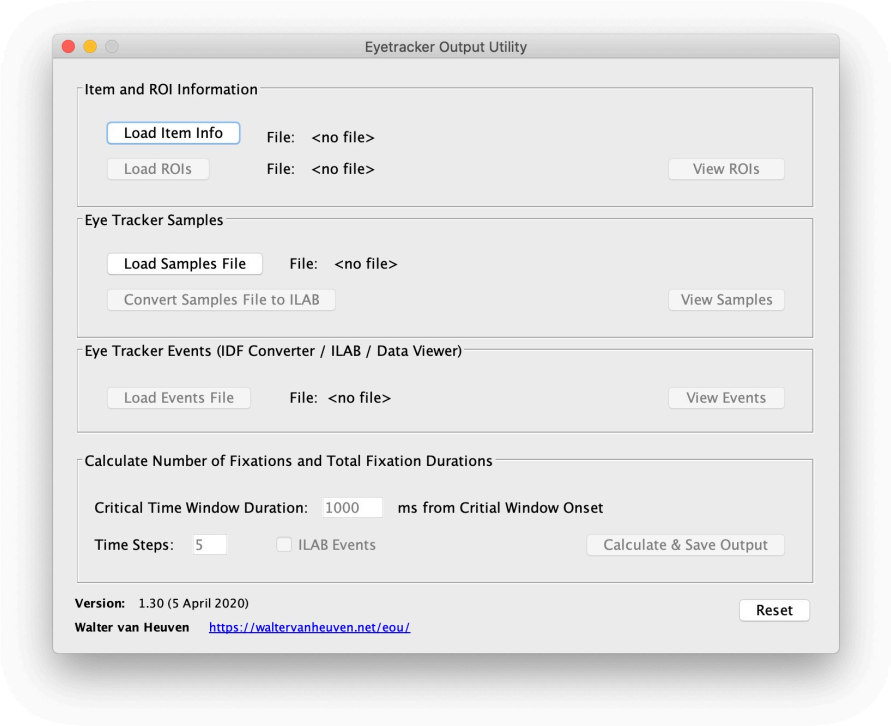
Eyetracker Output Utility



Latest version: 1.31, 6 April 2020

Please note that this program is still under development

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Eyetracker Output Utility is a program to visualize, analyze, and convert gaze data from different eye tracking systems (SMI, Tobii, SR Research). The program can visualize gaze data, create realtime QuickTime movies, convert data to ILAB, and calculate the number of fixations and total fixation durations in regions of interest within specified time windows.

SMI: http://www.smivision.com/
Tobii: http://www.tobii.com/
SR Research: http://sr-research.com/
ILAB: http://www.brain.northwestern.edu/ilab/

The ***Eyetracker Output Utility*** uses Werner Randelshofer **QuickTimeOutputStream** class included in **QuickTimeDemo.jar** to create QuickTime movies.

Disclaimer

Please note that this software is under development. The software is stable, but there is the possibility that not all functionality is in tact or correct, and that it may even crash.

Use of the ***Eyetracker Output Utility*** is entirely at your own risk. I will not be liable for any data loss, hardware damage or whatever this program might cause.

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1. Running the Program

macOS: Open the "EyetrackerOutputUtility.dmg" and double click on the "EyetrackerOutputUtility.pkg" to install the program. Use right click to open the installer. The installer will install the EyetrackerOutputUtility in the Applications folder.

Jar version: the jar version runs on Linux, macOS, and Windows. It requires Java SE 14. After Java is installed navigate to the "Eyetracker Output Utility" folder and type

```
java -jar EyetrackerOutputUtility.jar
```

in the "Command Prompt" in Windows or the "Terminal" in macOS. Please note that the program will write detailed feedback, warnings and error information in a log file, which is saved in the user's home folder.

Do not move EyetackerOutputUtility.jar outside of the "Eyetracker Output Utility "folder. The jar file should be in the same folder as the "lib" folder.

When you start the program it checks online whether there is a new version is available.

Figure 1. Folder content after unzipping the DMG file.

1.1 Required Files

To view gaze data the program requires a file with gaze data (samples or samples and events). In addition the program requires an item information file and a region of interest (ROI) file to calculate the number and percentage of fixations and total fixation durations in ROIs.

- Item Information file
- Region Information file
- Gaze data file (samples)

Place all files in the same folder when you use the program. Images associated with items can be placed inside another folder (e.g, img).

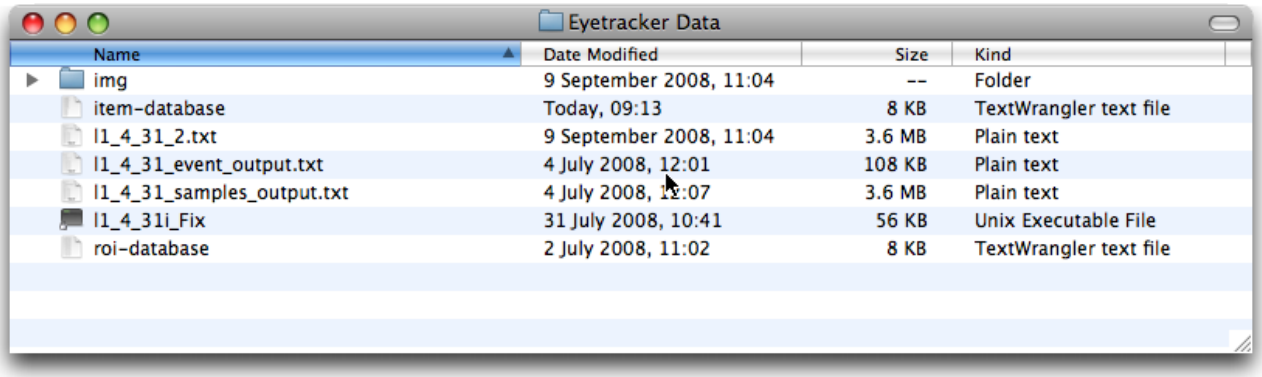

Figure 2. Example of the folder structure.

