for the current viewing session.
IA_AREA	Pixel area for the current interest area. This is based on the data from the first trial/instance in the trial group.
IA_BOTTOM	Y-coordinate of the lower-right corner of a rectangular or elliptic interest area ("." for a freehand interest area). This output is based on the data from the first trial/instance in the trial group.
IA_DWELL_TIME	Dwell time (i.e., summation of the duration across all fixations) on the current interest area. This is calculated as the sum of the duration of all fixations into the interest areas with this ID, divided by the number of trials using this interest area (TRIALS USING THIS IA).
IA_DWELL_TIME_%	Percentage of trial time spent on the current interest area. This is calculated as the sum of all fixation duration into the interest areas with this ID, divided by the total fixation dwell time of those trials using this interest area.
IA_DYNAMIC	Whether the current interest area is a dynamic one (true or false). This is based on the data from the first trial/instance in the trial group.
IA_END_TIME	Time (relative to the start of the current interest

	period) when the last instance of the current interest area ends. This variable is applicable to dynamic interest areas only and is based on the data from the first trial instance in the trial group.
IA_FIRST_FIXATION_DURATION	Duration of the first fixation event that was within the current interest area. This is an average value across all trials with a fixation into the interest area with this ID.
¶ IA_FIRST_FIXATION_TIME	Start time of the first fixation to enter the current interest area. This is an average value across all trials with a fixation into the interest area with this ID.
IA_FIRST_FIXATION_VISITED_IA_COUNT	The number of different interest areas visited so far before the first fixation is made into the current interest area. This is an average value across all trials with a fixation into the interest area with this ID.
IA_FIXATION_COUNT	Average number of total fixations falling in the interest area. This is calculated as the total number of fixations into the interest areas with this ID, divided by the number of trials using this interest area (TRIALS_USING_THIS_IA).
IA_FIX_COUNT_%	Percentage of all fixations in a trial falling in the current interest area. This is calculated as the total number of fixations into the interest areas with this ID, divided by the total number of fixations in those trials using this interest area (TRIALS_USING_THIS_IA).
IA_ID	Ordinal ID of the current interest area. In the Aggregate Interest Area report, all of the calculation is based on the ID of the interest areas.
IA_INSTANCES_COUNT	The total number of individual instances of the current dynamic interest area. This is based on the data from the first trial instance in the trial group.
IA_LABEL	Label for the current interest area. This is based on the data from the first trial instance in the trial group.
IA_LEFT	X-coordinate of the upper-left corner of a rectangular or elliptic interest area ("." for a freehand interest area). This is based on the data

	from the first trial/instance in the trial group.
IA_POINTS	List of points for a freehand interest area (otherwise "." is output). This is based on the data from the first trial/instance in the trial group.
IA_VISITED_TRIAL_%	This is calculated as the total number of trials with more than one run of fixations on the interest area with this ID, divided by the total number of trials using this interest area (TRIALS USING THIS IA).
IA_RIGHT	X-coordinate of the lower-right corner of a rectangular or elliptic interest area ("." for a freehand interest area). This is based on the data from the first trial/instance in the trial group.
IA_RUN_COUNT	Number of times the Interest Area was entered and left (runs). This is calculated as the sum of run count from all trials using this interest area, divided by the number of trials using this interest area (TRIALS USING THIS IA).
IA_START_TIME	Time (relative to the start of the current interest period) when the first instance of the current interest area starts. This variable is applicable to dynamic interest areas only and outputs the data from the first trial/instance in the trial group.
IA_TOP	Y-coordinate of the upper-left corner of a rectangular or elliptic interest area ("." for a freehand interest area). This outputs the data from the first trial/instance in the trial group.
IA_TYPE	Type of interest area (rectangular, elliptic, or freehand). This is based on the data from the first trial/instance in the trial group.
IA_VISITED_TRIAL_%	The total number of trials with at least one fixation on the interest area with this ID divided by the total number of trials using this interest area (TRIALS USING THIS IA).
IP_INDEX	The index (starting from 1) of interest period created by the user. For the Full-Trial period or Reaction-Time Period, a missing value is given as they are not created by the user.
IP_LABEL	Label of the current interest period selected in the viewing session.
TRIALS_IN_GROUP	Total number of trials in the trial group.
TRIALS_USING_THIS_IA	Total number of trials in the current trial group

	that have an interest area with this ID in the current interest period.
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Please note that the data output in the Aggregate Interest Area Report depends on the setting of the interest period filter (see section 6.4.2 or Figure 6-22)—only events falling within the active interest period will be reported. Presently, all user-defined trial variables will report a missing value.

6.12.3 Configuring the Aggregate Interest Area Report

To enable correct loading of string/text variables into some statistics software, Data Viewer provides an option of adding a pair of quotation marks for those variables.

Note: If the “Exclude from Reports” property of a trial or trial group is checked, data from that trial/trial group will not be included in the Aggregate Interest Area report (and other reports).

6.12.4 Time Course (Binning) Analysis Report

Some eye-tracking studies (e.g., Visual World Paradigm, or people working with dynamic stimuli such as videos) examine how likely participants are to look at specific areas of interest at different times during a trial and make inferences about the time course of the underlying cognitive processes. Researchers typically divide a recording trial into a set of consecutive time windows and examine the proportions of fixations on various interest areas during each time window. The Time Course (Binning) Analysis creates a series of consecutive time bins from the beginning of the currently-selected interest period and tallies the distribution of gaze in a set of predefined interest areas for each time bin. It generates two possible reports: a trial-based report which provides data output for each consecutive time window for each trial in the viewing session, and an optional collapsed report which provides averaged data in the same time window across all trials and participants within each trial group. The collapsed report allows users to examine how likely the participants are, on average, at a given moment in time, to look at each of the interest areas.

The time-course analysis offered by Data Viewer is intended as a replacement for the Visual World Analysis Script provided by the SR Research support forum. Using the same calculation principle, the current Time Course (Binning) Analysis provides a direct report output from Data Viewer without having to execute an external Python script. It has a much faster data processing speed and provides an easier interface to configure various report options. It also offers refinements of some calculation details. In particular, the Time Course Analysis now provides separate measures for blink, and off-screen sample count, which were grouped within the Interest Area 0 (any area onscreen that was not within a predefined interest area) in the Visual World analysis script.

6.12.5 Loading Samples into a Viewing Session

The time-course analysis will not be available from the Analysis menu if samples are not loaded into the viewing session. While recent versions of Data Viewer loads samples into the viewing session by default, please do the following in case samples are not loaded.

- 1) Before loading any EDF files, please go to "Start -> Programs -> SR Research -> EyeLink -> Data Viewer" to start the software.
- 2) Once the application starts up, click the "Preferences" tab and go to "Data Loading" preferences. If not already enabled, check the "Load Samples" option. If you want this changes to be persistent over future viewing sessions, you may consider saving this as the default setting. This can be done by selecting the topmost preference tree node, clicking the right mouse buttons and selecting "Save Properties as Defaults".
- 3) Now, start loading in the EDF files.

6.12.6 Creating a Time-Course (Binning) Analysis Report

To create a Time-Course (Binning) Analysis Report,

- 1) From the application menus, choose:
Analysis -> Reports -> Time Course (Binning) Analysis

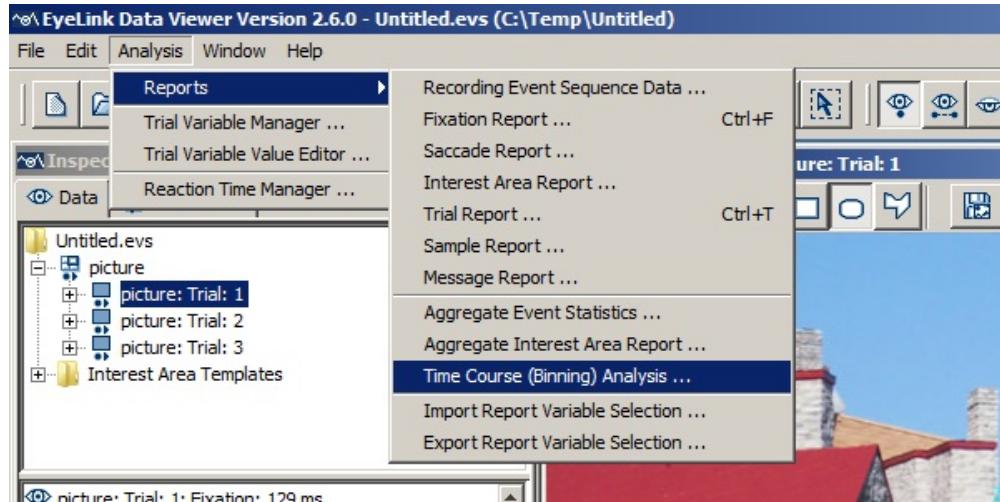


Figure 6-38. Creating a Time-Course (Binning) Report.

- 2) In the following output report dialog, select the variables in the list of available output variables (left panel) and press ">>" to enter the variables into the list of selected output variables. You can also drag the selected variables and drop them to the intended position in the selected variables list.

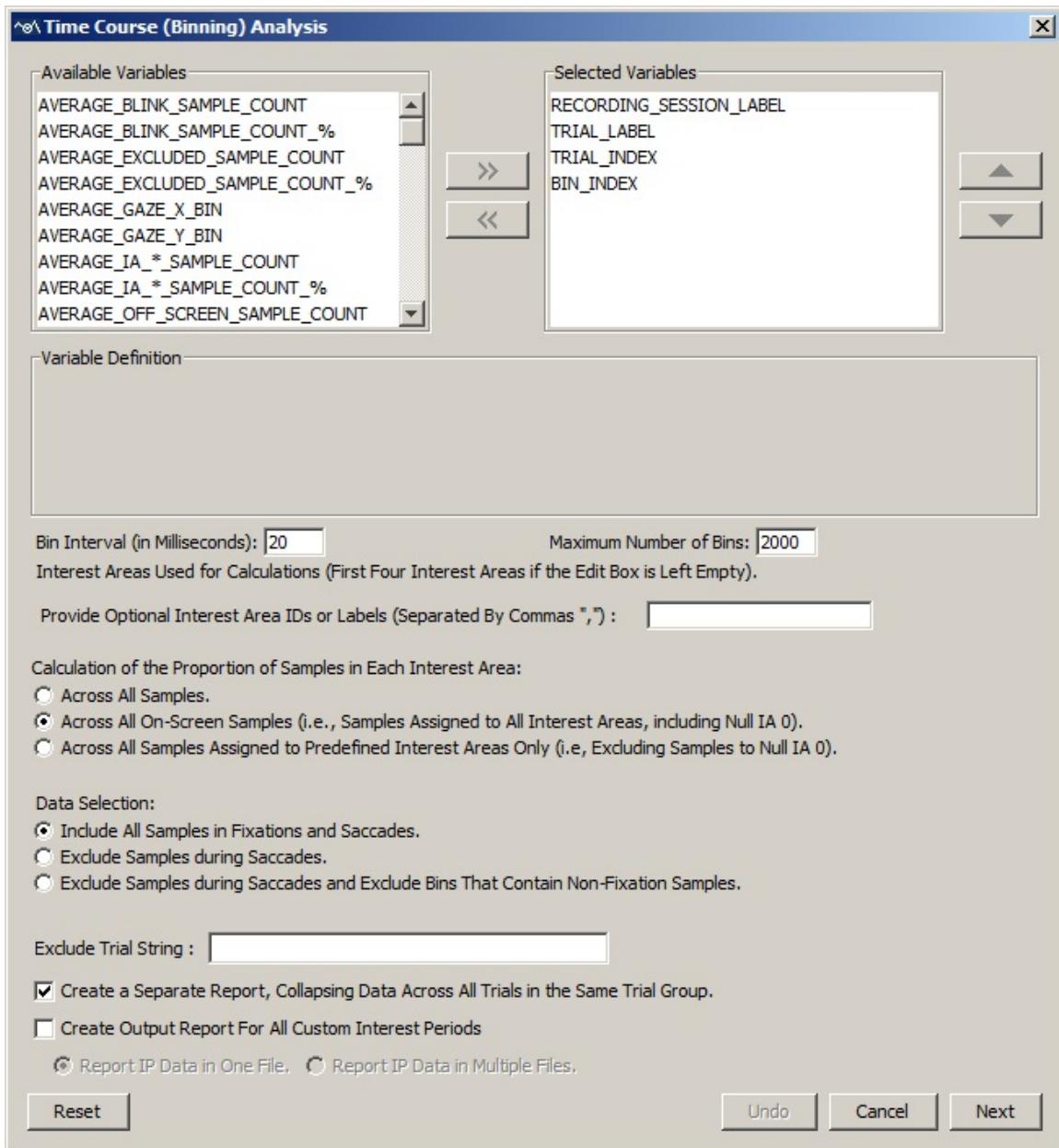


Figure 6-39. Variables and Configuration Options in a Time-Course Analysis Report.

- To remove variables from the output list, simply select the variables and press <<. You can also drag the selected variables and drop them back to the Available Variables list.
- To change the order in which the variables are listed, simply select the variable(s) and use the ▲ or ▼ button to move the selection to the desired position. Repeat this step until all variables are in the right position. You can also select the variable(s) and then drag and drop them to the intended position.

- Data Viewer supports exporting and importing of variable selection across viewing sessions. For example, users may go through each of the output reports to configure the selection of variables in an intended order, then export the variable selection into a property file by clicking “Analysis -> Reports -> Export Report Variable Selection”. For all future viewing sessions, the variable selection in the reports can be automated by importing the previously saved property file (through “Analysis -> Reports -> Import Report Variable Selection”).
- Several configuration options are available to the Time-Course Analysis report – please check section 6.13.4 “Configuring the Time Course Analysis Report” for details. In case you want to restore the changes made, click the “Undo” button to undo recent changes. Clicking on the “Reset” button will reset the configurations to factory settings.

- 3) Once all the desired variables have been entered into the output list and proper configurations are set, press the Next button.
- 4) In the Save dialog box, browse to the directory where you want to save the output report. The default output directory can be configured through "General Preferences".
- 5) In the File name text box, enter the file name and choose the appropriate file extension. Note, if the output report file extension is set to "All Files" and the file name does not contain an extension, the file name is appended with a ".txt" by default.
- 6) Press the "Save" button.

Note: Depending on the quantity and size of the EDF file(s), it may take some time to create this report.

6.12.7 Variables in the Time Course Analysis Report

Two possible Time Course Analysis reports are created: a trial-based report which provides output for each consecutive time window (bin) for each trial loaded in the viewing session, and a collapsed version which provides averaged data in the same time window across all trials and participants for each trial group in the viewing session. The following variables are available for the trial-based report.

Field	Contents
RECORDING SESSION LABEL	Label of the data file.
TRIAL_LABEL	Label of the trial.
#BIN_INDEX	Sequential order of the bin in the interest period.
#AVERAGE_BLINK_SAMPLE_CO UNT ¹	The total number of samples (based on the average data across both eyes) in the current bin that were in a blink event. In the collapsed output

	report, this reports the total number of blink samples in the current bin index across all trials within that trial group.
#AVERAGE_BLINK_SAMPLE_COUNT_% ¹	The percentage of the total number of samples (based on the average data across both eyes) in the current bin that were in a blink event across the total number of samples in the bin. In the collapsed output report, this variable is calculated similarly based on the samples in the current bin index across all trials within that trial group.
#AVERAGE_EXCLUDED_SAMPLE_COUNT ¹	The total number of samples (based on the average data across both eyes) in the current bin that are excluded from all other counts (due to the data selection configuration). In the collapsed output report, this reports the total number of excluded samples in the current bin index across all trials within that trial group.
#AVERAGE_EXCLUDED_SAMPLE_COUNT_% ¹	The percentage of the total number of samples (based on the average data across both eyes) in the current bin that are excluded from all other counts (due to the data selection configuration) across the total number of samples in the bin. In the collapsed output report, this variable is calculated similarly based on the samples in the current bin index across all trials within that trial group.
#AVERAGE_GAZE_X_BIN ^{1,2}	Average binocular/cyclopean X gaze position across all selected non-blink samples in the current bin.
#AVERAGE_GAZE_Y_BIN ^{1,2}	Average binocular/cyclopean Y gaze position across all selected non-blink samples in the current bin.
#AVERAGE_IA_*_SAMPLE_COUNT ¹	This will create several columns – it will create one column for each interest area that is included in the report calculations and one column for all on-screen samples outside of all interest areas. The symbol * will become an interest area index for each column and 0 will indicate the column for all on-screen samples that don't belong to any other interest areas used for calculations. The value in each column (* will become a number indicating the interest area index) will be the

	total number of samples (based on the average data across both eyes) in the current bin that fall in that interest area. In the collapsed output report, this reports the total number of samples in the current bin index across all trials within that trial group.
#AVERAGE_IA_*_SAMPLE_COU NT_% ¹	The percentage of the total number of samples (based on the average data across both eyes) in the current bin that fall in the * (=index) interest area across the total number of samples according to the selected calculation option (i.e, all samples, valid samples including IA_0, or valid samples excluding IA_0). In the collapsed output report, this variable is calculated similarly based on the samples in the current bin index across all trials within that trial group. Please note IA_0 is the null interest area (for all on-screen samples that don't belong to any other interest areas used for calculations).
#AVERAGE_OFF_SCREEN_SAMP LE_COUNT ¹	The total number of samples (based on the average data across both eyes) in the current bin that fall outside of the display boundary (off screen). In the collapsed output report, this reports the total number of off-screen samples in the current bin index across all trials within that trial group.
#AVERAGE_OFF_SCREEN_SAMP LE_COUNT_% ¹	The percentage of the total number of samples (based on the average data across both eyes) in the current bin that fall outside of the display boundary (off screen) across the total number of samples in the bin. In the collapsed output report, this variable is calculated similarly based on the samples in the current bin index across all trials within that trial group.
#AVERAGE_PUPIL_SIZE_BIN ^{1,2}	Average binocular/cyclopean pupil size across all selected non-blink samples in the current bin.
#BIN_DURATION	The duration (in milliseconds) of the bin.
BIN_END_TIME	The end time (in milliseconds relative to the start of the interest period) of the bin.
#BIN_SAMPLE_COUNT	The total number of samples in the bin. In the collapsed output report, it reports the sample count in the same bin index across all trials within that trial group. Please note that in the