1.1.1 Item Information file

The item information file is a tab-delimited text file with up to 7 columns. For data from SMI systems (e.g., Hi-Speed, RED) the file should have at least 3 columns. For data from the Tobii (e.g., T60, T120) and SR Research (e.g., EyeLink I, II, 1000/2000) eye trackers the file should have 7 columns. To create text files use on Windows Notepad++ and on OS X BBEdit. The file should use unicode encoding (UTF-8, no BOM).

Column **1**: Item Number

> SMI data: if the Samples file contains trigger information that corresponds to item numbers then use the same item numbers in the *Item Information* file.

Column **2**: Name and location of the picture file associated with the item

> Example: /img/batman.jpg
>
> The location of the image file is relative to the location of the *Item Information* file. Please note that file names should not contain any spaces. The image file format can be JPEG, GIF, PNG, BMP, or WBMP. If your image files are very large (e.g., several

megabytes) the program might run very slowly. Compress your images to improve the performance of the program (e.g., convert images to jpeg format).

Column **3**: Onset of the Critical Time Window of an item (in milliseconds)

You can define a critical time window onset within an item. For example, if a picture is visible for 20 seconds but you are only interested in the gaze data after 10 seconds you can set the onset of the critical time window to 10000 ms. This is especially useful when you combine visual and auditory information and you want to focus only on the gaze data when a particular word is spoken (e.g.,visual world paradigm, see Tanenhaus et al., 1995). The duration of the critical time window can be set in the main window.

If your experiment does not require a critical time window onset enter 0 in this column, which means that the onset of the critical time window is the trial onset.

Column **4** (optional): Item information

In this column you can enter text to describe the item or to indicate to which condition the item belongs.

Column **5** (optional for data from SMI data): Item number

If the Samples file (see Section 1.1.3.1) does not contain the correct trigger information that corresponds to the item number in the *Item Information* file (e.g., trigger is always 0) column 5 can be used to set the trigger information in the Samples file to the item number based on the set number in the Samples file.

Thus, if set number 4 corresponds to item number 16 you can put in the 5th column of item 16 number 4 so that the program knows which set number corresponds to which item number.

Enter 0 in this column when you use data from the Tobii or EyeLink eye trackers.

Column 6 (only for Tobii and EyeLink data): Start time of the item (in milliseconds) from the start time of the data collection.

You can use column 6 and 7 to define the start and end time of each item.

Note that the start of data collection is time point 0 ms. (see Section **1.1.3.3).**

Column 7 (ony for Tobii and EyeLink data): End time of the item (in milliseconds) from the start time of the data collection.

Note that the start of data collection is time point 0 ms. (see Section **1.1.3.3).**

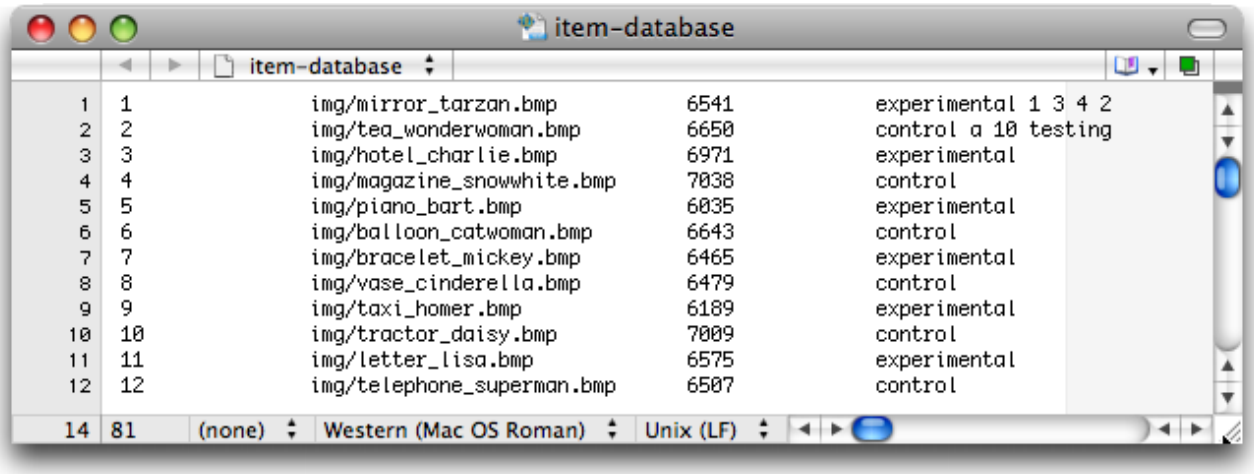

Figure 3a. Example of an item database file for data from an SMI eye tracker. The file has 4 columns: item number, image, critical time window onset, item information.