	latter report, the total bin samples don't necessary come by all trials but only the active trials, and hence the averaging is adjusted based on that.
BIN_START_TIME	The start time (in milliseconds relative to the start of the interest period) of the bin.
EYE_TRACKED	Reports which eye (left, right, both) is tracked for the current trial.
HTARGET_DISTANCE_BIN	Average Distance between the head target and eye camera (in millimeters) for an EyeLink Remote recording in the current bin. Returns a missing value if the head target was missing or if the data was recorded with a non-Remote eye tracker.
HTARGET_X_BIN	Average X position of the head target in camera coordinates for an EyeLink Remote recording in the current bin. Returns a missing value if the head target was missing or if the data was recorded with a non-Remote eye tracker.
HTARGET_Y_BIN	Average Y position of the head target in camera coordinates for an EyeLink Remote recording in the current bin. Returns a missing value if the head target was missing or if the data was recorded with a non-Remote eye tracker.
#IA_*_ID	The ID and label of the interest area that corresponds to the given IA Index. Please note IA_0 is the null interest area (for all on-screen samples that don't belong to any other interest areas used for calculations).
IP_DURATION	Duration of the interest period in milliseconds.
IP_END_EVENT_MATCHED	Whether an event that matches the start of the selected interest period has been found in the current trial.
IP_END_TIME	End time (in milliseconds since EyeLink tracker was activated) of the interest period.
IP_INDEX	The index (starting from 1) of interest period created by the user. For the Full-Trial period or Reaction-Time Period, a missing value is given as they are not created by the user.
#IP_LABEL	Label of the current interest period selected in the viewing session.
IP_START_EVENT_MATCHED	Whether an event that matches the start of the selected interest period has been found in the

	current trial.
IP_START_TIME	Start time (in milliseconds since EyeLink tracker was activated) of the interest period.
#LEFT_BLINK_SAMPLE_COUNT	The total number of left-eye samples in the current bin that were in a blink event. In the collapsed output report, this reports the total number of blink samples in the current bin index across all trials within that trial group.
#LEFT_BLINK_SAMPLE_COUNT_%	The percentage of the total number of left-eye samples in the current bin that were in a blink event across the total number of samples in the bin. In the collapsed output report, this variable is calculated similarly based on the samples in the current bin index across all trials within that trial group.
#LEFT_EXCLUDED_SAMPLE_COUNT	The total number of left-eye samples in the current bin that are excluded from all other counts (due to the data selection configuration). In the collapsed output report, this reports the total number of excluded samples in the current bin index across all trials within that trial group.
#LEFT_EXCLUDED_SAMPLE_COUNT_%	The percentage of the total number of left-eye samples in the current bin that are excluded from all other counts (due to the data selection configuration) across the total number of samples in the bin. In the collapsed output report, this variable is calculated similarly based on the samples in the current bin index across all trials within that trial group.
#LEFT_GAZE_X_BIN ²	Average left-eye X gaze position across all selected non-blink samples in the current bin.
#LEFT_GAZE_Y_BIN ²	Average left-eye Y gaze position across all selected non-blink samples in the current bin.
#LEFT_IA_*_SAMPLE_COUNT	This will create several columns – it will create one column for each interest area that is included in the report calculations and one column for all on-screen samples outside of all interest areas. The symbol * will become an interest area index for each column and 0 will indicate the column for all on-screen samples that don't belong to any other interest areas used for calculations. The value in each column (* will become a number indicating the interest area index) will be the

	total number of left-eye samples in the current bin that fall in that interest area. In the collapsed output report, this reports the total number of samples in the current bin index across all trials within that trial group.
#LEFT_IA_*_SAMPLE_COUNT_%	The percentage of the total number of left-eye samples in the current bin that fall in the * (=index) interest area across the total number of samples according to the selected calculation option (i.e, all samples, valid samples including IA_0, or valid samples excluding IA_0). In the collapsed output report, this variable is calculated similarly based on the samples in the current bin index across all trials within that trial group. Please note IA_0 is the null interest area (for all on-screen samples that don't belong to any other interest areas used for calculations).
#LEFT_OFF_SCREEN_SAMPLE_COUNT	The total number of left-eye samples in the current bin that fall outside of the display boundary (off screen). In the collapsed output report, this reports the total number of off-screen samples in the current bin index across all trials within that trial group.
#LEFT_OFF_SCREEN_SAMPLE_COUNT_%	The percentage of the total number of left-eye samples in the current bin that fall outside of the display boundary (off screen) across the total number of samples in the bin. In the collapsed output report, this variable is calculated similarly based on the samples in the current bin index across all trials within that trial group.
#LEFT_PUPIL_SIZE_BIN ²	Average left-eye pupil size across all selected non-blink samples in the current bin.
#RESOLUTION_X_BIN	Average horizontal angular resolution (in screen pixels per degree) across all samples in the current bin.
#RESOLUTION_Y_BIN	Average vertical angular resolution (in screen pixels per degree) across all samples in the current bin.
#RIGHT_BLINK_SAMPLE_COUNT	The total number of right-eye samples in the current bin that were in a blink event. In the collapsed output report, this reports the total number of blink samples in the current bin index across all trials within that trial group.
#RIGHT_BLINK_SAMPLE_COUN	The percentage of the total number of right-eye

T_%	samples in the current bin that were in a blink event across the total number of samples in the bin. In the collapsed output report, this variable is calculated similarly based on the samples in the current bin index across all trials within that trial group.
#RIGHT_EXCLUDED_SAMPLE_COUNT	The total number of right-eye samples in the current bin that are excluded from all other counts (due to the data selection configuration). In the collapsed output report, this reports the total number of excluded samples in the current bin index across all trials within that trial group.
#RIGHT_EXCLUDED_SAMPLE_COUNT_%	The percentage of the total number of right-eye samples in the current bin that are excluded from all other counts (due to the data selection configuration) across the total number of samples in the bin. In the collapsed output report, this variable is calculated similarly based on the samples in the current bin index across all trials within that trial group.
#RIGHT_GAZE_X_BIN ²	Average right-eye X gaze position across all selected non-blink samples in the current bin.
#RIGHT_GAZE_Y_BIN ²	Average right-eye Y gaze position across all selected non-blink samples in the current bin.
#RIGHT_IA_*_SAMPLE_COUNT	This will create several columns – it will create one column for each interest area that is included in the report calculations and one column for all on-screen samples outside of all interest areas. The symbol * will become an interest area index for each column and 0 will indicate the column for all on-screen samples that don't belong to any other interest areas used for calculations. The value in each column (* will become a number indicating the interest area index) will be the total number of right-eye samples in the current bin that fall in that interest area. In the collapsed output report, this reports the total number of samples in the current bin index across all trials within that trial group.
#RIGHT_IA_*_SAMPLE_COUNT_%	The percentage of the total number of right-eye samples in the current bin that fall in the * (=index) interest area across the total number of samples according to the selected calculation option (i.e, all samples, valid samples including

	IA_0, or valid samples excluding IA_0). In the collapsed output report, this variable is calculated similarly based on the samples in the current bin index across all trials within that trial group. Please note IA_0 is the null interest area (for all on-screen samples that don't belong to any other interest areas used for calculations).
#RIGHT_OFF_SCREEN_SAMPLE_COUNT	The total number of right-eye samples in the current bin that fall outside of the display boundary (off screen). In the collapsed output report, this reports the total number of off-screen samples in the current bin index across all trials within that trial group.
#RIGHT_OFF_SCREEN_SAMPLE_COUNT %	The percentage of the total number of right-eye samples in the current bin that fall outside of the display boundary (off screen) across the total number of samples in the bin. In the collapsed output report, this variable is calculated similarly based on the samples in the current bin index across all trials within that trial group.
#RIGHT_PUPIL_SIZE_BIN ²	Average right-eye pupil size across all selected non-blink samples in the current bin.
SAMPLE_INTERVAL	The time interval between samples (4, 2, 1, or 0.5 milliseconds) for the trial, depending on the version of the tracker and setting used during data collection.
SAMPLING_RATE	The sampling rate of the eye tracking system (250, 500, 1000, or 2000 Hz) for the trial, depending on the version of the tracker and setting used during data collection.
TRIAL_INDEX	Sequential order of the trial in the recording.
TRIAL_LABEL	Label of the trial.
¶ TRIAL_START_TIME ³	The start time (in milliseconds since EyeLink tracker was activated; i.e., EDF file time) of the trial. If a valid reaction time is found in the trial, TRIAL_START_TIME will be set to the start time of the reaction time definition instead.

Those variables in the trial-based report marked with # will also be available in the collapsed report. The following variables are specific to the collapsed report.

Field	Contents
-------	----------

GROUP_INDEX	Order of the trial group in the viewing session.
GROUP_LABEL	Label of the trial group (encoding the value(s) of the grouping variable(s) for the current trial group).
GROUPING_VARIABLES	Label(s) of the grouping variable(s) for the current viewing session.
BIN_TRIAL_COUNT	Total number of trials that contribute data to the current bin.

Note ¹: Variables beginning with “AVERAGE_” are affected by the “Cyclopean Mode” setting in the Output/Analysis Preferences. If one eye has valid data whereas the other eye has missing data or is not recorded at all, the “AVERAGE_*” data in the report will be based on the good eye if the “Cyclopean Mode” is enabled. Otherwise, a missing value will be reported if no valid data is available from either eye. The “Cyclopean Mode” option has no effect when both eyes have valid or missing data. In addition to the analysis of binocular recording data, the “AVERAGE_*” variables will be useful for reports when the original EDF files were recorded with different eyes across participants (please make sure the “Cyclopean Mode” option in the Output/Analysis Preferences is turned on).

Note ²: The pupil size and gaze data change rapidly when a blink starts or ends. As a result, all of the samples in a blink saccade are removed in the average X, Y, and pupil size calculations.

Note ³: If a valid reaction time definition is found in a trial, the ¶ TRIAL_START_TIME variable will be set as the start of the reaction time definition; otherwise this will be set as the start of trial recording (see section 6.5.3 on discussion of three time periods used in Data Viewer). Please note that the data output in the Time Course Analysis report critically depends on the setting of the interest period filter (see section 6.4.2 or Figure 6-22) because consecutive time windows are created starting from the beginning of the currently-selected interest period.

6.12.8 Configuring the Time Course Analysis Report

The Time Course Analysis report provides the following configurable settings.

- 1) Bin Interval (in Milliseconds): This sets the size of consecutive time windows (by default, 20 milliseconds). The first time bin starts from the beginning of the currently-selected interest period.
- 2) Maximum Number of Bins: This sets the maximum possible time bins (by default, 2000) that will be created for the trial-based and collapsed reports. Fewer time bins will be actually created if trials are short. If set to -1, the maximum bin number will be based on the longest loaded trial in the currently-selected interest period.

- 3) Interest Areas Used for Calculations: This allows users to specify a set of interest areas to be used in the Time Course Analysis. If the edit box is left empty, four interest areas will be used with the IDs being 1, 2, 3, and 4. Users can provide customized interest area settings (IDs or labels) in the edit box, using a comma to delimit interest areas.
- i. If a single number is specified in the edit box, interest area IDs are mapped from 1 to the given number. Maximum number of interest areas supported is 10.
 - ii. If a series of elements (IDs or labels) are provided in the edit box separated by commas, the interest areas will be mapped according to the IDs or labels provided in sequence. Examples entries can be “1, 3, 4, 6” or “Target, 2nd_targ, comp_1, comp_2” (all of the characters are case-sensitive). Adding the IA_*_ID variable to the report will provide feedback on the ID and label of the interest areas used. The interest area IDs or labels that you type into the edit box have to map on to the actual IDs or labels used in your viewing session; otherwise, the time-course analysis will not be able to identify the interest areas required for the calculations.

Note – should a collapsed report be created to average data in the same time bin across all trials within each trial group, users must make sure the type of interest areas are consistent across all trials (e.g., interest area #1 refers to target across all trials, #2 refers to 2nd_targ, #3 refers to comp_1, etc.).

- 4) Calculation of the Proportions of Samples in Each Interest Area: In any given time window, the eye samples can be classified into the following categories (assuming that there are four valid interest areas): blink samples, off-screen samples, samples in Interest Area 1, samples in Interest Area 2, samples in Interest Area 3, samples in Interest Area 4, samples not falling into any interest areas (i.e., Null Interest Area 0), and other possible excluded samples. The last category consists of samples excluded due to certain data selection considerations discussed in the next section (e.g., users may just analyze the fixation data while ignoring all samples during saccades). For most time series analyses, the AVERAGE_IA_*_SAMPLE_COUNT, LEFT_IA_*_SAMPLE_COUNT, RIGHT_IA_*_SAMPLE_COUNT, and / or the corresponding *_% variables will be required.

The proportions of samples to each interest areas can be calculated in several ways.

- i. Across All Samples – this simply divides the number of samples in each interest area by the total number of samples in the time bin to get the percentage value.

- ii. Across All On-Screen Samples (i.e., Samples Assigned to All Interest Areas, including Null IA 0) - this divides the number of samples in each interest area by the sum of all samples made to each interest area, including the Null interest area 0 (i.e., IA_1_samples + IA_2_samples + IA_3_samples + IA_4_samples + IA_0_samples) to get the percentage value.
- iii. Across All Samples Assigned to Predefined Interest Areas Only (i.e., Excluding Samples to Null IA 0) - this divides the number of samples in each interest area by the sum of all samples made to each interest area ignoring the null interest area 0 (i.e., IA_1_samples + IA_2_samples + IA_3_samples + IA_4_samples) to get the percentage value.

For all of the above scenarios, the percentage values for the blink, off-screen, and other-exclusion samples are calculated based on the total samples in the time bin.

- 5) Data Selection: The EyeLink event parser groups individual eye samples into fixations, and saccades (a blink is contained within and is part of a saccade event). The Time-Course Analysis report allows users to choose which samples to be included in the analysis.
 - i. Include All Samples in Fixations and Saccades – this uses all of the samples in the time window.
 - ii. Exclude Samples during Saccades – this basically uses fixation samples only (samples during saccades and blinks are excluded from analysis).
 - iii. Exclude Samples during Saccade and Exclude Bins that Contain Non-Fixation Samples – this checks whether any samples in the time bin belong to a saccade or blink. If so, data from the entire time bin are excluded from the analysis.
- 6) Create a Separate Report, Collapsing Data Across All Trials in the Same Trial Group: This option, if checked, allows users to create a collapsed Time-Course Analysis report by averaging data in the same time window across all trials within each trial group. Please make sure trial grouping is performed before creating the report (by default, data will be averaged across all trials of the same participant as trials are grouped by Recording Sessions/EDF files).

6.13 Recording Event Sequence Data

Recording Event Sequence Data is a trimmed version of the EyeLink ASC file. For each trial, it outputs the selected events only and excludes the hidden events.

6.13.1 Creating Recording Event Sequence Data

To create a recording event sequence data report:

- 1) From the menus, choose:
Analysis → Reports → Recording Event Sequence Data.
- 2) In the “Please select the Recording Session(s)” dialog box, select the recording session(s) to be included in the Event Sequence Data report.

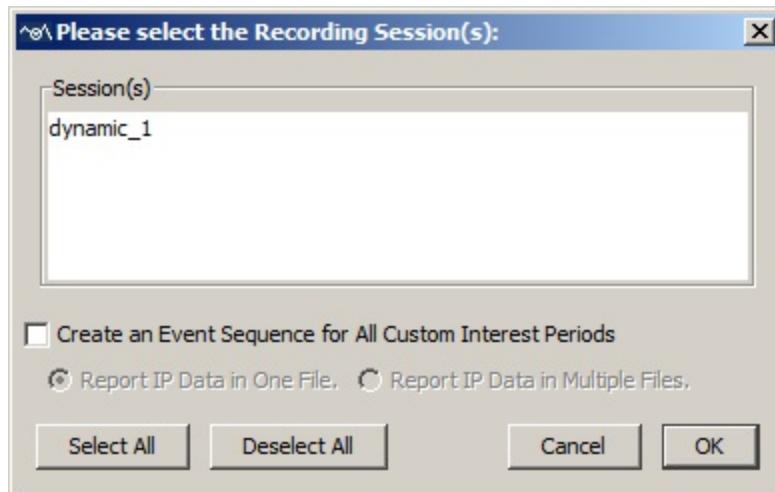


Figure 6-40. Creating a Recording Event Sequence Data Report

- 3) In the Save dialog box, browse to the directory in which you want to save the data. Type in the name for the report file in the File name text box.
- 4) Click “Save” button.

6.13.2 Formats of the Recording Event Sequence Data

The following output is a trimmed version of a sample recording event sequence report.

```
text
START 63636314
MSG    63595059 TRIALID PAGE1
BUTTON 63636283 5      true
MSG    63636309 DRIFTCORRECT LR LEFT at 512,384  OFFSET 0.55 deg.  14.7,-8.8 pix.
MSG    63636309 DRIFTCORRECT LR RIGHT at 320,40   OFFSET 0.15 deg.  -1.9,-4.7 pix.
MSG    63636312 RECCFG CR 250 2 1
MSG    63636312 GAZE_COORDS 0.00 0.00 1023.00 767.00
EFIX   R    63636322 63636732 414      515.0    389.5    1684.0  false  [72: dogs,]
MSG    63636446 DISPLAY ON
MSG    63636449 SYNCNTIME 3
BUTTON 63636709 5      false
ESACC  R    63636736 63636788 56      514.0    388.2    257.7    25.9    13.546693
      374.97235  false
EFIX   R    63636792 63636912 124     249.2    36.0     1368.0   false  [4: read]
ESACC  R    63636916 63636940 28      243.7    40.9     124.3    32.9    3.9540324
      215.27245  false
EFIX   R    63636944 63637164 224     115.4    40.3     1244.0   false  [1: Buck]
ESACC  R    63637168 63637192 28      116.7    42.6     197.1    43.5    2.6579807
      165.28857  false
EFIX   R    63637196 63637376 184     199.5    47.6     1363.0   false  [3: not]
ESACC  R    63637380 63637396 20      204.1    49.7     272.5    52.5    2.285299 168.15387
      false
EFIX   R    63637400 63637616 220     277.6    55.6     1537.0   false  [4: read]
ESACC  R    63637620 63637640 24      281.3    59.2     360.4    51.3    2.6691074
      179.91034  false
EFIX   R    63637644 63637840 200    364.0    57.4     1665.0   false  [6: newspapers,]
```

```

ESACC R 63637844 63637872 32 364.3 58.8 520.4 43.3 5.276039 284.2054 false
E FIX R 63637876 63638016 144 522.9 48.2 1772.0 false [6: newspapers, ]
ESACC R 63638020 63638044 28 523.9 47.8 637.2 36.6 3.7913043
233.63866 false
E FIX R 63638048 63638328 284 635.6 42.6 1848.0 false [9: would]
...
E FIX R 63658584 63658824 244 603.0 686.2 2092.0 false [141: four]
ESACC R 63658828 63658844 20 601.5 691.9 526.2 690.5 2.4371634
178.58197 false
E FIX R 63658848 63659080 236 520.3 695.5 2070.0 false [139: around]
ESACC R 63659084 63659104 24 519.7 698.5 616.3 687.9 3.133251 208.82329
false
E FIX R 63659108 63659372 268 621.5 691.2 2141.0 false [141: four]
ESACC R 63659376 63659400 28 620.2 694.5 737.4 700.3 3.723637 224.23352
false
E FIX R 63659404 63660120 720 746.9 711.4 2172.0 false [142: sides.]
BUTTON 63660033 5 true
MSG 63660033 ENDBUTTON 5
MSG 63660150 TRIAL_RESULT 5
END 63660135

```

6.13.2.1 Fixation Events

Fixation events are recorded in the format of:

- E FIX <eye> <stime> <etime> <dur> <axp> <ayp> <aps> <ma> <ia>

The values following E FIX (end fixation) report the eye used in the recording, the time of the first and last sample in the fixation, and computes the duration of the fixation in milliseconds. The average X and Y eye position (the type of position data is determined when the event was generated) and the average pupil size (area or diameter) are reported. In addition, the output contains information on whether the fixation has been manually adjusted <ma> and the ID and name of the interest area in which the current fixation falls <ia>.

6.13.2.2 Saccade Events

Saccade events are recorded in the format of:

- ESACC <eye> <stime> <etime> <dur> <sxp> <syp> <exp> <eyp> <ampl> <pv> <ma>

The values following ESACC (end saccade) report the eye used in the recording, the time of the first and last sample in the saccade, its duration in milliseconds. The X and Y eye position at the start and end of the saccade (<sxp>, <syp>, <exp>, <eyp>) are listed. The total visual angle covered in the saccade is reported by <ampl>, which can be divided by (<dur>/1000) to obtain the average velocity. Peak velocity is given by <pv>. In addition, the output contains information on whether the saccade has been manually adjusted <ma>.

6.13.2.3 Blink Events

Blink events are recorded in the format of:

- EBLINK <eye> <stime> <etime> <dur>

The values following EBLINK (end blink) report the eye used in the recording, the time of the first and last sample in the blink, and the duration of the blink in milliseconds.

6.13.2.4 Message Events

Messages are recorded in the format of:

- MSG <time> <message>

A message line contains the text of a time stamped message. The <message> text fills the entire line after the timestamp <time> and any blank space following it.

6.13.2.5 Button Events

Button events are recorded in the format of:

- BUTTON <time> <button #> <button_pressed>

Button lines report a change in state of buttons on a supported button box attached to the host computer. The <button #> reports which button has changed state. The <button_pressed> value will be true if the button has been pressed, false if it has been released.

6.13.2.6 Input Events

Input events are recorded in the format of:

- INPUT <time> <input value>

INPUT lines report a change in state of input channel (e.g., digital input port of the analog card, or the input channel on the Host PC parallel port) the tracker is monitoring. The <input value> reports the value of the input event received.

7 Protocol for EyeLink Data to Viewer Integration

Data Viewer can interpret a range of message commands contained within EyeLink data files that allow the software to automate some of the viewer configuration for a given data file or trial. Examples of these commands include defining the image or images over which gaze data is plotted, and specifying trial variables. These messages can be written by the display experiment to the EDF file using the API function that allows the writing of a custom message to the EDF file.

Messages that make up the EyeLink data file protocol for the viewer are not added to the Message list that is created for viewing within the viewer tool. Message commands are therefore invisible to the viewing windows, and are only interpreted by the Viewer during data file loading.

Important: Do not use space characters in any component of a viewer message command; the space character is used to tokenize and interpret all viewer messages. Instead of using a space character within a message token, use the _ character.

7.1 Defining the Start and End of a Trial

Data Viewer uses two special message commands to define what should be considered the start and end of a trial for the purpose of parsing the EyeLink data files.

7.1.1 Trial Start Message

Identifier (Default): TRIALID

Description:

This message defines the start of a trial. This is not the same as the start of recording message “START” that is logged when the trial recording begins. The viewer will not parse any messages, events, or samples that exist in the data file prior to this message. The command identifier can be changed in the data loading preference settings.

Format:

TRIALID <Trial ID value list>

Example:

MSG 3362269 TRIALID PIX1 Blurred

Note: If the trial start message is not found, or if no trial start message is defined for the viewing session, the START message is used to indicate the start of a trial for the Viewer.

7.1.2 Trial End Message

Identifier (Default): TRIAL_RESULT

Description:

This message defines the end of a trial. This is not the same as the end of recording message “END” that is logged when the trial recording ends. The viewer will not parse any messages, events, or samples that exist in the data file after this message. The command identifier can be changed in the data loading preference settings.

Format:

```
TRIAL_RESULT <possible trial result values>
```

Example:

```
MSG 3383842 TRIAL_RESULT 0
```

Note: If the trial end message is not found, or if no trial end message is defined for the viewing session, the END message is used by Data Viewer to indicate the end of a trial.

7.2 Pre-Trial Message Commands

The following message commands, if defined, MUST be sent to the EyeLink data file prior to the Trial Start message defined above (i.e., outside the scope of a trial as defined for Data Viewer). If they are sent during trial recording, these messages will not be interpreted.

7.2.1 Trial Variable Labels

Identifier (Default): TRIAL_VAR_LABELS

Description:

This message allows the definition of the labels to be used for trial variables within Data Viewer. The command identifier can be changed in the data loading preference settings.

Format:

```
TRIAL_VAR_LABELS <trial variable list>
```

Example:

```
MSG    3363553 TRIAL_VAR_LABELS TRIAL_VAR_1 TRIAL_VAR_2 TRIAL_VAR_3
```

7.2.2 Display Coordinates

Identifier: DISPLAY_COORDS or GAZE_COORDS

Description:

This message specifies the display coordinates to be used within Data Viewer. This message MUST be present for the viewer to function correctly.

Format:

```
DISPLAY_COORDS <left> <top> <right> <bottom>
```

Left, top, right, and bottom refer to the x-y coordinates of the top-left and bottom-right corners of display.

Example:

```
MSG    3325521 DISPLAY_COORDS 0 0 1279 1023
```

7.2.3 Trial Grouping

Identifier: V_TRIAL_GROUPING

Description:

The trial grouping message is used to group together trials that are in the same experimental condition, so that they can be manipulated (e.g., selecting, hiding, deleting, applying interest area templates) collectively. This message must be sent after TRIAL_VAR_LABELS message but before first trial start message in the EDF file.

Format:

```
V_TRIAL_GROUPING <trial variable list>
```

The trial grouping variable(s) must be a member of the variables listed in the TRIAL_VAR_LABELS; otherwise, this variable is ignored.

Example:

```
MSG    3363553 V_TRIAL_GROUPING TYPE DIRECTION
```

Note: Trial variables are space delimited. Trial variables that do not exist in the variable list for that trial (see section 7.2.1) are ignored.

7.3 Trial Message Commands

The following message commands MUST be specified within the scope of a trial, or the message commands will not be interpreted by Data Viewer.

IMPORTANT: All message commands within the trial scope must start with a !V directive, or the command will not be interpreted and will instead appear as a regular message in the visible message list.

Tip: In almost all instances, each of the following commands will be repeated for every trial of an EyeLink data file.

7.3.1 Trial Variable Values

Identifier (Default): TRIAL_VAR_DATA

Description:

This message specifies the list of trial variable values for the trial. The list of trial variable values must be in the same order as was specified in the TRIAL_VAR_LABELS command for the viewer to properly match the variable label with the variable value. The command identifier can be changed in the data loading preference settings.

Note: If this command is the same as the Trial Start Command (TRIALID), the values will still be extracted from the Trial Start Line; however a !V is not needed in the message.

Format:

```
!V TRIAL_VAR_DATA <trial_variable_list>
```

Example:

```
MSG 3363553 !V TRIAL_VAR_DATA value1 value2 value3
```

7.3.2 Single Trial Variable Message Token

Identifier (Default): TRIAL_VAR

Description:

This command lets users specify a trial variable and value for the given trial. One message should be sent for each trial condition variable and its corresponding value. If this command is used there is no need to use TRIAL_VAR_LABELS. The default command identifier can be changed in the data loading preference settings. Please note that the eye tracker can handle about 20 messages every 10 milliseconds. So be careful not to send too many messages too quickly if you have many trial condition messages to send. Add one millisecond delay between message lines if this is the case.

Format:

```
!V TRIAL_VAR <trial_var_label> <trial_var_value>
```

<trial_var_label> is the label for the variable being set. If the current Data Viewer session does not have this variable yet, it is created. <trial_var_value> defines the value to set for the variable for the given trial.

Example:

```
MSG 9350338 !V TRIAL_VAR trial 1
MSG 9350339 !V TRIAL_VAR condition gap
MSG 9350340 !V TRIAL_VAR direction Left
MSG 9350341 !V TRIAL_VAR gap_duration 200
MSG 9350342 !V TRIAL_VAR t_x 212
MSG 9350343 !V TRIAL_VAR t_y 384
```

7.3.3 Image Commands

Data Viewer supports a set of commands that display a default image on the overlay mode of the Trial View Window. All image commands use the IMGLOAD token, followed by a sub command.

7.3.3.1 Image Loading – Fill Full Screen

Identifier: FILL

Description:

This message specifies the image to be used as the background for the Spatial Overlay View of a trial within the viewer. The image is sized to fit the dimensions specified in the DISPLAY_COORDS command message. If images are specified with names only (without a relative or absolute path), Data Viewer will look for the image in the following order:

- 1) In the default image directory specified in the General Preferences settings.
- 2) In the directory the EyeLink data file is loaded from.
- 3) In the directory the viewer application is running from.

Format:

```
!V IMGLOAD FILL <relative_image_path>
```

Example:

```
MSG 3388468 !V IMGLOAD FILL Sac_blur.jpg
```

7.3.3.2 Image Loading – Top Left

Identifier: TOP_LEFT

Description:

This message specifies an image to be used as a segment of the Spatial Overlay View. The image size is not changed (unless width and height parameters are also specified) and will be positioned by using the x and y positions specified as the top left corner of the image. If images are specified with names only (without a relative or absolute path), Data Viewer will look for the image in the following order:

- 1) In the default image directory specified in the General Preferences settings.
- 2) In the directory the EyeLink data file is loaded from.
- 3) In the directory the viewer application is running from.

Format:

```
!V IMGLOAD TOP_LEFT <relative_image_path> <x_position>
<y_position> [width] [height]
```

Note: width and height are optional parameters

Example:

```
MSG 2740540 !V IMGLOAD TOP_LEFT fixations.gif 200 200
```

7.3.3.3 Image Loading – Centered

Identifier: CENTER

Description:

This message specifies an image to be used as a segment of the Spatial Overlay View of a trial within the viewer. The image size is not changed (unless width and height parameters are specified) and will be positioned centered on the x-y coordinate specified. If images are specified with names only (without a relative or absolute path), Data Viewer will look for the image in the following order:

- 1) In the default image directory specified in the General Preferences settings..
- 2) In the directory the EyeLink data file is loaded from.
- 3) In the directory the viewer application is running from.

Format:

```
!V IMGLOAD CENTER <relative_image_path> <x_position> <y_position>
[width] [height]
```

Note: width and height are optional parameters

Example:

```
MSG 2740540 !V IMGLOAD CENTER fixations.gif 200 200
```

7.3.4 Simple Drawing

Besides image loading, Data Viewer also supports a set of commands that draw simple graphics, such as lines, framed boxes, or filled boxes, as well as display clearing.

7.3.4.1 Clear Overlay View

Identifier: CLEAR

Description:

This command clears the overlay view to the color specified by the red, green, blue integer values specified in the command. Each RGB value should be an integer between 0 and 255.

Format:

```
!V CLEAR <red> <green> <blue>
```

Example:

```
MSG 2740540 !V CLEAR 255 255 255
```

This clears the display to white color.

7.3.4.2 Drawing a Line

Identifier: DRAWLINE**Description:**

This command draws a line with the color specified by the red, green, blue integer values specified in the command. Each RGB value should be an integer between 0 and 255.

Format:

```
!V DRAWLINE <red> <green> <blue> <x_start> <y_start> <x_end>  
<y_end>
```

<x_start>: x-coordinate of the starting point; <y_start>: y-coordinate of the starting point;
<x_end>: x-coordinate of the end position; <y_end>: y-coordinate of the ending position.

Example:

```
MSG 9441901 !V DRAWLINE 255 0 0 100 100 300 400
```

This draws a red line, connecting (100, 100) and (300, 400).

7.3.4.3 Drawing a Rectangle

Identifier: DRAWBOX**Description:**

This command draws an unfilled rectangle in the color specified by the red, green, blue integer values specified in the command. Each RGB value should be an integer between 0 and 255.

Format:

```
!V DRAWBOX <red> <green> <blue> <left> <top> <right> <bottom>
```

Note: Left, top, right, and bottom refer to the x-y coordinates of the top-left and bottom-right corners of rectangle.

Example:

```
MSG 9441901 !V DRAWBOX 0 255 0 200 300 400 500
```

This draws a green rectangle (frame), with the top-left corner at (200, 300) and the bottom-right corner at (400, 500).

7.3.4.4 Drawing a Filled Rectangle

Identifier: FILLBOX

Description:

This command draws a filled rectangle with the color specified by the red, green, blue integer values specified in the command. Each RGB value should be an integer between 0 and 255.

Format:

```
!V FILLBOX <red> <green> <blue> <left> <top> <right> <bottom>
```

Note: Left, top, right, and bottom refer to the x-y coordinates of the top-left and bottom-right corners of rectangle.

Example:

```
MSG 9441901 !V FILLBOX 0 0 255 400 500 500 600
```

This draws a rectangle, with the top-left corner at (400, 500) and the bottom-right corner at (500, 600). The rectangle is filled with the blue color.

7.3.4.5 Drawing a Fixation Point

Identifier: FIXPOINT

Description:

This command draws a fixation point at a specified position.

Format:

```
!V FIXPOINT <target_red> <target_green> <target_blue> <erase_red>
<erase_green> <erase_blue> <x> <y> <outer_diameter>
<inner_diameter>
```

Note: The RGB values for the fixation point drawing color is specified by the <target_red> <target_green> <target_blue> whereas the color of the fixation center is specified by <erase_red> <erase_green> <erase_blue>. The fixation point is drawn at the screen coordinate specified by <x> and <y>. The <outer_diameter> and <inner_diameter> specify the diameters of the drawing circles.

Example:

```
MSG 9441901 !V FIXPOINT 0 0 0 255 255 255 511 383 18 4
```

This draws a fixation point at (511, 383), with a diameter of 18 pixels for the outer ring and 4 pixels for the inner ring. The fixation point is drawn in black and its center is erased with white.

7.3.4.6 Draw List File

Identifier: DRAW_LIST**Description:**

When a large number of simple drawings have to be made, it is easier to first record all of the simple drawings in a draw list file. Data Viewer reads in the drawing commands from the pre-recorded draw list file and re-creates the display drawing. In a draw list file (.dlf), each line represents one simple drawing or an image loading command written in the same format as mentioned above except that "!V" directive is not necessary.

Format:

```
!V DRAW_LIST <relative path>
```

Example:

```
Example: MSG 262495 !V DRAW_LIST BER\s1106.dlf
```

The content of the file being:

```
CLEAR 255 255 255
IMGLOAD TOP_LEFT BER\color.bmp 772 644 33 33
IMGLOAD TOP_LEFT BER\shape.bmp 772 314 33 33
IMGLOAD TOP_LEFT BER\orient.bmp 222 424 33 33
IMGLOAD TOP_LEFT BER\color.bmp 552 94 33 33
```

This first clears the display and then loads four small bitmap images.

7.3.5 Interest Area Commands

Data Viewer supports a set of interest area commands that inform the software which interest areas to create by default for a given trial. Trials that have interest area commands specified in the data file have a custom interest area set created when the data is loaded containing the specified interest areas.

All interest area commands start with the IAREA token and are followed by a one word sub command.

7.3.5.1 Rectangular Interest Area

Identifier (Default): RECTANGLE

Description:

This message specifies the attributes of a rectangular interest area for the trial. Each trial can have a set of such rectangular interest areas.

Format:

```
!V IAREA RECTANGLE <id> <left> <top> <right> <bottom> [label  
string]
```

Note: The label string parameter is optional.

Example:

```
MSG 2740540 !V IAREA RECTANGLE 1 547 410 585 449 square
```

7.3.5.2 Elliptical Interest Area

Identifier (Default): ELLIPSE

Description:

This message specifies the attributes of an elliptical interest area for the trial. Each trial can have a set of such elliptical interest areas.

Format:

```
!V IAREA ELLIPSE <id> <left> <top> <right> <bottom> [label string]
```

Note: The label string parameter is optional. Left, top, right, and bottom refer to the x-y coordinates of the top-left and bottom-right corners of the bounding rectangle.

Example:

```
MSG 2740540 !V IAREA ELLIPSE 2 647 310 685 349 circle
```

7.3.5.3 Freehand Interest Area

Identifier (Default): FREEHAND

Description:

This message specifies the attributes of a freehand interest area for the trial. Each trial can have a set of such freehand interest areas.

Format:

```
!V IAREA FREEHAND <id> < $x_1, y_1$ > < $x_2, y_2$ > ... < $x_n, y_n$ > [label string]
```

Note: The label string parameter is optional. x_n, y_n refers to the x, y coordinates of a point. The x, y coordinates of each point are separated by a comma.