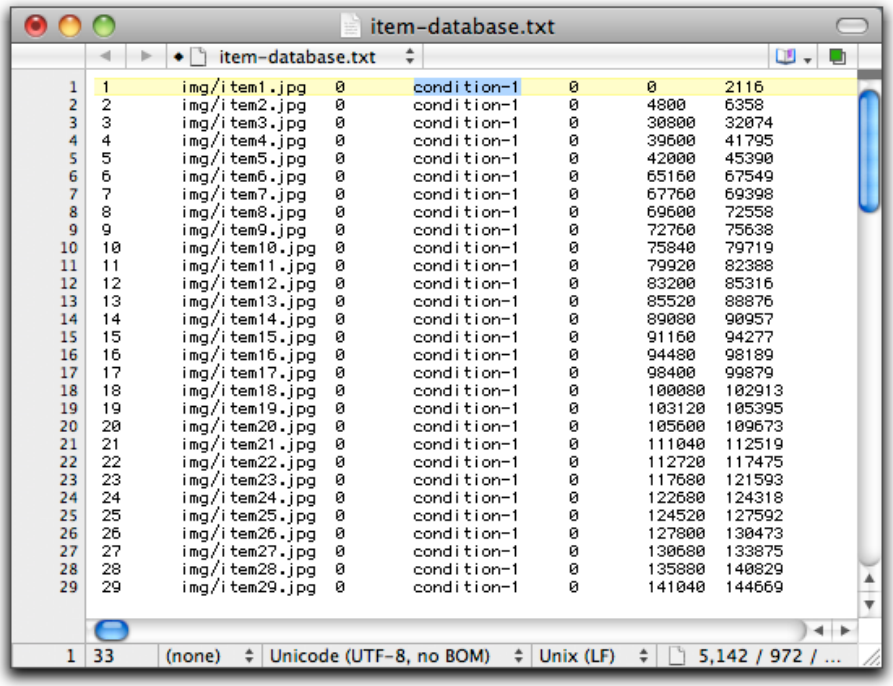

Figure 3b. Example of an item database file for data from an EyeLink eye tracker (SR Research). The file has 7 columns.

1.1.2 Region of Interest (ROI) information file

Tab-delimited text file with at least 5 columns. The file should use Unicode encoding (UTF-8, no BOM). A ROI is a rectangle on the screen defined by the top-left X-coordinate and Y-coordinate and the width and height of the rectangle (e.g., 50, 50, 200, 100).

Column **1**: Item Number

Column **2 - 5**: X-coordinate,Y-coordinate, Width, Height

Note that the top left of the screen is X=0, Y=0. Each additional ROI requires 4 more columns. If a ROI is undefined for some of the items use -1,-1,-1,-1 for the ROI.

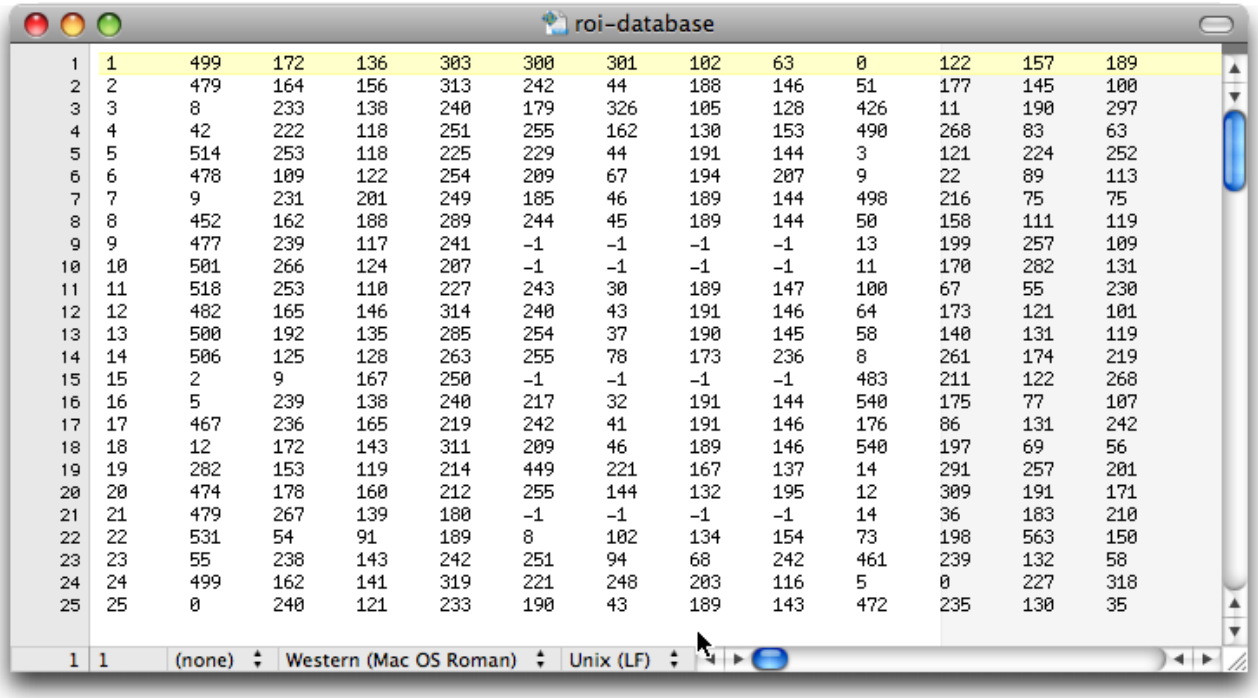

Figure 4. ROI information file example. Each item in this file has three ROIs (4 x 4 = 16 columns).

1.1.3 Samples File

The ***Eyetracker Output Utility*** can read gaze data (samples) from SMI (e.g., RED/Hi-Speed), Tobii (e.g., T60, T120, TX300) and SR Research (e.g., EyeLink I,II, 1000/2000) eye trackers.

1.1.3.1 SMI

Use the **IDF Converter** program that comes with the SMI eye tracker to convert IDF files to text files. Software can also be downloaded here.

The ***Eyetracker Output Utility*** only reads samples files with the following 8 columns: Time, Type, Set, R POR X [px], R POR Y [px], Timing, Latency, Trigger. It is also important that the columns appear in precisely this order (see Figure 5).

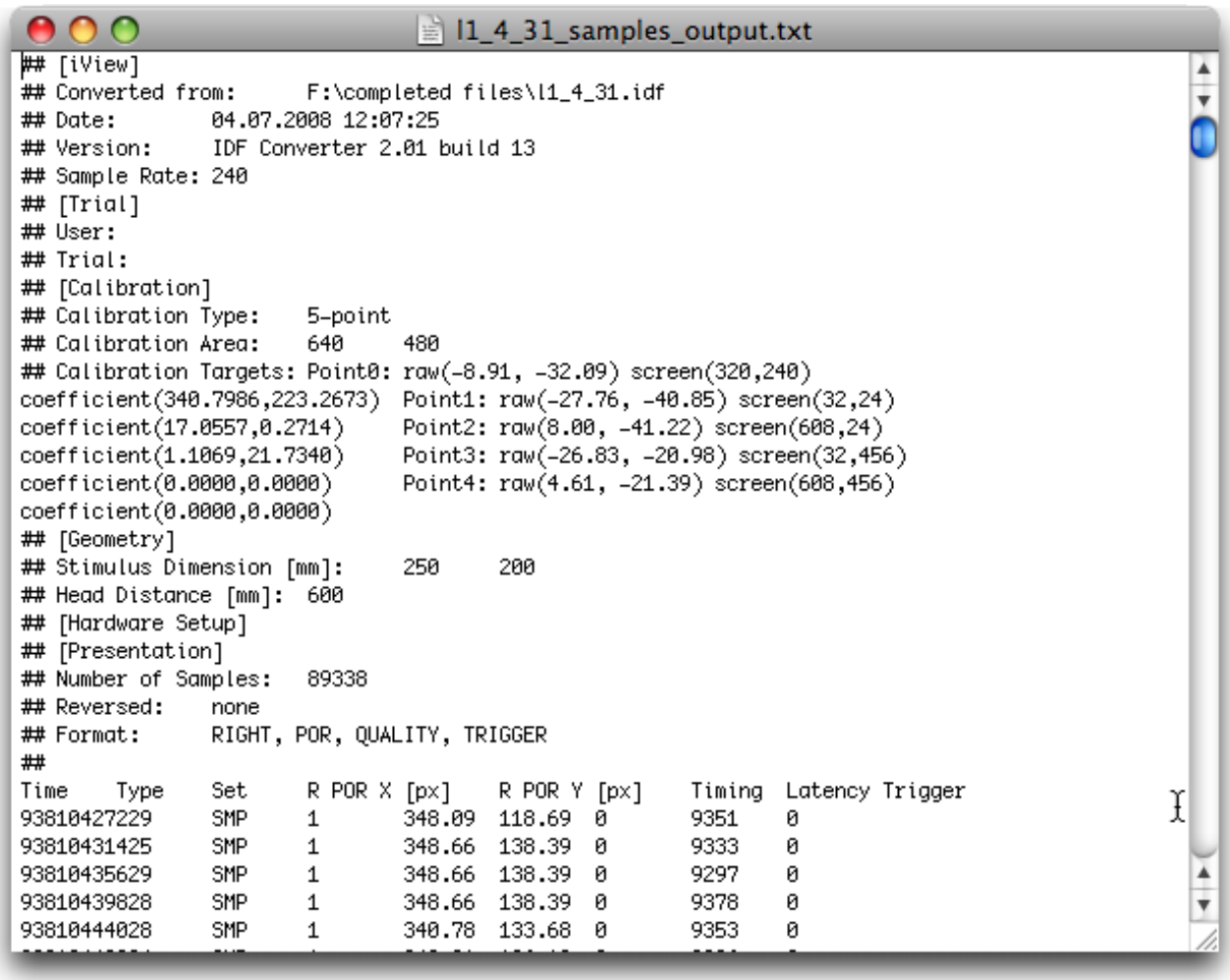

Figure 5. SMI Hi-Speed 240 eye tracker samples output.

1.1.3.2 Tobii

Use Text Export in **Tobii Studio** to export gaze data (see Figure 6). The exported text files (see Figure 7) should have at least these 4 columns: Timestamp, Number, GazepointXLeft, GazepointYLeft. Only gazepoint data from the left eye is used.