Example:

```
MSG 2740540 !V IAREA FREEHAND 3 512,284 612,384 512,484 412,384 diamond
```

7.3.5.4 Interest Area Set

Identifier (Default): FILE

Description:

When a large number of interest areas have to be specified (such as in reading research), it is easier to first write all the interest area information into a text file and Data Viewer can then locate and import this interest-area set file. The `!V IAREA FILE` serves this purpose. In an interest-area file, each line represents one interest area, recorded in the format of “RECTANGLE id left top right bottom [label]” for a rectangular interest area, “ELLIPSE id left top right bottom [label]” for

an elliptical interest area, and “FREEHAND id x_1, y_1 $x_2, y_2 \dots x_n, y_n$ [label]” for a freehand interest area.

Format:

```
!V IAREA FILE <relative_file_path>
```

Example:

```
MSG 2740540 !V IAREA FILE segments\example.ias
```

The following are some example interest areas contained in an .ias file.

RECTANGLE	1	51	29	146	82	Buck
RECTANGLE	2	146	29	195	82	did
RECTANGLE	3	195	29	244	82	not
RECTANGLE	4	244	29	311	82	read
RECTANGLE	5	311	29	360	82	the
RECTANGLE	6	360	29	536	82	newspapers,

7.3.6 Target Position Commands

For experiments in which a moving resource is used, users may need to keep track of the position of the resource. Data Viewer allows users to calculate the position, velocity, and acceleration data of the target for each individual sample in the sample output report. With such messages, position, velocity, and acceleration can also be displayed in the Temporal Graph View.

Identifier (Default): TARGET_POS

Description:

This message specifies the position and visibility of the targets at the specific message time. The command identifier can be changed in the data loading preference settings. A semicolon is required if you are supplying two target positions.

Format:

```
!V TARGET_POS <Target1 Key> <(target1 x, target1 y)> <target 1  
visibility> <target 1 step>; <Target2 Key> <(target2 x, target2  
y)> <target 2 visibility> <target 2 step>
```

Where <Target1 Key> and <Target2 Key>: the tokens to extract the position(s) of target(s);
<(target1 x, target1 y)> and <(target2 x, target2 y)>: the position(s) of the targets. The coordinates must be enclosed in a pair of brackets;
<target 1 visibility> and <target 2 visibility>: if 1, the targets are visible; if 0, the targets are hidden;
<target 1 step> and <target 2 step>: if 1, the position of the target will be in steps; if 0, the position of the target is interpolated across samples.

Example:

```
MSG 9071000 !V TARGET_POS TARG1 (351, 278) 1 0; TARG2 (590, 134) 1 0
```

Note: Users can use any token word to indicate the target ID. The "key" property of the Temporal Graph View preference settings is set to blank by default so that various token words can be used. If two targets are involved and if the order of the two targets is important, set that field to the token strings used in the target position command string.

7.4 Reaction Time Definitions

To obtain an accurate reaction time (RT) measure, the EyeLink Data Viewer relies on a set of reaction time definitions to parse the start and end events for RT calculation. The reaction time definition command messages inform the Viewer of the RT start message, the type of RT end events (fixation, saccade, message, or button), the parameters of the end event, as well as the conditions to which the RT definition is applied. Reaction time definition commands can be provided in two ways. Users can employ a pre-trial (condition-based) command message to specify an RT definition for each of the experimental conditions. All pre-trial reaction time commands start with the V_RT token and are followed by a one word subcommand, indicating the type of RT end event (BUTTON, MESSAGE, FIXATION, or SACCADE). Alternatively, users can supply a custom reaction time definition specifically for each trial. All custom trial-specific reaction time commands start with the !V V_CRT token and are followed by a one word subcommand. Users can also choose to create the reaction time definitions right in the viewing session after the data is collected.

Important: When an EyeLink Data File is loaded into the Viewer, existing Reaction Time Definitions for the Viewing Session will be applied to the new data file just imported, and override custom RT definitions if there are any in the newly imported EDF files.

7.4.1 Button Events

Identifier: BUTTON

Description:

This will treat a particular button press/release as the reaction time end event.

Pre-Trial Message Command Format:

```
V_RT  BUTTON  <rt_start_msg>  <button_id>  <state>  [CONDITION LABEL 1]
      [condition value 1]  [CONDITION LABEL 2]  [condition value 2]
```

Trial-specific Message Command Format:

```
!V  V_CRT  BUTTON  <rt_start_msg>  <button_id>  <state>
```

Note: Button_id refers to the intended button ID (from 1 to 8, use 0 for any button event). Button state could be 0 (button release) or 1 (button press). Condition labels and their values are not required for the trial-specific message commands and are optional for the pre-trial message command (if not specified, the RT definition is applied to all conditions). In case both a condition-based pre-trial message command and a custom trial-specific message command are applicable for one trial, the trial-specific command will override the more general one.

Example:

```
MSG 329381 V_RT BUTTON SYNCTIME 5 1 TYPE normal
```

In this example, the end event for RT calculation is pressing button 5. This RT definition is applicable to the condition in which the value of the variable TYPE is “normal”.

7.4.2 Fixation Events

Identifier: FIXATION

Description:

This will treat the appearance of a specific fixation as the RT end event. Users can specify the parameters of the fixation end event: the minimum fixation duration (in milliseconds) required, the xy coordinates for the region center, as well as the diameter of the fixation region.

Pre-Trial Message Command Format:

```
V_RT FIXATION <rt_start_msg> <fixation_duration> <x> <y>
    <diameter> [CONDITION LABEL 1] [condition value 1] [CONDITION
    LABEL 2] [condition value 2] ...
```

Trial-specific Message Command Format:

```
!V V_CRT FIXATION <rt_start_msg> <fixation_duration> <x> <y>
    <diameter>
```

Note: If the location information of the target fixation is not important, set the values of x , y , and diameter as -1. Condition labels and their values are not required for the trial-specific message command and are optional for the pre-trial message command (if not specified, the RT definition is applied to all conditions).

Example:

```
MSG 329381 V_RT FIXATION SYNCNTIME 500 -1 -1 -1
```

In this example, the RT end event is the occurrence of the first fixation with a minimum duration of 500 milliseconds whereas the location information of the fixation is not important.

7.4.3 Saccade Events

Identifier: SACCADe

Description:

This will treat the appearance of a specific saccade as the RT end event. Users can specify the parameters of the saccade end event: the minimum saccadic amplitude (in degrees of visual angle) required, the xy coordinates for the region center, as well as the diameter of the fixation region.

Pre-Trial Message Command Format:

```
V_RT SACCADe <rt_start_msg> <saccadic_amplitude> <x> <y> <diameter>
    [CONDITION LABEL 1] [condition value 1] [CONDITION LABEL 2]
    [condition value 2] ...
```

Trial-specific Message Command Format:

```
!V V_CRT SACCAYE <rt_start_msg> <saccadic_amplitude> <x> <y>
<diameter>
```

Note: If the location information of the saccade is not important, set the values of x , y , and diameter as -1. Condition labels and their values are not required for the trial-specific message command and are optional for the pre-trial message command (if not specified, the RT definition is applied to all conditions).

Example:

```
MSG 329381 V_RT SACCAYE SYNCTIME 5.0 300 400 100 TYPE Normal
```

In this example, the RT end event is the occurrence of the first saccade with a minimum amplitude of 5.0 degrees of visual angle. The saccade must fall within 50 pixels (the radius given a diameter of 100) from the region center (300, 400).

7.4.4 Message Events

Identifier: MESSAGE**Description:**

This will treat the first occurrence of a matching message as the end event for reaction time calculation.

Pre-Trial Message Command Format:

```
V_RT MESSAGE <rt_start_msg> <rt_end_msg> [CONDITION LABEL 1]
[condition value 1] [CONDITION LABEL 2] [condition value 2] ...
```

Trial-specific Message Command Format:

```
!V V_CRT MESSAGE <rt_start_msg> <rt_end_msg>
```

Note: Condition labels and their values are not required for the trial-specific message command and are optional for the pre-trial message command (if not specified, the RT definition is applied to all conditions).

Example:

```
MSG 329381 V_RT MESSAGE SYNCTIME END_RT
```

7.4.5 Reaction Time Definition Set

Identifier: FILE

Description:

When a large number of RT definitions have to be specified, it is easier to first record all RT definitions into a file and later on the Data Viewer can read the RT definition file with the V_RT FILE command. In a reaction-time definition file, each line represents one RT definition, which is written in the same format as the pre-trial message command for each respective type of RT end event, except that in this case V_RT token is not necessary.

Pre-Trial Message Command Format:

```
V_RT FILE <relative path>
```

Example:

```
MSG 329381 V_RT FILE rt\default.rts
```

The following is the content of an example defaults.rts file.

```
BUTTON SYNCTIME 2 1  
MESSAGE SYNCTIME ENDBUTTON
```

7.5 Changes in the Sample Experiments

The preceding sections list the special messages and commands that can be sent to the EDF file to enable the EyeLink Data Viewer to extract information in a more efficient way. The current section provides an overview of the changes made in the sample experiment templates. Please refer to the “Programming EyeLink Experiments in Windows Version 2.0” manual for the description of individual templates.

7.5.1 “Simple” Template

Two EyeLink Data Viewer commands have been introduced in the “Simple” template: “TRIAL_VAR_LABELS” for the definition of the labels to be used for trial condition variables within the viewer and “TRIAL_VAR_DATA” for the assignment of condition values for each trial. All these changes, listed in the following table, were made in the w32_simple_trials.c file of the template.

Data Viewer Functionality	Message Commands
Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS TRIAL WORD");
Trial Variable Values	eyemsg_printf("!V TRIAL_VAR_DATA %s", trial word[num-1]);

7.5.2 “Text” Template

Along with the “TRIAL_VAR_LABELS” and “TRIAL_VAR_DATA” commands, the “Text” template also uses “IMGLOAD FILL” to load a single image and “IAREA FILE” to import a file containing interest areas for the trial. All of these changes, listed in the following table, were made in the w32_text_trials.c file of the template.

Data Viewer Functionality	Message Commands
Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS PAGE");
Trial Variable Values	eyemsg_printf("!V TRIAL_VAR_DATA %d", num);
Images	eyemsg_printf("!V IMGLOAD FILL Images/%s", image_fn);
Interest Areas	eyemsg_printf("!V IAREA FILE Segments/%s", seg_fn);

7.5.3 “Picture” Template

One additional feature of the “Picture” template is the demonstration of another approach to load images and to specify interest areas for the trial. The third trial of the template loads individual images (IMGLOAD TOP_LEFT) to create a composite image in Data Viewer and reads individual rectangular interest areas directly (“IAREA RECTANGLE”). All these changes, listed in the following table, were made in the w32_picture_trials.c file of the template.

Data Viewer Functionality	Message Commands
Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS TYPE");
Trial Variable Values	eyemsg_printf("!V TRIAL_VAR_DATA %s", imgname[num-1]);
Images	
“Normal” image	eyemsg_printf("!V IMGLOAD FILL images/sacrmeto.jpg");
“Blurred” image	eyemsg_printf("!V IMGLOAD FILL images/sac_blur.jpg");
“Composite” image	eyemsg_printf("!V IMGLOAD TOP_LEFT %s %d %d %d %d", small_images[i], points[i].x, points[i].y, SCRWIDTH/2, SCRHEIGHT/2);
Interest Areas	

“Composite” image	<code>eyemsg_printf("!V IAREA RECTANGLE %d %d %d %d %d %s", i+1, points[i].x, points[i].y, points[i].x + SCRWIDTH/2, points[i].y + SCRHEIGHT/2, small_images[i]);</code>
-------------------	--

7.5.4 “EyeData” Template

The following table lists all of the changes made to the w32_data_trials.c file of the “EyeData” template.

Data Viewer Functionality	Message Commands
Trial Variable Labels	<code>eyemsg_printf("TRIAL_VAR_LABELS CONDITION");</code>
Trial Variable Values	<code>eyemsg_printf("!V TRIAL_VAR_DATA Playback");</code>
Images	<code>eyemsg_printf("!V IMGLOAD FILL images/grid.png");</code>
Interest Areas	<code>eyemsg_printf("!V IAREA FILE segments/grid.ias");</code>

7.5.5 “GCWindow” Template

The following table lists all of the changes made to the w32_gcwindow_trials.c file of the “GCWindow” template.

Data Viewer Functionality	Message Commands
Trial Variable Labels	<code>eyemsg_printf("TRIAL_VAR_LABELS TYPE CENTRAL PERIPHERAL");</code>
Trial Variable Values	
Trial 1	<code>eyemsg_printf("!V TRIAL_VAR_DATA TEXT TEXT MASK");</code>
Trial 2	<code>eyemsg_printf("!V TRIAL_VAR_DATA TEXT MASK TEXT");</code>
Trial 3	<code>eyemsg_printf("!V TRIAL_VAR_DATA IMAGE IMAGE MASK");</code>
Trial 4	<code>eyemsg_printf("!V TRIAL_VAR_DATA IMAGE MASK IMAGE");</code>
Trial 5	<code>eyemsg_printf("!V TRIAL_VAR_DATA IMAGE IMAGE BLURRED");</code>
Images	
Trials 1 & 2	<code>eyemsg_printf("!V IMGLOAD FILL images/text.png");</code>
Trials 3, 4, & 5	<code>eyemsg_printf("!V IMGLOAD FILL images/sacrmeto.jpg");</code>
Interest Areas	
Trials 1 & 2	<code>eyemsg_printf("!V IAREA FILE segments/text.ias");</code>

7.5.6 “Control” Template

The following messages and commands have been added to the w32_control_trials.c file of the “Control” template.

Data Viewer Functionality	Message Commands
Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS CONDITION");

The following messages and commands have been added to the w32_control_trial.c file of the “Control” template.

Data Viewer Functionality	Message Commands
Trial Variable Values	eyemsg_printf("!V TRIAL_VAR_DATA GAZECTRL");
Images	eyemsg_printf("!V IMGLOAD FILL images/grid.png");
Interest Areas	eyemsg_printf("!V IAREA FILE segments/grid.ias");

7.5.7 “Dynamic” Template

One important feature introduced in the “Dynamic” template is the addition of custom reaction time definition (!V V_CRT) for the saccade trials. Reaction time is defined as the interval between the onset of the target (“SYNCTIME” message) and the occurrence of the first saccade, with a minimum amplitude of 2.0°, that falls within 25 pixels from the saccade target (*goal_x*, *goal_y*). The following table lists all of the messages and commands that have been added in the w32_data_trials.c file of the “Dynamic” template.

Data Viewer Functionality	Message Commands
Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS TRIAL TYPE DIRECTION");
Trial Variable Values	eyemsg_printf("!V TRIAL_VAR_DATA %d %s %s", num, trial_labels[0][num-1], trial_labels[1][num-1]);
Reaction Time Definitions	
Trials 3-8	eyemsg_printf("!V V_CRT SACCade SYNCTIME 2.0 %d %d 50", goal_x, goal_y);

7.5.8 “Comm_simple” Template

Similar to the “Simple” template, “TRIAL_VAR_LABELS” and “TRIAL_VAR_DATA” commands were added to the w32_simple_trials.c file of the template (see the Table).

Data Viewer Functionality	Message Commands
Trial Variable Labels	eyemsg_printf("TRIAL_VAR_LABELS TRIAL WORD");
Trial Variable Values	eyemsg_printf("!V TRIAL_VAR_DATA %s", trial_word[num-1]);

7.5.9 Other Templates

Since the “Broadcast” and “Comm_listener” templates do not produce EyeLink data files, no change has been made in those templates to support Data Viewer analysis.

8 Preference Settings

Many properties of Data Viewer can be configured by users from the Preference tab of the Inspector Window. These include everything from the default colors used, to which elements of an EDF file are loaded. All the changes can be saved, allowing the changed preference settings to be applied to subsequent viewing sessions.

Any preferences setting can be edited by clicking on the value cell and changing the value. To make the changed preference settings persist over future sessions, users can click the right mouse button and select "Save Properties as Defaults". Data Viewer also supports exporting and importing of preference settings across viewing sessions. Exporting the preference settings into a property file can be done by right-clicking and selecting "Export Properties". To use the saved preference settings for a given session, right click and select "Import Properties".

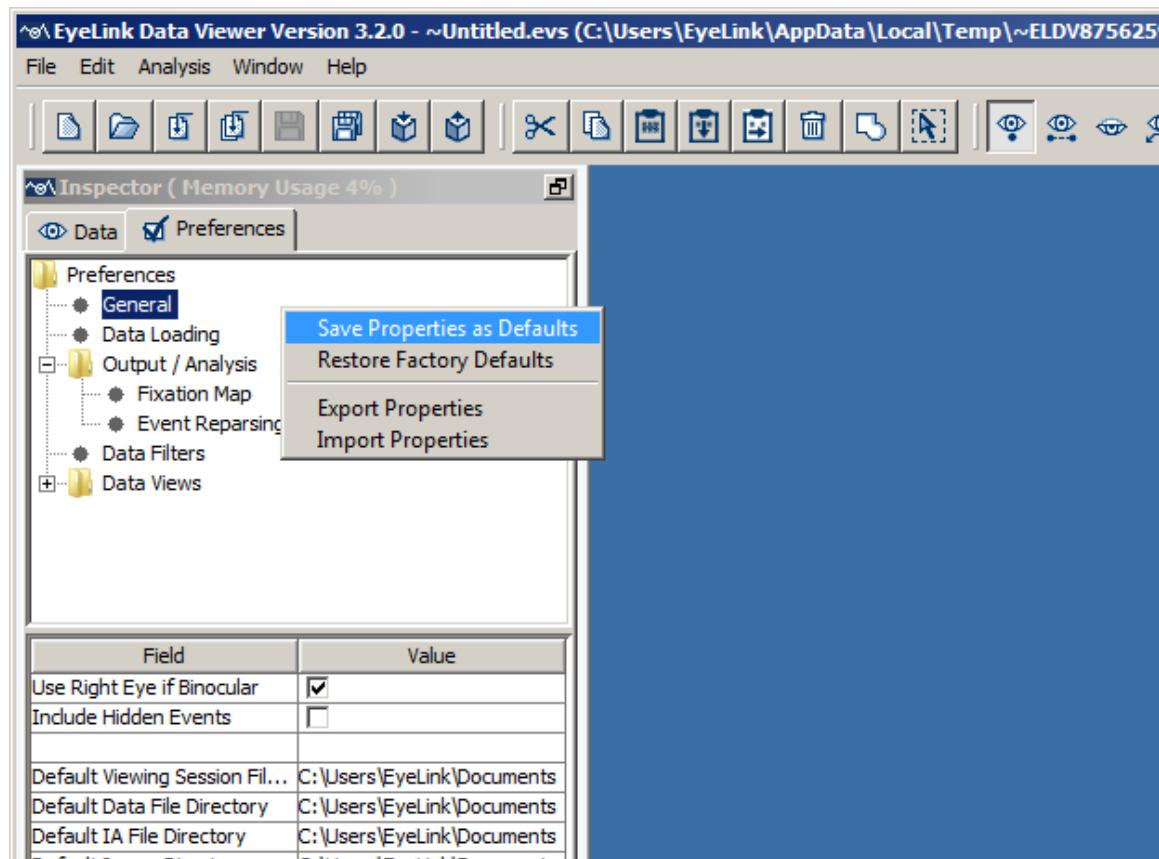
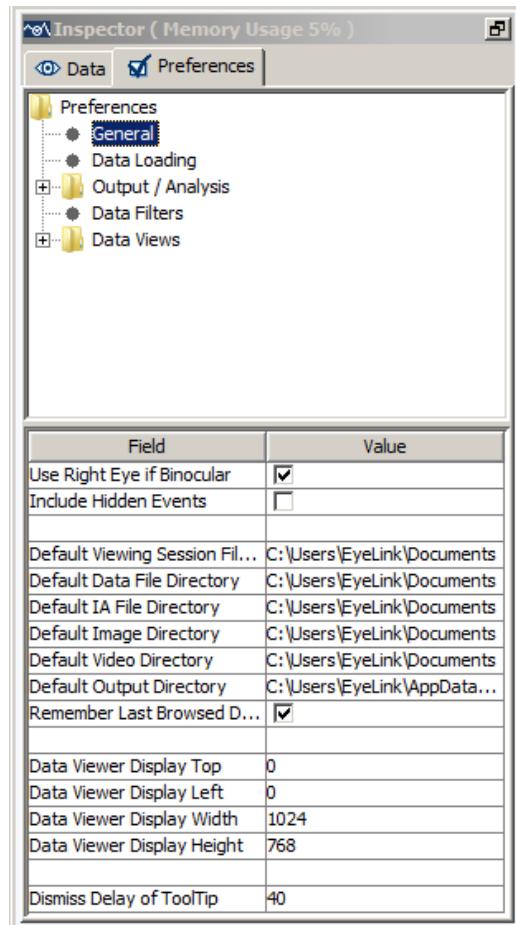


Figure 8-1. Saving Properties as Defaults.