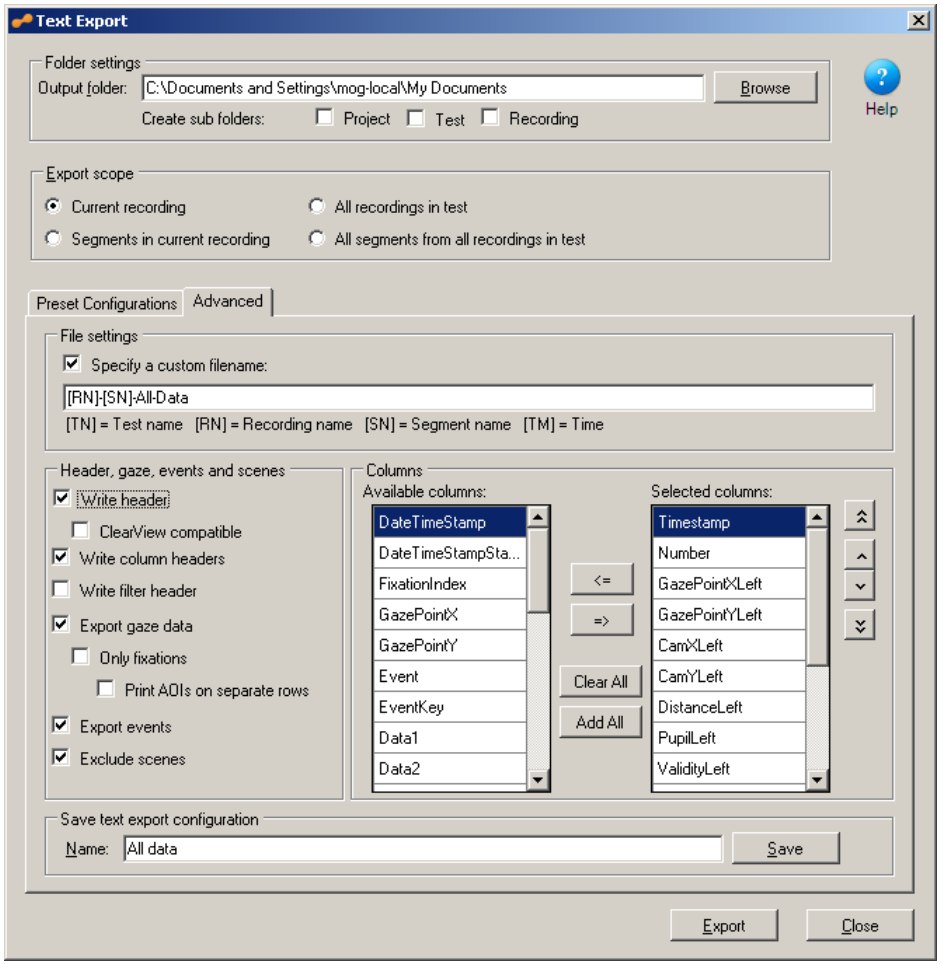

Figure 6. Text Export in Tobii Studio.

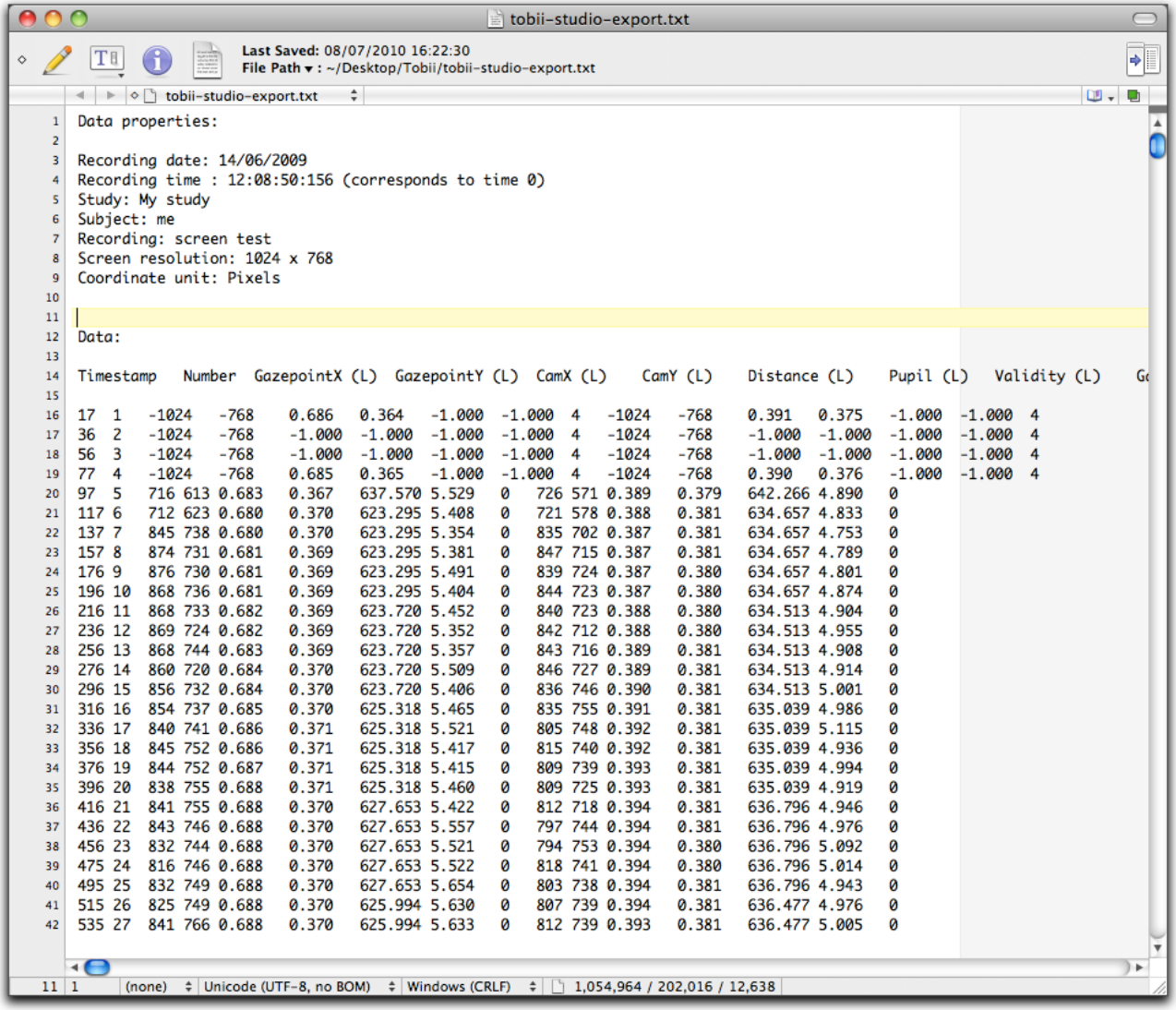

Figure 7. Exported gaze file from Tobii Studio.

1.1.3.3 SR Research (EyeLink)

For eye tracking systems from SR Research (e.g., EyeLink I, II, 1000, 2000) use the ***edf2asc*** program to convert ".edf" to ".asc" files. The ".asc" files contain samples and events information. The ***Eyetracker Output Utility*** will read both information when you click on the "Load Samples File" button.

To determine the correct timings of your relevant events you have to find time point zero. First look for the row that begins with **START** in the ".asc" file. In the example below (Figure 8) **START** is followed by the time stamp 1465324. This is considered in the program as time point 0 and items need to be defined in the *Item Information* file relative to this time point.

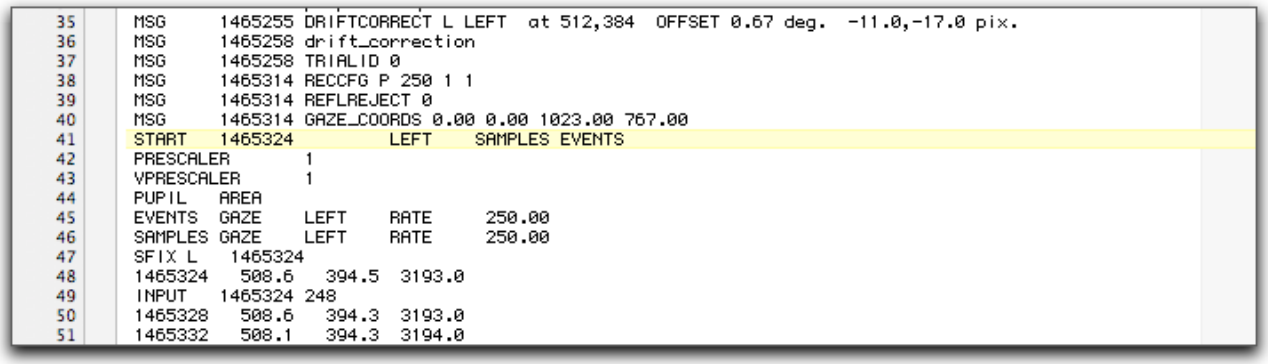

Figure 8. Output file of the edf2asc program.

edf2asc can be downloaded from the SR-Research Support Site.

1.1.4 Events File

The program can read Events files created by the ***IDF converter*** and ***ILAB*** (only fixation output).

Use the "IDF Converter" software that comes with the SMI eye tracker to convert the eye tracker output file to Events output.

1.1.4.1 Example 1: IDF Events file

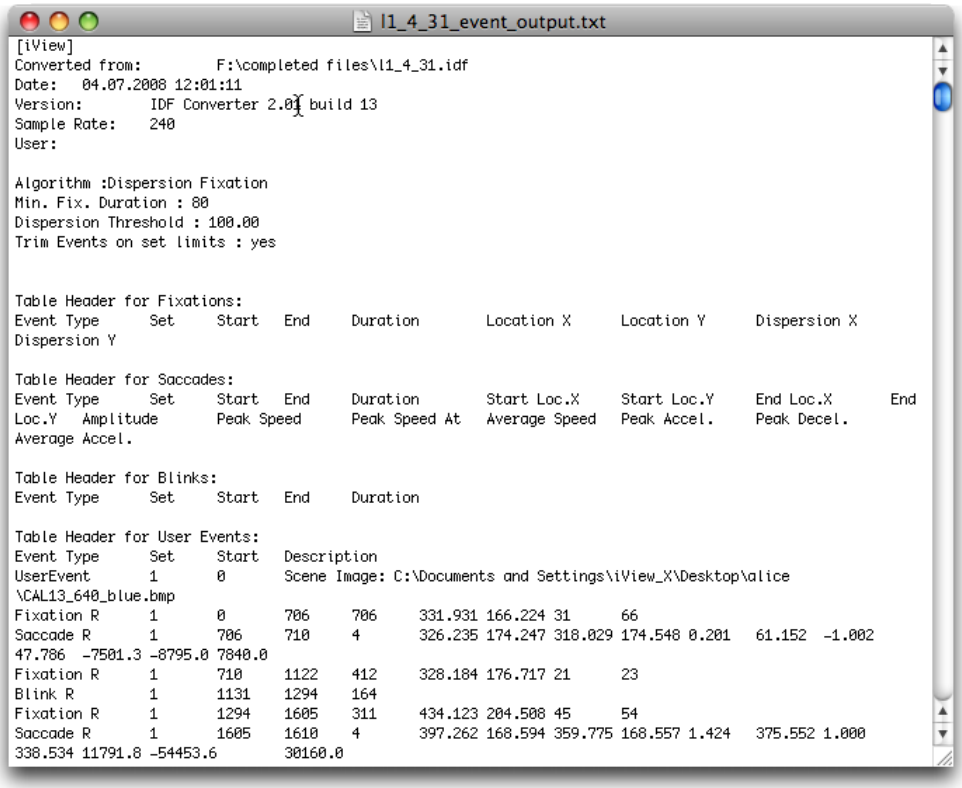

Figure 9. Example of an event output file created with **IDF converter**.