8.1 General Preferences

The General Preferences setting covers the following elements:



Use Right Eye if Binocular: For a binocular recording, which eye's data is to be displayed and output in any reports (right eye if checked; left eye if unchecked);

Include Hidden Events: Whether or not to include hidden events in the trial views and output reports. Hidden events falling outside of the currently selected interest period are drawn in dashed-lines. Checking this option will affect report variables related to the reporting of individual events (e.g., fixation, saccade, message), index of the event in the trial (e.g., CURRENT_FIX_INDEX), as well as the total event count in the trial (e.g., FIXATION_COUNT).

Default Viewing Session File Directory, Default Data File Directory, Default IA File

Directory, Default Image Directory, Default Video Directory, and Default

Output Directory: Set default directories for accessing viewing session files, data file loading, interest area, images/video loading/saving, and data output (analysis report, fixation map, moving and trial image saving, etc.). These settings can be changed by clicking on the current values and choosing a default directory from a Set window. Note, changes to these preference settings only take effect on files loaded after the change. Versions 2.1 and above support selection of multiple directories for the "Default Image Directory" and "Default Video Directory".

Remember Last Browsed Directory: If enabled, Data Viewer - when Viewing Session File Directory, Data File Directory, IA File Directory and Output Directory are needed - will use (and automatically update) the last browsed directory instead of the default ones.

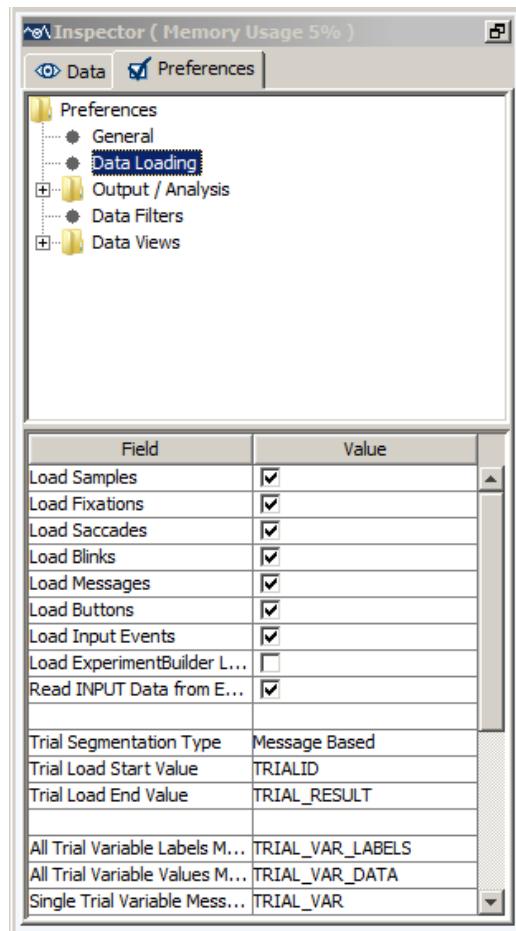
Data Viewer Display Left and Data Viewer Display Top: Set the X and Y coordinate of the top-left corner for Data Viewer to run properly if DISPLAY_COORDS/GAZE_COORDS message is not found in the EDF file; otherwise, these preferences are ignored.

Data Viewer Display Width and Data Viewer Display Height: Set the display width and height to enable Data Viewer to run properly if DISPLAY_COORDS/GAZE_COORDS message is not found in the EDF file; otherwise, these preferences are ignored.

Dismiss Delay of Tooltip: This sets how long (in seconds) a tooltip (description of a property or preference settings when you hover the mouse pointer over the item without clicking on it) will be displayed.

8.2 Data Loading Preferences

Data loading preference settings consist of the following parameters:



Load Samples, Load Fixations, Load Saccades, Load Blinks, Load Messages, Load Buttons, Load Input Events:

Allow the loading of samples, fixations, saccades, blinks, messages, and buttons from the EDF files. By default samples and all events are loaded.

Load Experiment Builder Log Messages:

If enabled, Data Viewer will import Experiment Builder generated log messages into the viewing session (if the log file exists in the same folder as the EDF file).

Read INPUT Data from Events: This determines whether the INPUT events in the viewing session are loaded from the events or from the sample stream in the EDF file. This option is ignored if the EDF file contains the INPUT data in the sample stream only, or in the event stream only.

Trial Segmentation Type: This allows users to define the start and end of a trial in Data Viewer based on the supplied message or input values. For each trial, all events/samples before the start message/input event or after the end message/input event will not be loaded. By default, Data Viewer treats "TRIALID" as the start message for data loading and "TRIAL_RESULT" as the end message. Users can supply their own messages to split a continuous long recording into shorter trial segments. An alternative to the default Message Based trial segmentation is to use Input data, in which case users should supply input values to mark trial start and trial end.

Trial Load Start Value: This message/input value is used to define the start of a trial segment. A new trial segment will be created upon the START of the recording if the

Trial Load Start Value is not supplied, missing, or found after the start of the recording segment.

Trial Load End Value: This message/input value is used to define the end of a trial segment. This field is optional. If the end value is not supplied or found, Data Viewer will define the end of trial using the next start message/input value or the END event of the trial recording, whichever comes first.

All Trial Variable Labels Message and **All Trial Variable Values Message:** The former allows the definition of labels to be used for trial variables within the viewer and the latter specifies the list of trial variable values for the trial. By default, the trial variable labels message is set as “TRIAL_VAR_LABELS” and the trial variable values message is set as “TRIAL_VAR_DATA”.

Single Trial Variable Message: This command lets users specify a trial variable and value for the given trial. Send one message for each pair of trial condition variable and its corresponding value. This means that there is really no need to use the TRIAL_VAR_LABELS command when using the TRIAL_VAR command. Default command token is "TRIAL_VAR".

Target Position String: String used to specify the position of the targets at the specific message time.

Collapse Identical Interest Areas with Different Time Stamps: If checked (the default setting), all interest areas with identical coordinates and label will be merged together (and thus treated as one single interest area). If unchecked, interest areas are organized based on the time stamps and therefore interest areas with identical coordinates and label but different time stamps are treated as separate items. In general, the former approach is typically used if the data analysis is done on the whole trial recording whereas the latter setting is used if the data analyses are done based on individual interest periods.

Prompt for the Interest Area Import: When saving an interest area set into a file, this option will make the interest area set available to the current viewing session so that you don't have to re-import the saved interest area set file.

Exclude Message String: Any messages (within the scope of a trial as defined by the Trial Load Start Message and Trial Load End Message) containing the string will be ignored by the Viewer. Add a “;” to separate multiple message strings.

Enable SceneLink Gaze Mapping: If checked, allows users to load EDF file with mapped gaze data to scene video coordinates.

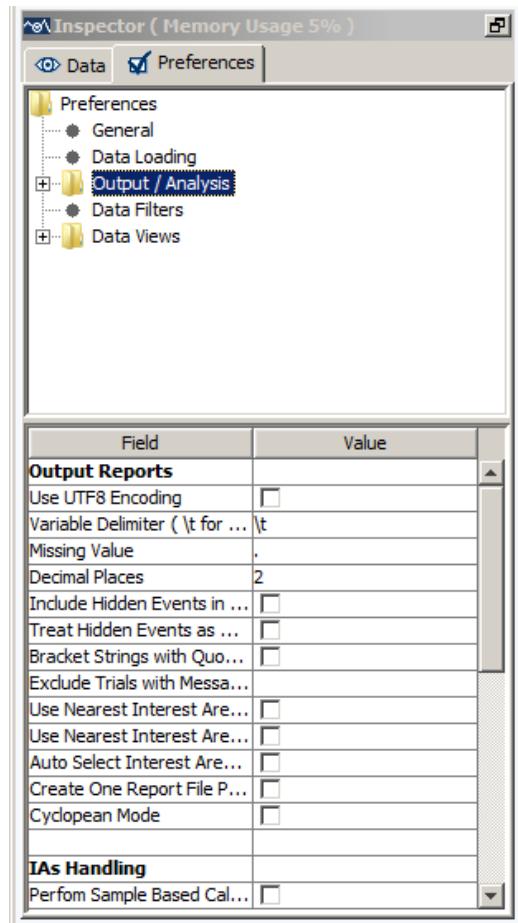
Generate SceneLink Frame Message: If checked, allows users to generate frame number messages when loading file. The frame number message will only be written if a lookup table has been created for synchronized playback of eye movement data over the scene video (see section 5.1 of the "EyeLink II Scene Camera User Manual").

Default Encoding: This option is used in case the interest area files are saved in a different encoding type. Leave this to Default unless you know the exact encoding of the interest area files to import.

Note: Users have to save the preferences and reload the data file before the changes in the above preference settings take effect.

8.3 Output / Analysis

The Output / Analysis preferences settings consist of the following elements:



Output Reports

Use UTF8 Encoding: By default (unchecked), the saved report output file and interest area file will be a plain text file in ANSI encoding. If checked, the saved tab-delimited text file will be in UTF-8 encoding and the .XLS file will be in Unicode Text to better support non-ASCII characters in the output reports.

Variable Delimiter (\t for Tab):

Specifies the delimiter string for separating columns in the output file.

Missing Value: Replaces variables with missing values with a string specified here.

Decimal Places: Specifies the number of digits to appear after the decimal point.

Data Viewer uses the default decimal symbol set in the operating system. On Mac, to change the decimal symbol to a point, you need to change the "Preferred language" to one that uses decimal point, rather than decimal coma. On windows, you need to change the "Formats" property in Region and Language settings to a language that uses decimal point (e.g., English).

Include Hidden Events in Relative Variables: Allows the inclusion of hidden events in the relative event variables [i.e., those variables beginning with PREVIOUS_FIX_, NEXT_FIX_, PREVIOUS_SAC_, NEXT_SAC_, LEFT/RIGHT_FIX_INDEX, and LEFT/RIGHT_SACCADE_INDEX].

Treat Hidden Events as Missing Values: If hidden events in the relative variables are included in the analysis, users can further decide whether or not to

treat these events as missing data.

Bracket Strings with Quotes: Adds a pair of quotation marks for string variables.

Exclude Trials with Message String: Excludes trials containing the specified message string. This string should be one message or part of a message within the scope of a trial that uniquely defines that subset of trials to be excluded.

Use Nearest Interest Area for Outlier Fixations: If the current fixation is not in any defined interest areas, assigns the nearest interest area (the one with lowest interest area ID if multiple interest areas are found) as the current interest area for the fixation. Please note that this option is applicable to static interest areas only.

Use Nearest Interest Area for Outlier Samples in Sample Report: When creating a sample report, if the current sample is not in any defined interest areas, use the nearest interest area (the one with lowest interest area ID if multiple interest areas are found) as the current interest area for the sample.

Auto Select Interest Area Set for Trial: If true, trial interest area set association is done automatically by using the "Image Name mapping" attribute of interest area set templates in the Data Viewer session. The default is false.

Create One Report File Per EDF File: If checked, this will create one report file for each of the EDF files loaded into the viewing session.

Cyclopean Mode: If one eye has valid data whereas the other eye has a missing value or is not recorded at all, the "AVERAGE_%" data in the Sample Report and Time-Course (Binning) Analysis Report will be based on the good eye if the "Cyclopean Mode" option is turned on. If this is not enabled, then a missing value is reported if no valid data are available from either eye. The option has no effect when both eyes have valid or missing data.

IAs Handling

Perform Sample Based Calculation: If selected, samples within fixations (if loaded) are used for interest area matching and report calculation. If disabled (default option), the average x, y position of the fixation is used. This option makes a difference for those data sets where fixations have a large spatial spread (e.g., smooth pursuit).

Include Fixation in Single IA: This is applicable when a fixation lands in multiple overlapping interest areas. When this option is enabled, the fixation is assigned only to the winner interest area (for static interest areas, the winner IA is the

one with the lower ID; for dynamic interest areas, the winner is decided based on the setting "Assign Fixations to Dynamic IA Ordered by Relative Duration"). The assigned interest area gets the full length of the fixation when calculating dwell times. If this option is disabled (default setting), the fixation can be assigned to multiple overlapping interest areas, and the effective duration (the total amount of time that fixation and instances of the same IA intersect) for each of the interest areas is used for the calculation of dwell times.

Assign Fixations to Dynamic IA Ordered by Relative Duration: Some variables (e.g., "CURRENT_FIX_INTEREST_AREA_INDEX" in the Fixation Report) require a fixation to be assigned to a single interest area. If a fixation lands in multiple dynamic interest areas, the assignment by default will be based on the duration of fixation in the interest areas - the interest area in which the fixation stayed the longest gets the fixation assignment. Unchecking this option will do the fixation assignment by interest area index (so the fixation will be assigned to the IA with the lowest index).

Allow Interpolation: If selected, any dynamic interest area that has its interpolation property enabled will interpolate spatially across its duration to the next instance's position and shape (if it's of the same shape type).

Interpolation Interval in ms: Sets how often dynamic interest areas are interpolated.

Identify First/Last Saccade Based on First/Last Fixation: The end point of a saccade doesn't necessarily have the same coordinate as the following fixation event (because the eye is not absolutely still during a fixation; small eye movements such as drifts, tremors, microsaccades can occur during a fixation). As a result, a saccade and the following fixation may end in different interest areas. If the "Identify First/Last Saccade Based on First/Last Fixation" option is checked, Data Viewer first identifies the first and last fixation event in a trial and then finds the preceding saccade of the fixation event and uses this as the first/last saccade of the trial, despite the fact that occasionally the end x, y location of the identified saccade may not actually land in the current interest areas. If this option is unchecked, the saccades are identified based on the actual end point and there might be a disconnect between the first/last saccade and the first/last fixation in an interest area.

Apply Offset to Pasted Items: If checked, then pasted interest areas or interest area instances will be offset slightly down and to the right from the location of the original interest area or interest area instance that has been cut/copied to the clipboard. This option will be ignored if the "Paste to Current Mouse Position"

option is enabled.

Paste to Current Mouse Position: If this option is enabled, the location of the interest areas for the paste, paste current, paste after operation will be at the current mouse position. If the option is not checked, the location is based on the original interest area location (with an offset if the "Apply Offset to Pasted Items" option is enabled).

Interest Area Report

Reading Direction: This determines the calculation method for the IA_FIRST/SECOND/THIRD/LAST_RUN_LANDING_POSITION and IA_FIRST/SECOND/THIRD/LAST_RUN_LAUNCH_SITE variables in the Interest Area Report. By default, this is checked to accommodate the left-to-right reading languages - the landing position is calculated as the difference between the horizontal position of the fixation and the left edge of the interest area; the launch site is calculated as the distance between the horizontal position of the previous fixation and the left edge of the current interest area. For the right-to-left languages, the landing position is calculated as the difference between the horizontal position of the fixation and the right edge of the interest area; the launch site is calculated as the distance between the horizontal position of the previous fixation and the right edge of the current interest area.

Report Distance in: This determines whether the distance values are reported in screen pixels or degrees of visual angle for the IA_FIRST/SECOND/THIRD/LAST_RUN_LANDING_POSITION and IA_FIRST/SECOND/THIRD/LAST_RUN_LAUNCH_SITE variables in the Interest Area Report.

Fixation/Saccade Report

Maximum Message Variables for Eye Event: Maximum number of messages associated with a given fixation or saccade that will be shown in the output report.

Eye Event Msg. Variable String Match Token: If left blank, all messages associated with an eye event will be reported; otherwise, only those messages containing the "token" will be reported. Use a ";" to separate multiple message strings.