1.1.4.2 Example 2: ILAB fixations file

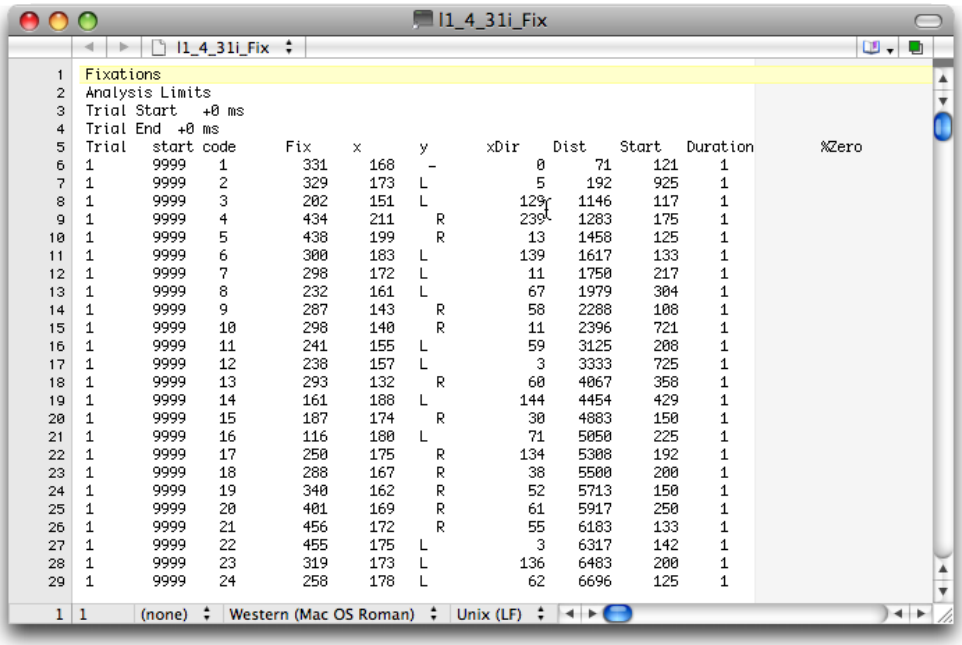

Figure 10. Example of an ILAB fixations output file.

2. Guide to calculate the number of fixations and total fixation durations

2.1 Load Item Info file: e.g., "item-database"

Click on the button "Load Item Info". Section 1.1.1 describes the format of the Item Information file.