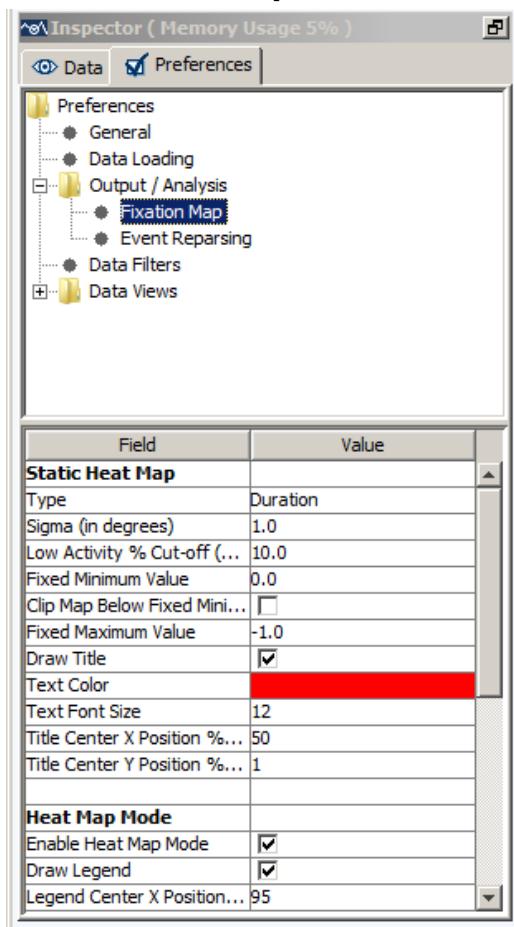
Calculate Saccade Average Velocity based on Average of Sample Velocities: If enabled (default), the average velocity of a saccade is calculated as the velocity data averaged across individual samples within the saccade event. If the option is turned off, the average velocity of a saccade is calculated based on

the amplitude and duration of the event.

Fixation Stream Analysis

Fixation Skip Count: Defines the number of fixations to skip when looking for the next interest area to use in the fixation sequence analysis variables of the Interest Area report. Default is 1. Cannot be less than 1.

8.4 Fixation Map



Static Heat Map

Type: The fixation map is created based on the duration of fixations, count of the fixation, probability of fixation across the display, or proportion of trial dwell time.

Sigma (in degrees): Sets the standard deviation of the Gaussian distribution for each fixation point when creating a fixation map.

Low Activity % Cut-off (0.0 - 100.0):

Sets the minimum amount of activation required to have an area painted with an activation color—this is a certain percent of the actual maximum per-trial-average value for the map to keep the contour of the fixation map in case the actual maximum per-trial-average value is different from the "Fixed Maximum Value". If set to 0, the whole map is painted (with most of the areas in low-activity color).

Fixed Minimum Value: By default, the scale of the legend starts from 0. A non-zero value set here will be used as the minimum value of the scale. Any areas with an activation value below this "fixed minimum value" but above the "Low Activity % Cut-off (0.0- 100.0)" threshold, will be painted with the low activity color.

Clip Map Below Fixed Minimum: If this enabled, this will not color an area with an activation value below the "Fixed Minimum Value" set above.

Fixed Maximum Value: If set to the default value of -1, the maximum value in the legend is based on the actual heat map maximum value. Any value > 0 will be used as the maximum legend scale. Any areas with an activation value above this "fixed maximum value" will be painted with the high activity color.

Draw Title: If checked, a title is displayed on the fixation map.

Text Color: Sets the color for the text of the heat map title and legend.

Text Font Size: Sets the font size for the text of the heat map title and legend.

Title Center X Position % (0-100): The X position for the center of the title in percent of the display width.

Title Center Y Position % (0-100): The Y position for the center of the title in percent of the display height.

Heat Map Mode

Enable Heat Map Mode: If checked, the fixation map will be drawn in a colored heat map; if unchecked, a grayscale version will be created.

Draw Legend: If checked, a color scale is displayed on the fixation map.

Legend Center X Position % (0-100): The X position for the center of the legend in percent of the display width.

Legend Center Y Position % (0-100): The Y position for the center of the legend in percent of the display height.

Apply Aggregate Heatmap to Group: If enabled (default), the fixation map will be created and applied to all trials within the current trial group. If not checked, the fixation map will be created only for the trial that you clicked the "Create and Use Fixation Map" button for.

Export Heat Map Matrix: If enabled, the raw heat map data will be exported as a text file to the default output directory. The matrix has the same resolution as the viewing session in Data Viewer (you can find this in the Display Width and Display Height properties of the session node in the Inspector panel). So if the viewing session resolution is 1024×768 , there will be 1024 columns and 768 rows of data. Each number corresponds to the computed activation value at one pixel in the heat map.

High Positive Activity Color: This sets the color used to paint high activity area (more fixations) on a heat map. This is also the color used to draw the high positive activity area on a difference heat map.

Medium Positive Activity Color: This sets the color used to paint medium activity area on a heat map. This is also the color used to draw the medium positive activity area on a difference heat map.

Low Activity Color: This sets the color used to paint low activity (least fixated) area on a heat map.

Medium Negative Activity Color: This is the color used to paint the medium negative activity area on a difference heat map.

High Negative Activity Color: This is the color used to draw the high negative activity area on a difference heat map.

Transparency (0.0 - 100.0): Sets the transparency level of the heat map. If 100, the heat map will be solid and the underlying image will not be visible.

Dynamic Aggregate Heat Map

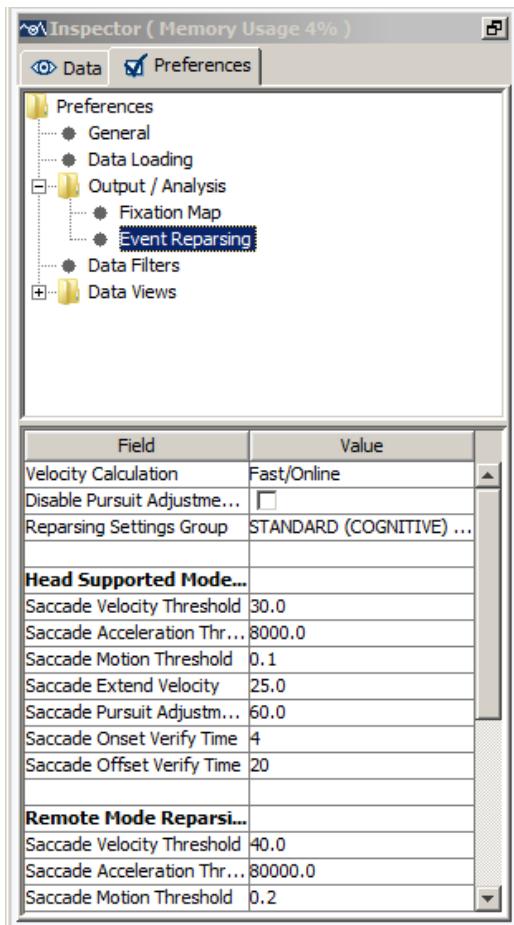
Adjust According to Contributing Trials: If the option is enabled, the calculation of the dynamic heatmap will be adjusted by the number of trials that contribute data to the current time window (i.e., the fixation duration will be calculated based on the actual surviving trials in the current time window instead of the total number of trial when the playback starts).

Show Gaze Cursor when in Heat Map Mode: If enabled, individual gaze cursors will be drawn on top of the dynamic heat map.

Heat Map Window Duration: The amount of data (in milliseconds centering on the current playback position) in each trial to be included in the dynamic heat map calculation.

Fixed Maximum Value: This sets the fixation duration of high activity area on a dynamic heat map. Any areas with a duration value above this "Fixed Maximum Value" will be painted in red.

8.5 Event Reparsing



Velocity Calculation: Velocity and acceleration can be calculated with different algorithms. The online event parser implemented in the EyeLink host software uses a fast velocity calculation ("Fast/Online") algorithm that involves relatively few samples in the calculation. This minimizes the delays required for the calculation but is more susceptible to any noise in the data. Data Viewer provides an additional velocity option ("Slow/Offline") that involves more samples in the calculation, and is less susceptible to noise.

Disable Pursuit Adjustment at Saccade

End: The EyeLink parser algorithm allows saccades to be detected during smooth pursuit (against a background of eye motion). This is done by using the acceleration data for detecting saccade onset and by raising the velocity threshold by the average velocity of a small number of preceding samples. However, this "Pursuit Adjustment" may cause a portion of the slow "drift" that can occur at the end of some saccades to be included as part of the subsequent fixation, rather than as part of the saccade. The "Disable Pursuit Adjustment at Saccade End" option allows users to disable this velocity adjustment at the saccade end. In general, enabling this option will make the saccade slightly longer, especially for those saccades that exhibit slow motion similar to drift or pursuit.

Repar싱 Settings Group: This selects the preset saccade detector configuration for the standard (STANDARD (COGNITIVE) [0]) or more sensitive (PSYCHOPHYSICAL [1]) saccade detector. The psychophysical settings allow very small saccades to be

detected, but as a consequence it may produce short fixations as well. Users can customize their detector configuration by choosing the “CUSTOM [2]” configuration. Please note that any changes in the parser settings in the standard (0) and psychophysical (1) configuration will switch the Reparsing Settings Group to “CUSTOM [2]”.

Head-Supported Mode/Remote Mode Reparsing Thresholds

Saccade Velocity Threshold: This sets the velocity threshold (in degrees/sec) for saccade detection. The threshold differs between the cognitive and psychophysical settings. In general, the cognitive setting has a higher / more conservative threshold, ideal for reading and cognitive research (shortening saccades and lengthening fixations, and reducing the number of small saccades detected).

Saccade Acceleration Threshold: This sets the acceleration threshold (in degrees/sec/sec) of saccade detection. Use of eye-movement acceleration is important for the detection of small saccades, especially in smooth pursuit. Acceleration data has much more noise than velocity data - thresholds of 4000°/sec/sec for small saccade detection, 8000°/sec/sec for reading and cognitive research, and much higher for the data collected in the remote mode are recommended.

Saccade Motion Threshold: This sets a spatial threshold (in degrees) that is used to confirm that the eye has moved significantly. If the motion threshold is not reached (whilst velocity is above threshold) then the saccade detector does not signal saccade onset.

Saccade Extend Velocity: This extends the length of a saccade while velocity remains above this threshold (in degrees/sec) within the saccade offset verification time limit.

Saccade Pursuit Adjustment Velocity: This sets the maximum value that the velocity threshold can be adjusted to, based on the average velocity over the last 40 msec. During smooth pursuit / nystagmus, saccades must be detected against a background of eye motion—in other words, the eye already has non-zero velocity before the saccade. In order to avoid false alarms during pursuit/nystagmus, the parser raises the saccade velocity threshold by an average velocity from the preceding 40 milliseconds. This parameter limits the amount that the saccade threshold can be raised to. A limit of 60°/sec works well for most pursuit and other research, but may be raised if, for example, very rapid pursuit or nystagmus is being recorded.

Saccade Onset Verify Time: This sets the minimum time (in milliseconds) that a saccade needs to exceed the velocity threshold. This is used to verify that saccade isn't borderline or noise.

Saccade Offset Verify Time: This is a verification step to make sure the saccade signal

does not end prematurely. It is necessary to prevent some saccades from being broken into multiple smaller ones.

Blink Handling

Blink Offset Verify Time: This is used to fill in any gaps in the segments of a blink event so that the blink event does not end prematurely. This is useful for example to prevent creating multiple blink events which are separated by a few samples with no missing data.

Apply Blink Minimum Samples Threshold: This decides whether Data Viewer needs to fill in gaps in a data stream with sporadic missing samples.

Minimum Blink Samples: The minimum number of samples required to report a blink event. If Data Viewer detects a sequence of missing samples under this threshold, a blink event will not be created.

Pixel-per-degree Sample Resolutions

Resolution Options: For eye event parsing, Data viewer needs proper pixel-per-degree resolution data for the calculation of velocity and saccade amplitude. In case of a non-optimal setup, users can substitute the pixel-per-degree resolution data with fixed numbers or re-scale the resolutions.

Rescale X Pixel-per-degree Resolution: This allows users to rescale the horizontal pixel-per-degree resolution to a new value. Enter the intended % scaling factor in the value field (100.0 is the original resolution).

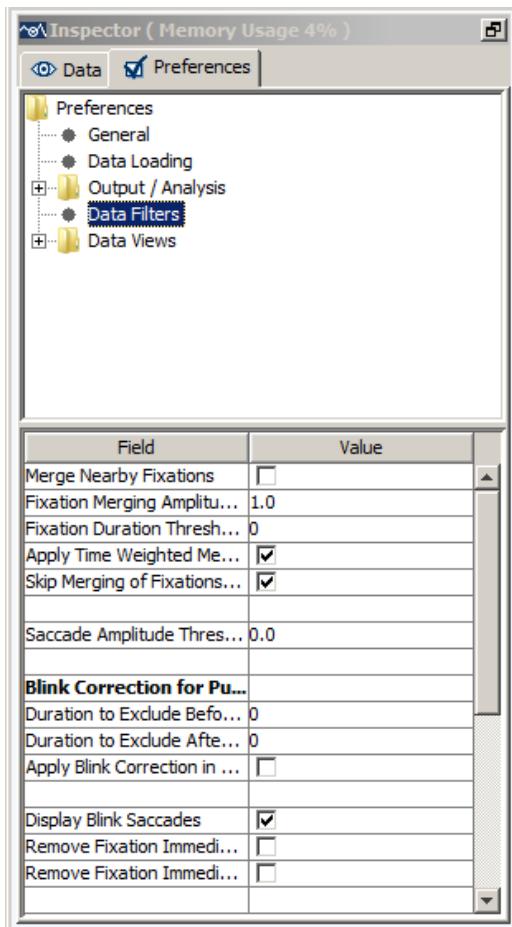
Rescale Y Pixel-per-degree Resolution: This allows users to rescale the vertical pixel-per-degree resolution to a new value. Enter the intended % scaling factor in the value field (100.0 is the original resolution).

Fixed X Pixel-per-degree Resolution: This allows users to apply a constant horizontal pixel-per-degree resolution to all of the samples for velocity/acceleration and amplitude calculations. Enter the intended resolution value in the field (the existing sample resolution will be applied if 0.0 is used)

Fixed Y Pixel-per-degree Resolution: This allows users to apply a constant vertical pixel-per-degree resolution to all of the samples for velocity/acceleration and amplitude calculations. Enter the intended resolution value in the field (the existing sample resolution will be applied if 0.0 is used).

8.6 Data Filters Preferences

The Data Filters preference settings consist of the following elements:



Merge Nearby Fixations: If checked, neighboring brief fixations are merged. In order to be merged, a fixation must have a duration less than that specified by the Fixation Duration Threshold and be within 1° of the target fixation. These default thresholds are set in the “Fixation Duration Threshold” and “Amplitude Threshold” fields. If Merge Nearby Fixations is not checked, but a Fixation Duration Threshold is set, the below-threshold fixations will be hidden rather than merged. **Note: Fixation merging cannot be undone; please make a backup copy of the viewing session or test out in a different viewing session before applying this option.**

Fixation Merging Amplitude Threshold: Sets the amplitude threshold for fixation merging. The default value is 1.0°.

Fixation Duration Threshold: Sets the duration threshold for fixation merging or hiding. A fixation will be merged if “Merge Nearby Fixations” is on and its duration is less than the specified duration threshold and within “Fixation Merging Amplitude Threshold” of another fixation. If the "Merge Nearby Fixations" option is unchecked, the under-threshold fixations will be hidden rather than merged. Likewise if "Merge Nearby fixations" is enabled, fixations that are under the fixation-merging threshold but above the "Fixation Merging Amplitude Threshold" will be hidden.

Apply Time Weighted Merge: When two Fixations are merged the duration of each fixation is taken into consideration (time-weighted) for the calculation of the average spatial location of the newly created Fixation.

Skip Merging of Fixations Separated by Blink: If checked, neighboring brief fixations that are separated by a blink event are not merged. **Note: When not checked, the**

fixations will be merged and the blink event will be removed. This cannot be undone – please make a backup copy of the viewing session or test out in a different viewing session before applying this option.

Saccade Amplitude Threshold: Sets the minimum size of a saccade to be displayed in the viewing session. All saccades will be displayed with an amplitude threshold set to 0.0.

Blink Correction for Pupil Size Calculation

Duration to Exclude Before Blink Saccades (msec):

Milliseconds of samples to exclude before the start of the blink saccades for pupil size calculation. This is applicable to variables in the Trial Report related to the pupil size calculation (PUPIL_SIZE_*); it does not affect the AVERAGE_LEFT_ / RIGHT_PUPIL_SIZE output in the Sample Report. If the "Apply Blink Correction in the Sample Report" option is checked, this will also affect the AVERAGE_LEFT_ / RIGHT_IN_BLINK output in the Sample Report (but not the AVERAGE_LEFT_ / RIGHT_PUPIL_SIZE variable output).

Duration to Exclude After Blink Saccades (msec): Milliseconds of samples to exclude after the end of the blink saccades for pupil size calculation. This is applicable to variables in the Trial Report related to the pupil size calculation (PUPIL_SIZE_*); it does not affect the AVERAGE_LEFT_ / RIGHT_PUPIL_SIZE output in the Sample Report. If the "Apply Blink Correction in the Sample Report" option is checked, this will also affect the AVERAGE_LEFT_ / RIGHT_IN_BLINK output in the Sample Report (but not the AVERAGE_LEFT_ / RIGHT_PUPIL_SIZE variable output).

Apply Blink Correction in the Sample Report: If unchecked, the AVERAGE_LEFT_ / RIGHT_IN_BLINK output in the Sample Report will be based on whether the samples are collected during a blink event (1 if true, 0 if false). If this option is checked, the reporting of the AVERAGE_LEFT_ / RIGHT_IN_BLINK output will be affected by the above-mentioned blink correction mechanism. That is, samples in a blink saccade as well as those falling within the exclusion period before/after the blink saccade will be treated as blink samples.

Display Blink Saccades: Shows flanking saccades of a blink.

Remove Fixation Immediately Before Blink, Remove Fixation Immediately After

Blink: If enabled, this will remove a fixation if it occurs immediately before/after a blink event. Please note that this option has no effect if the current viewing session was created using a version of Data Viewer before 2.2 (because fixation/blink sequences need to be marked during the data loading process for this feature to work).

Hide Fixations Beyond Display Bounds: Whether or not to hide the fixations falling beyond the display boundaries;

Show Interest Areas Pre Interest Period: If interest periods are defined, whether or not to display interest areas timed before the start of a selected interest period. If no interest periods are defined, the interest areas are displayed anyway.

Show Interest Areas Post Interest Period: If interest periods are defined, whether or not to display interest areas timed after the end of a selected interest period. If no interest periods are defined, the interest areas are displayed anyway.

Hide Eye Events Only: If checked, filters out eye events (fixations, saccades, and blinks) falling outside of the RT definition. If unchecked, filters out all events, including button events and messages.

Hide Spanned Events at Start of IP: Hide eye events (fixations, saccades, and blinks) that start before the beginning of the currently-selected interest period and end after the beginning of the currently-selected interest period. This will hide them from the various views of Data Viewer and will exclude them completely from Reports and Fixation Maps. If the “Trim Spanned Fixation Duration” option is enabled, only spanned saccades and blinks will be hidden; spanned fixation durations will be trimmed.

Hide Spanned Events at End of IP: Hide eye events (fixations, saccades, and blinks) that start before the end of the currently-selected interest period and end after the end of the currently-selected interest period. This will hide them from the various views of Data Viewer and will exclude them completely from Reports and Fixation Maps. If the “Trim Spanned Fixation Duration” option is enabled, only spanned saccades and blinks will be hidden; spanned fixation durations will be trimmed.

Trim Spanned Fixation Duration at Start of IP: Trim the duration of fixations that start before the beginning of the currently-selected interest period and end after the beginning of the currently-selected interest period. Trimming them will effectively exclude the portion of the spanned fixation that falls outside the interest period. This will influence the spanned fixations' durations in the various views of Data Viewer and in the output that goes into Reports and Fixation Maps. This preference setting takes precedence over the “Hide Spanned Events at Start of IP” preference.

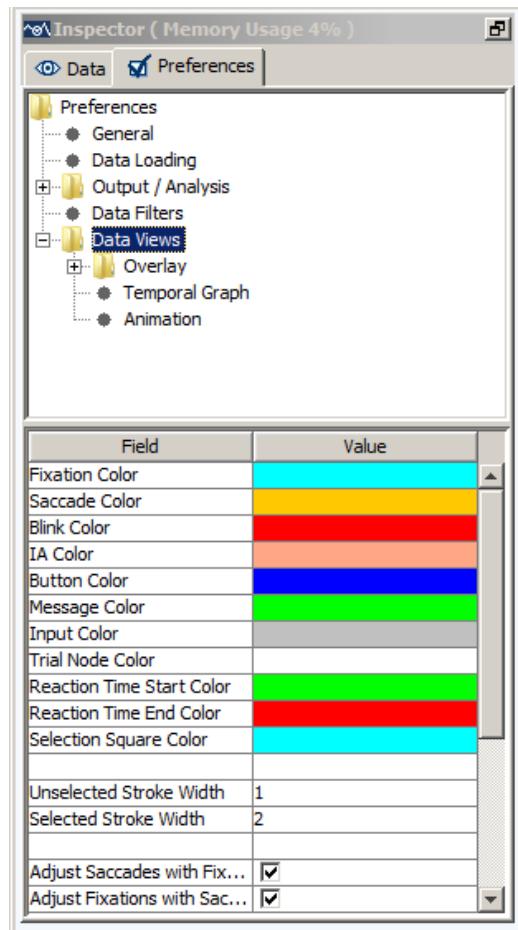
Trim Spanned Fixation Duration at End of IP: Trim the duration of fixations that start before the end of the currently-selected interest period and end after the end of the currently-selected interest period. Trimming them will effectively exclude the portion of the spanned fixation that falls outside the interest period. This will influence the spanned fixations' durations in the various views of Data Viewer and in the output that goes into Reports and Fixation Maps. This preference setting takes precedence over the “Hide Spanned Events at End of IP” preference.

Include Display Command Messages: Whether display command messages (i.e., command message starts with "!V" listed in sections 7.3.3 image loading and 7.3.4 simple graphics) should be visible.

Include Audio Command Messages: Whether audio command messages should be visible. The following built in audio messages are supported: "!V ARECSTART", "!V ARECSTOP", "!V VOICEKEY", "!V APLAYSTART", and "!V APLAYSTOP".

8.7 Data Views Preferences

The parameters related to the general Trial View Window preference settings are covered below:



Fixation Color, Saccade Color, Blink Color, IA color, Button Color, Message Color, Input Color, Reaction Time Start Color, Reaction Time End Color, and Selection Square Color: Set the colors to be used to show fixations, saccades, blinks, interest areas, button events, messages, input events, the start/end of reaction time calculation, and the event selection square. These settings can be changed by clicking the corresponding cell and choosing a color from the palette dialog or entering the value in RGB or HSB scales.

Trial Node Color: Sets the default color used to paint the trial nodes in the tree view panel of the Inspector Window. Changing this property will only affect recording sessions loaded after the change. For the existing recording sessions, the color of the trial nodes can be changed through the “Color” property of the trials/trial groups.

Unselected Stroke Width and **Selected Stroke Width**: Pixel width for the unselected and selected events.

Adjust Saccades with Fixations: Whether or not to adjust saccade parameters when the fixations are shifted or merged.

Adjust Fixations with Saccades: Whether or not to adjust fixation parameters when the saccades are shifted or merged.

Batch Drift Correction Error Threshold: The maximum tolerable deviation in the Y dimension (or the X dimension if the next field is unchecked) for a fixation from the mean of the group of fixations to be drift-corrected in a batch. If any fixation within

the group exceeds this threshold, batch drift correction cannot be performed.

Batch Drift Correction Y (X->false): If checked, chooses the Y dimension for batch drift correction. If unchecked, the X dimension is used.

Auto Select Fixation in Selected IA: When an interest area is selected, whether or not to select fixations inside the IA as well.

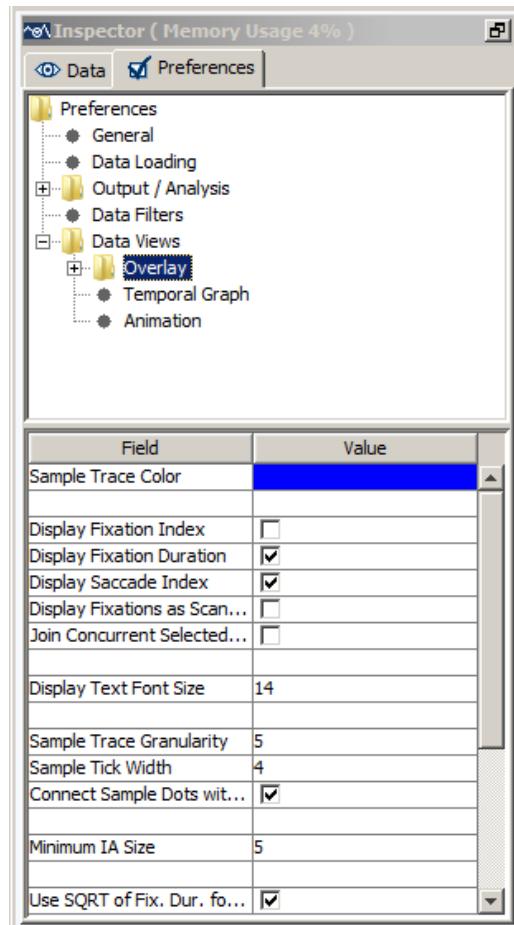
Initial Data View: Selects the mode (Temporal Graph View; Spatial Overlay View; Animation Playback View) of the Trial View Window when the data is first loaded.

Display RT Graphics: If reaction time definitions are initialized, whether or not to show the “RT” symbol in the spatial overlay view and to draw the Reaction Time Start/End lines in the Temporal Graph View of the trial data.

Use Graphics Commands Sent Prior to IP: If no graphics commands are found within the current interest period, uses those sent prior to the current interest period.

8.8 Spatial Overlay View Preferences

The Spatial Overlay View preference settings cover the following parameters:



Sample Trace Color: Sets the color to be used to show the sample trace.

Display Fixation Index, Display Fixation Duration, and Display Saccade Index: Whether or not to show the fixation index/fixation duration/saccade index in the Spatial Overlay View.

Display Fixations as Scan Path: If checked, two temporally contiguous fixations are connected by an arrow, pointing towards the more recent fixation.

Join Concurrent Selected Fixations: For the selected fixations, connects temporally contiguous fixations.

Display Text Font Size: Size of the font used in the Overlay view (e.g., size of the font for fixation durations/indices).

Sample Trace Granularity: If the sample visibility is toggled on, shows every *n*th sample (by default, n = 5).

Sample Tick Width: Diameter (in pixels) of the sample ticks.

Connect Sample Dots with Lines: If enabled (default), neighboring sample dots are connected with a line when drawn in the Spatial Overlay View.

Minimum IA Size: Minimum width or height of an interest area. Please note this is only applicable to the interest areas manually drawn by mouse.

Use SQRT of Fixation Duration for Circle Size: Uses the square root of fixation duration to calculate the width of the fixation circle if checked.

Fixation Circle Scalar, Maximum Fixation Circle Width, and Minimum Fixation

Circle Width: If the above **Use SQRT of Fixation Duration for Circle Size** option is not used, use **Fixation Circle Scalar** to define a scalar for fixation circle width calculation. The maximum and minimum circle widths are set with the **Maximum Fixation Circle Width/Minimum Fixation Circle Width** elements;

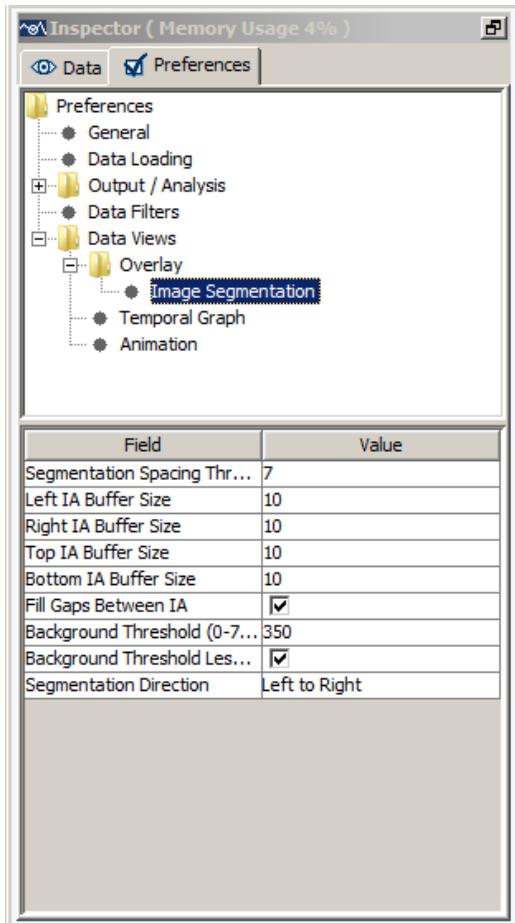
Overlay Background Color: Background color for the Spatial Overlay View (used only if the trial image is not loaded).

Maximum Graphics Commands to Process: Sets the maximum number of graphics commands to process in each trial. This command is useful for those trials in which there are many viewer graphics commands while users may just need to see a few of them. If set to -1, the viewer will process all graphics commands. For all other entries of integer numbers, the viewer will process the number of graphics commands specified when creating the background image for overlay view.

Fit Overlay Image Change to Display: If True, when the background image for a trial is manually changed, the image is scaled to fit the display dimensions for the trial. If false, the image size is not altered and the image is centered on the trial overlay view.

8.9 Image Segmentation Preferences

The parameters related to the auto image segmentation preference settings are covered below:



Segmentation Spacing Threshold: Number of consecutive pixels below threshold before segment end is identified.

Left IA Buffer Size, Right IA Buffer Size, Top IA Buffer Size, Bottom IA Buffer Size: Number of pixels added to the left, right, top, and bottom of the interest area. Note that the **Top IA Buffer Size** and **Bottom IA Buffer Size** fields will not have an effect if **Fill Gaps Between IA** is checked.

Fill Gaps Between IA: If checked, gaps between consecutive Interest Areas will be filled by expanding the size of each Interest Area.

Background Threshold (0-765): Combined RGB (R+G+B) to be used as the threshold limit for segmentation.

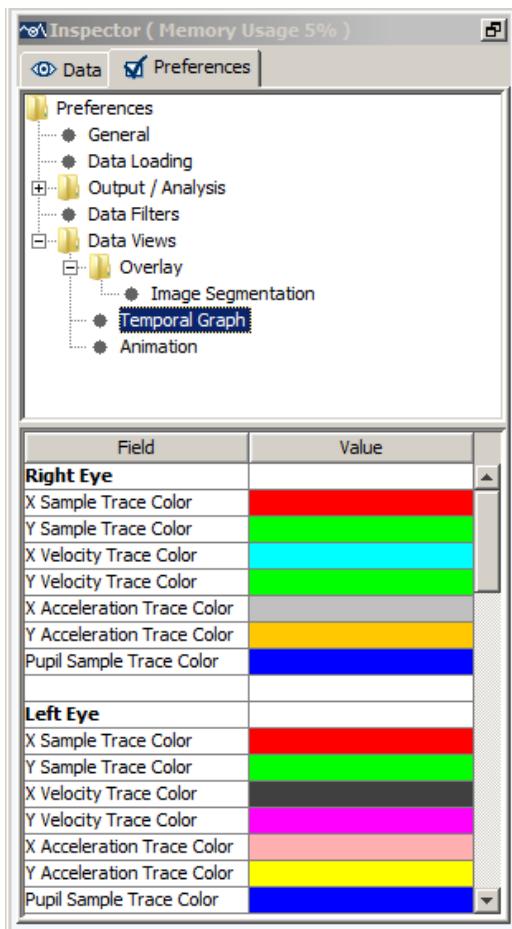
Background Threshold Less Than: If checked, pixels with an RGB value less than the threshold color are considered ‘background’ pixels. This setting is good for displays with a lighter background. If this field is unchecked, pixels with an RGB value greater than the threshold are considered background pixels (good for displays with a darker background).

Segmentation Direction: If "Left to Right" is selected then the interest areas will be created such that the interest areas furthest to the left will have the lowest index/id and the index/id values will increase in a left-to-right manner. If "Right to Left" is selected, then the interest areas will be created such that the interest areas furthest to the right will have the lowest index/id and the index/id values will increase in a right-to-left manner.

Note: Auto segmentation may not work for a display with vertical stripes along its border(s) that have the 'foreground' color. If such stripes are not part of the original image, try to reload the background image or to change the background color for the Spatial Overlay View to match with the background color of the original image.

8.10 Temporal Graph Preferences

The parameters related to the Temporal Graph View preference settings are covered below:



Left Eye/Right Eye

X Sample Trace Color, Y Sample Trace Color, X Velocity Trace Color, Y Velocity Trace Color, X Acceleration Trace Color, Y Acceleration Trace Color, and Pupil Sample Trace Color: Set the colors to be used to show the horizontal and vertical position, velocity, and acceleration traces of the eye samples. The pupil sample traces of both eyes are also displayed. The default settings can be changed by clicking the corresponding cell and choosing a color from the palette or entering the value in RGB or HSB scales.

Target 1/Target 2 Key: Token word to indicate the target ID. This field is set to blank by default so that various token words can be used. If two targets are involved and if the order of the two targets is important, set this field to the token string used in the EDF file.

X Position Trace Color, Y Position Trace Color, X Velocity Trace Color, Y Velocity Trace Color, X Acceleration Trace Color, and Y Acceleration Trace Color: Set the colors to be used to show the horizontal and vertical position, velocity, and acceleration traces of the targets. The default settings can be changed by clicking the corresponding cell and choosing a color from the palette or entering the value in RGB or HSB scales;

Acceleration Trace Scaling Factor and Velocity Trace Scaling Factor: Sets the scaling factor for the acceleration and velocity data so that these two traces can be displayed appropriately in this view.

Pupil Trace Scaling Factor: Sets the scaling factor for the pupil size data so that the

trace can be displayed appropriately in this view. Default scaling factor is 0.1.

Message Triangle Width, Message Triangle Height, Button Triangle Width, Button Triangle Height, Input Triangle Width, and Input Triangle Height: Sets the width and height of the symbols for message, button, and input events.

Background Color and Ruler Color: Sets the colors for the background and ruler of the Temporal Graph View.

Split Y Axis: If true, 0 appear in the middle of the screen, positive values on the top and negative values at the bottom; otherwise, a descending scale is used, with large values on the Y-axis appearing at the bottom of the screen. Note, this setting will only be effective when the data are loaded in a new viewing session.

Display Sample Indicator: Whether or not to show the sample cursor line (and a pointer/circle at the intersection of the sample cursor line and data traces) in the Temporal Graph View.

Display Graph Grid Lines: Whether or not to show the graph grid lines in the Temporal Graph View.

Sample Indicator Color: Sets the color to be used to show the sample cursor line.

Graph Grid Lines Color: Sets the color to be used to show the graph's grid lines.

Interest Period Boundaries Color: Sets the color to be used to show the currently-selected interest period boundaries.

X Trace Highlighted, Y Trace Highlighted, and Pupil Trace Highlighted: Whether or not by default the X trace, Y trace, and pupil trace are highlighted.

Initial Visible Sample Count: Total number of initially visible samples in the Temporal Graph View window (the default is 5000).

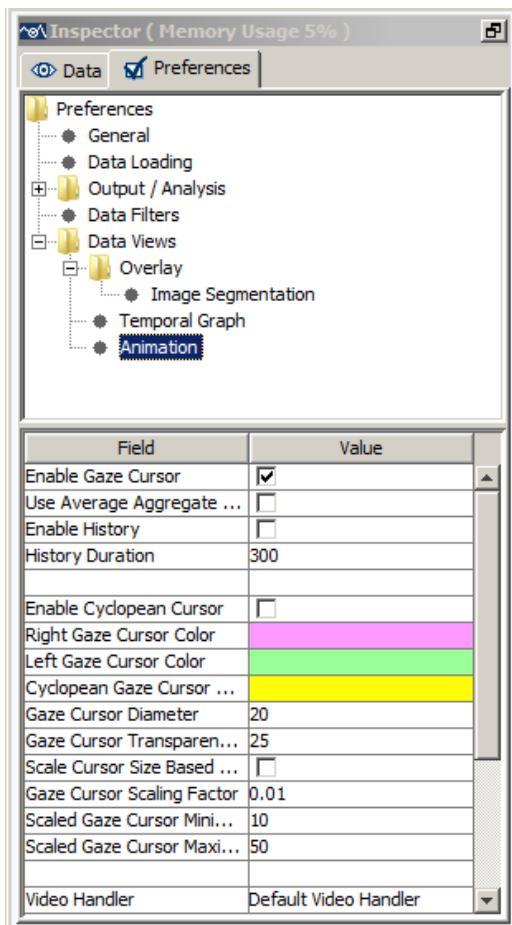
Exclude Samples Traces Outside Interest Period: Whether or not to show the traces of the samples that fall outside the Interest Period in the Temporal Graph View.

Sample Traces Out Of IP Color: Sets the color to be used to show the samples that fall outside the Interest Period.

Use X Position for Fixation Location: If checked, use the X position to indicate the position of a fixation event in the Temporal Graph View; otherwise, use the Y position.

8.11 Animation Preferences

The parameters related to the Animation Playback View preference settings are covered below:



Enable Gaze Cursor: By default, the gaze cursor is drawn on top of the background image/video during trial playback. If the option is turned off, the gaze cursor will be removed from the animation panel. This can be useful in case users want to look at or record trial playback without the gaze cursor being visible on the screen.

Use Average Aggregate Cursor: When Aggregate View is turned on, whether or not to display only the averaged gaze cursor across all trials.

Enable History: If checked, this displays a history of prior eye samples in the animation view.

History Duration: Duration of the eye position history prior to the current frame (300 ms by default).

Enable Cyclopean Cursor: For a binocular recording, enabling this option will display a cyclopean gaze cursor (instead of two separate gaze cursors) in the animation view.

Right Gaze Cursor Color, Left Gaze Cursor Color, Cyclopean Gaze Cursor: Set the colors to be used to show the right, left, and cyclopean gaze cursor. The default settings can be changed by clicking the corresponding cell and choosing a color from the palette or entering the value in RGB or HSB scales. Please note that these color settings are used in the animation view for both the current gaze position and the history trace (if the “Enable History” option is checked). In the Aggregate Mode, if the default trial/trial group colors are modified, then these color settings are ignored. The customized colors specified in the property table of the trial/trial group will be applied to left, right, and cyclopean cursors.

Gaze Cursor Diameter: Sets the diameter of the gaze cursor (in pixels); this option is ignored if the “Make Gaze Cursor Size Dependent on Pupil Size” option is enabled.

Gaze Cursor Transparency (0 - 100): Sets the transparency of the gaze cursor.

Scale Cursor Size Based on Pupil Size: If enabled, the diameter of the gaze cursor in the animation view is scaled based on pupil size of the current sample. If no samples are loaded in the trial, the average pupil size for the fixation will be used during playback within a fixation, and the average of the previous and next fixation pupil size will be used during playback within a saccade.

Gaze Cursor Scaling Factor: Sets the scaling factor so that the pupil size can be properly indicated by the size of the gaze cursor. Scaling factor directly multiplies the pupil size; the resulted cursor size is constrained by the Scaled Gaze Cursor Minimum and Maximum Diameter.

Scaled Gaze Cursor Minimum Diameter: This sets the smallest possible gaze cursor size (diameter in pixels) when the size of the gaze cursor is scaled based on the pupil size data.

Scaled Gaze Cursor Maximum Diameter: This sets the largest possible gaze cursor size (diameter in pixels) when the size of the gaze cursor is scaled based on the pupil size data.

Video Handler: The codec used to play the video clips. In general, users are recommended to use the default option as the software will automatically choose the optimal video loader for you based on the file extension. This option is applicable to the Windows version only.

Animation Background Color: Background color for the Animation View (used only when the trial image is not loaded).

Trial Time Color: Sets the color of the trial time code.

Trial Time X Position (%), Trial Time Y Position (%): Sets the x (percent of screen width) and y (percent of screen height) coordinates of the trial time code.

Trial Time Font Size: Sets the font size of the trial time code.

Display Frame Number: If checked, displays the frame number of the video being played.

Display Trial Time: If checked, displays the current playback time relative to the start of the trial.

Display IP Time: If checked, displays the current playback time relative to the start of the currently selected interest period.

9 Release History

Version 3.2.1

- Added support for reparsing eye events for selected trials or recording sessions
- Added “Event Reparsing” options to the “Output / Analysis” preferences
- Supported saving color and group label of interest areas into an interest area file
- Added support for duplicating selected interest periods in the Interest Period Editor
- Provided more example EDF files.

Version 3.1.246

- Added support for macOS High Sierra (version 10.13)
- Added the following variables to the Interest Area Report:
IA_FIRST_FIXATION_PREVIOUS_FIX_IA,
IA_FIRST_FIXATION_PREVIOUS_IAREAS,
IA_FIRST/LAST_SECOND_THIRD_RUN_LANDING_POSITION,
IA_FIRST/LAST_SECOND_THIRD_RUN_LAUNCH_SITE
- Added “Reading Direction” and “Report Distance in” Options to the Output\Analysis preferences
- Texts of the message events are now displayed in the event list

Version 3.1.97

- Provided various bug fixes and documentation updates for the 3.1.1 release
- Added options to skip some stages when performing four-stage fixation cleaning
- Added the following variables to the Trial Report:
SD_SACCADE_AMPLITUDE, and SD_FIXATION_DURATION
- Added the following variables to the Saccade Report:
CURRENT_SAC_NEAREST_START_INTEREST_AREA_DISTANCE
CURRENT_SAC_NEAREST_END_INTEREST_AREA_DISTANCE

Version 3.1.1

- Added “Add/Edit Event Mode” to the Temporal Graph View
- Added grid lines to the Temporal Graph View
- Added a sample cursor line to the current mouse position in the Temporal Graph View
- Added “Sample Info” button and floating window to the Temporal Graph View
- Added interest period boundaries to the Temporal Graph View
- Supported displaying dynamic interest areas in the Temporal Graph View
- Added “IA Shape Actions” option to support the following operations when interest areas are selected:
 - Conversion between different interest area shapes
 - Horizontal or vertical flip
 - Rotating interest areas
 - Resizing/rescaling interest areas

- Moving interest areas
- Added interest area “Link” option to replace multiple interest areas with a linked object; added “Unlink” option to restore the original interest areas
- Added “Create Output Report for all Custom Interest Periods” option to the Reports
- Added option to create multiple consecutive duration-based interest periods
- Added “Use Average Aggregate Cursor” option to Animation View Preferences
- Allowed to import messages relative to the currently-selected interest period
- Added “Gaze Cursor Transparency (0.0 – 100.0)” to Animation View Preferences
- Added “Video Handler” option to Animation Preferences (Windows version only)
- Added support for playing back .mov video files in the Animation View (for the data collected with SR Research Experiment Builder)
- Added the following variables to the Trial Report:
MEDIAN_SACCADE_AMPLITUDE, and MEDIAN_FIXATION_DURATION
- Added the following variables to the Saccade and Fixation Report:
 - CURRENT/PREVIOUS/NEXT_SAC_BLINK_START
 - CURRENT/PREVIOUS/NEXT_SAC_BLINK_END
 - CURRENT/PREVIOUS/NEXT_SAC_BLINK_DURATION

Version 2.6.1

- Provided a new interface for creating and editing interest periods
- Provided options to create a shorter sample report (i.e., down-sampling)
- Added “File -> Unpack” menu option
- Added “Selected Freehand Point” property to freehand interest areas for the precise adjustment of vertex coordinate
- Added "Remember Last Browsed Directory" for some default directories
- Added HTARGET_DISTANCE_BIN, HTARGET_X_BIN, HTARGET_Y_BIN, SAMPLING_RATE, and SAMPLE_INTERVAL variables to the Time-Course Analysis Report
- Added “Start Event Offset” option to the Reaction Time Definitions
- Added “Animation Background Color” to the Animation View preferences
- Added “Apply Blink Correction in the Sample Report” option to the Data Filters preferences

Version 2.5.0

- Added Time-Course (binning) Analysis Report
- Supported .mov file output on Mac OS X
- Added property to fixation event to indicate if the event is trimmed by interest period filter.

Version 2.4.1

- Data Viewer now runs on Windows (XP, Vista, 7, 8, and 10), Mac OS X (Intel Mac 10.6 or later), Linux (Ubuntu 14.04LTS)
- Supported dynamic heat map presentation in the Animation View
- Supported creating a difference heat map

- Added option to export the fixation map matrix as a text file.
- Allowed playback of supported video clips on Mac OS X
- Added a history of eye positions in the Animation View
- Added Backward Frame and Forward Frame buttons in the Animation View
- Supported zooming in or out of the Spatial Overlay View
- Supported toggling on/off the background image in the Spatial Overlay View
- Added keyboard shortcut help menu to the Trial View Window
- Supported scaling gaze cursor size in the Animation View based on pupil size
- Added “Pupil Trace Scaling Factor” to the Temporal Graph View preferences
- Bug fix for the "Include Hidden Events" option being toggled on randomly. The hidden events now are drawn in dashed-lines.
- Added new variable to Trial Report:
`INTEREST_AREA_FIXATION_SEQUENCE`
- Added new variable to Interest Area Report: `IA_LEGAL_IMMEDIATE`
- Added “Apply Strict Event Matching” option to the Interest Period Editor
- Added new variables to Trial, Fixation, Saccade, Message, Sample, and Interest Area Reports: `IP_END_EVENT_MATCHED`, `IP_START_EVENT_MATCHED`

Version 2.3.1

- Supported Aggregate Mode
 - Displays the aggregate data in the Spatial Overlay and Animation View of the Trial View Window
 - Displays aggregated statistics for the events and interest areas in the trial group in the property table
 - Provided Aggregate Event Statistics and Aggregated Interest Area Report
- Added support for color coding the visible data in a trial/group of trials
- Supported selecting variables in the output reports though drag-and-drop
- Provided option to display the fixation map in the Spatial Overlay View
- Supported merging viewing sessions
- Supported adjusting the location of the interest areas using the center position
- Added Step Backward button in the toolbar of the Animation View
- Added Xvid lookup table support for faster frame seeking.

Version 2.2.1

- Added support for loading input events from EDF files.
- Supported using the input events as the end event in the interest period and reaction-time definitions.
- Supported trial splitting based on the messages or input events.
- Added “Use Substring Match for Messages” option to the Interest Period and Reaction Time Definition Editor.
- Supported packaging and unpacking viewing session files.
- Added support for removing fixations immediately before or after a blink event.
- Added new properties to the trial node: Number Input Events, Mode, Pupil Data Type, Eyes, Event Parse Type, Mount Type, File Filtering Level, and Pupil Tracking Algorithm.

- Supported inserting a message / editing message text in the viewing session.
- Added “Create one report file per each EDF file” option in each of the reports.
- Added “Default Video Directory” in the General preference.
- Added new properties to the Data file node: EyeLink Version, and Recorded by.
- Added new variables to the sample reports: SAMPLE_INPUT
- Added the following variables to the fixation report and saccade report:
 - CURRENT_PREVIOUS_NEXT_FIX_INPUT_EVENTS,
 - CURRENT_PREVIOUS_NEXT_SAC_INPUT_EVENTS
- Added the following variables to the trial report: INPUT_COUNT, RT_EVENT_INPUT
- Added the following variables to the saccade report:
 - CURRENT_SAC_START-END_INTEREST_AREA_X_OFFSET
 - CURRENT_SAC_START-END_INTEREST_AREA_Y_OFFSET
 - CURRENT_SAC_START-END_INTEREST_AREA_DATA
- General bug fixes for video playback and saving in Data Viewer animation view.

Version 2.1.1

- General performance improvements and reworked on the playback in the Animation View and video saving.
- Added Dynamic Interest Area Support
 - Modified interest area format
 - Added Mouse Record Mode for creating dynamic interest area instances
 - Added Paste Current and Paste After options
 - Modified interest area creation dialog box
 - Supported position and shape interpolation across instances of Dynamic Interest Area
 - Interest Area data reporting can be either based on the fixation events or samples
- Improved Trial Grouping interface
- Supported adding or removing points for a freehand interest area
- Animation View now displays time relative to start of the trial and/or start of the current interest period.
- Added “Default Video Directory” setting to the General Preferences; supported selection of multiple directories for the “Default Image Directory” and “Default Video Directory”.
- Allowed independent setting for “Hide Spanned Events” and “Trim Spanned Fixation Duration” at the start and end of interest period.
- Added a "Use Substring Match for Messages" option to the Reaction Time and Interest Period definitions.
- Added new variables to the Interest Area Report: IA_DYNAMIC, IA_END_TIME, IA_INSTANCE_COUNT, IA_START_TIME, REPORTING_METHOD, TRIAL_IA_COUNT, TRIAL_TOTAL_VISITED_IA_COUNT.

- Added new variables to the Fixation Report and Saccade Report:
 CURRENT_NEXT_PREVIOUS_FIX_INTEREST_AREA_DATA,
 CURRENT_NEXT_PREVIOUS_FIX_INTEREST_AREA_PIXEL_AREA,
 CURRENT_NEXT_PREVIOUS_FIX_INTEREST_AREA_ID,
 CURRENT_NEXT_PREVIOUS_SACCADE_START_INTEREST_AREA_ID,
 and
 CURRENT_NEXT_PREVIOUS_SACCADE_END_INTEREST_AREA_ID.
- Added new variables to the Message Report:
 CURRENT_MSG_INTEREST_AREA_ID.
- Added new variables to the Trial Report:
 AVERAGE_BLINK_DURATION, and IA_COUNT
- Added new variables to the Sample Report:
 LEFT_FIX_INDEX, RIGHT_FIX_INDEX,
 AVERAGE_LEFT_RIGHT_INTEREST_AREAS,
 AVERAGE_LEFT_RIGHT_INTEREST_AREA_DATA,
 AVERAGE_LEFT_RIGHT_INTEREST_AREA_DISTANCE,
 AVERAGE_LEFT_RIGHT_INTEREST_AREA_PIXEL_AREA,
 LEFT_SACCADE_INDEX, RIGHT_SACCADE_INDEX

Version 1.11.900:

- Added support for EyeLink 1000 Plus recording files.
- Fixed crashes in loading some EDF files on Mac OS X.
- Added blink correction for pupil size calculation for PUPIL_SIZE_MIN and PUPIL_SIZE_MEAN variables in the trial report; now samples during a blink are not included in the pupil size calculation.
- Added options to exclude some samples before and after a blink event in the pupil size calculation ("Duration to Exclude Before Blinks (msec)" and "Duration to Exclude After Blinks (msec)" in the Data Filters preferences).
- Bug fix for handling blink events in some EDF files.
- Bug fix in handling target position commands ("!V TARGET_POS").
- Supported saving interest area files in UTF-8 encoding.
- Added variables to the Interest Area Report: IA_FIRST_SACCADE_INDEX and IA_LAST_SACCADE_INDEX.
- Bug fix for Interest Area Report variables: IA_FIRST_FIXATION_RUN_INDEX and IA_FIRST_FIXATION_VISITED_IA_COUNT.
- Added option in the "Output/Analysis Preferences" (Identify first/last saccade based on the first last/last fixation) to match the first/last saccade event to the first/last fixation event in the Interest Area Report.

Version 1.11.1:

- Added support for multiple EDF file loading contained in different directories.
- Trial variable value editor now supports copy and paste.
- Added a "Report Hidden" option for the Recording Session and trial groups.

- Added FIXATION_DURATION_MAX, FIXATION_DURATION_MIN, FIXATION_DURATION_MAX_TIME, and FIXATION_DURATION_MIN_TIME to trial report.
- Added IA_LAST_RUN_DWELL_TIME, IA_LAST_RUN_END_TIME, IA_LAST_RUN_FIXATION%, IA_LAST_RUN_FIXATION_COUNT, IA_LAST_RUN_START_TIME, IA_LAST_FIXATION_RUN, and IA_THIRD_RUN_FIXATION_COUNT to the interest area report.
- Fixed various EDF file loading issues.
- Bug fix for setting the directories in "General Preferences".
- Bug fix for displaying non-ASCII characters in the interest area label, trial variable value editor, and messages.

Version 1.10.123:

- Added support for exporting and importing variable selection in the output reports (trial, fixation, saccade, interest area, sample, and message).
- Added support for exporting and importing interest periods across sessions.
Added support for exporting and importing preference settings.
- Added legend to the grayscale version of fixation maps.

Version 1.10.1:

- This version runs on Windows 2000, XP, Vista, Windows 7, and Mac OS X.
- Better support for non-ASCII characters in the trial variable value editor, interest area label, messages, and report outputs.
- Added "Use UTF-8 Encoding" option to the "Output/Analysis" preference.
- Bug fix for saving the animation view with cyclopean gaze cursor.

Version 1.9.193:

- Added IA_FIRST_FIXATION_X, IA_FIRST_FIXATION_Y, IA_SECOND_FIXATION_X, IA_SECOND_FIXATION_Y, IA_THIRD_FIXATION_X, IA_THIRD_FIXATION_Y, IA_LAST_FIXATION_X, and IA_LAST_FIXATION_Y variables to the interest area report.
- Added CURRENT_MSG_INTEREST AREAS, CURRENT_MSG_INTEREST_AREA_INDEX, and CURRENT_MSG_INTEREST_AREA_LABEL to the message report.
- Added LAST_BUTTON_RELEASED, LAST_BUTTON_PRESS_TIME, and LAST_BUTTON_RELEASE_TIME to the fixation report. The LAST_BUTTON_TIME variable now returns the time when the last button is pressed or released.
- Added PUPIL_SIZE_MIN_X, PUPIL_SIZE_MIN_Y, PUPIL_SIZE_MIN_TIME, and VISITED_INTEREST_AREA_COUNT to the trial report.

- Bug fix for interest period selection if the end time of the interest period is equal to the start time of a fixation event.

Version 1.9.1:

- Fixation map/heat map is completely redone with the following modifications:
 - Four variants of fixation maps are provided: 1 = based on duration; 2 = based on fixation count; 3 = based on count density; and 4 = based on duration density.
 - A fixation map color legend is provided.
 - Renamed "Minimum Contrast Multiplier" option in the fixation map preference settings to "Low Activity % Cut-off".
 - Supported drawing a title.
 - Transparency setting supported.
 - Option added to customize the Low, Medium, and High activity colors.
 - Option added to set a fixed maximum and minimum value for heatmap scale.
- The compressed EDF files collected on EyeLink CL eye trackers are now supported.
- Added TRIAL_INDEX variable to the fixation, saccade, sample, message, and interest area reports.
- Added IA_FIRST_FIXATION_INDEX, IA_FIRST_FIXATION_RUN_INDEX, and IA_FIRST_FIXATION_VISITED_IA_COUNT variables to the interest area report.