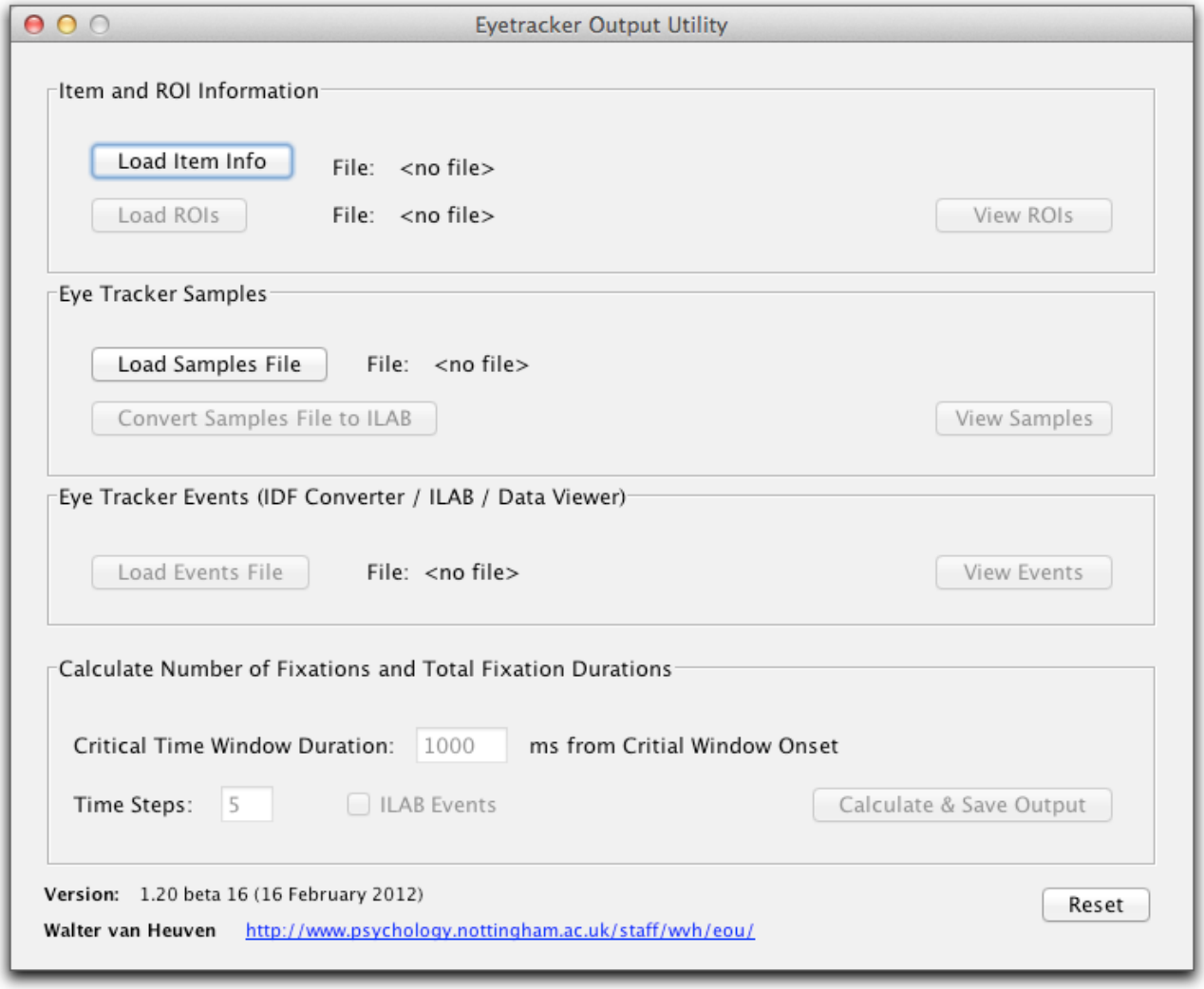

Figure 11. Main window of the ***Eyetracker Output Utility***.

2.2 Load ROIs file: e.g., "roi-database"

Click on the button "Load ROIs". Section 1.1.2 described the format of the ROI file.

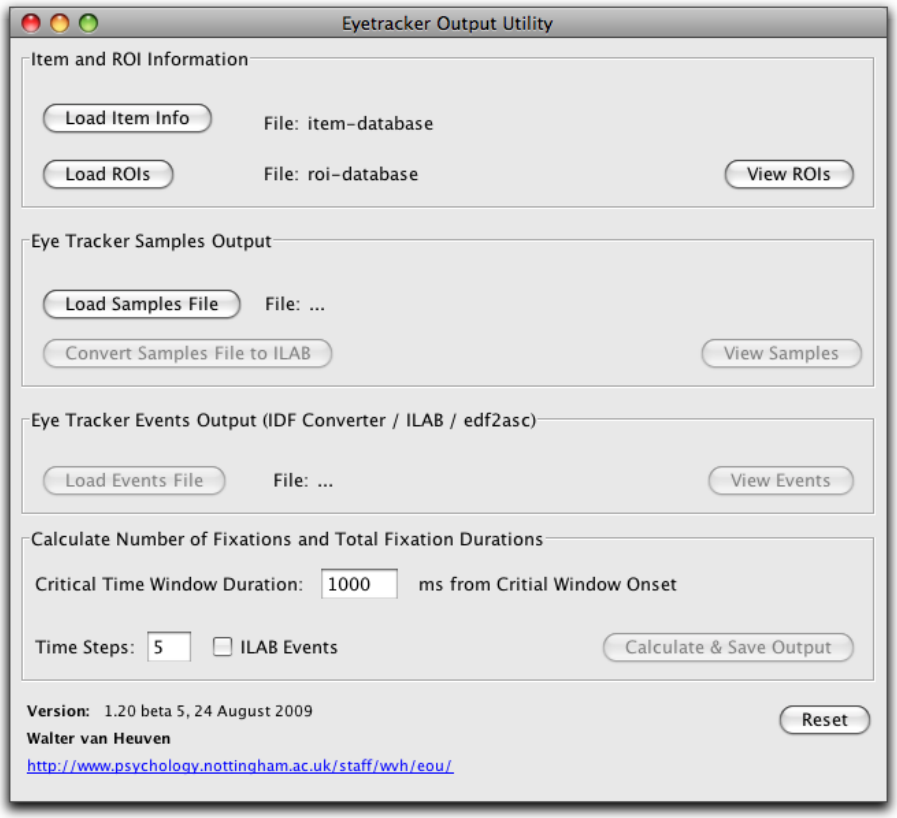

Figure 12. Name of the ROI file is shown.

You can view the ROIs by clicking on the button "View ROIs".

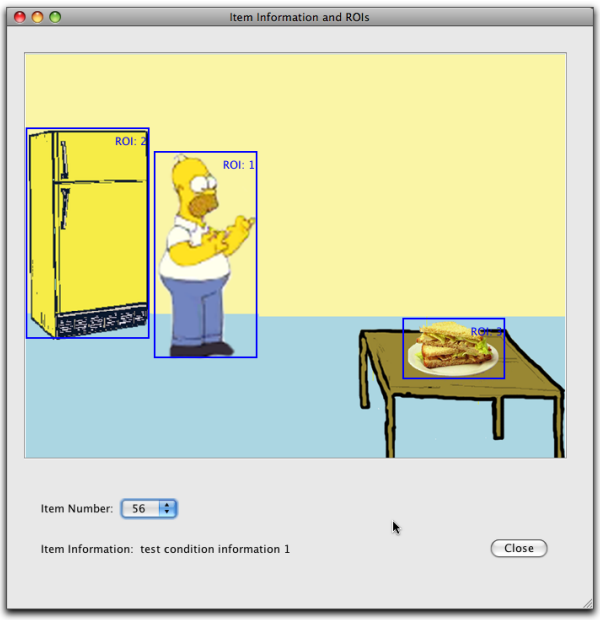

Figure 13. Item Information and ROI screen.

2.3 Load Samples File

Click on the button "Load Samples File". The format of the gaze data file is different for each eye tracker (SMI, Tobii, SR Research). The program reads exported gaze data from the IDF converter, Tobii Studio, edf2asc and EyeLink Data Viewer.

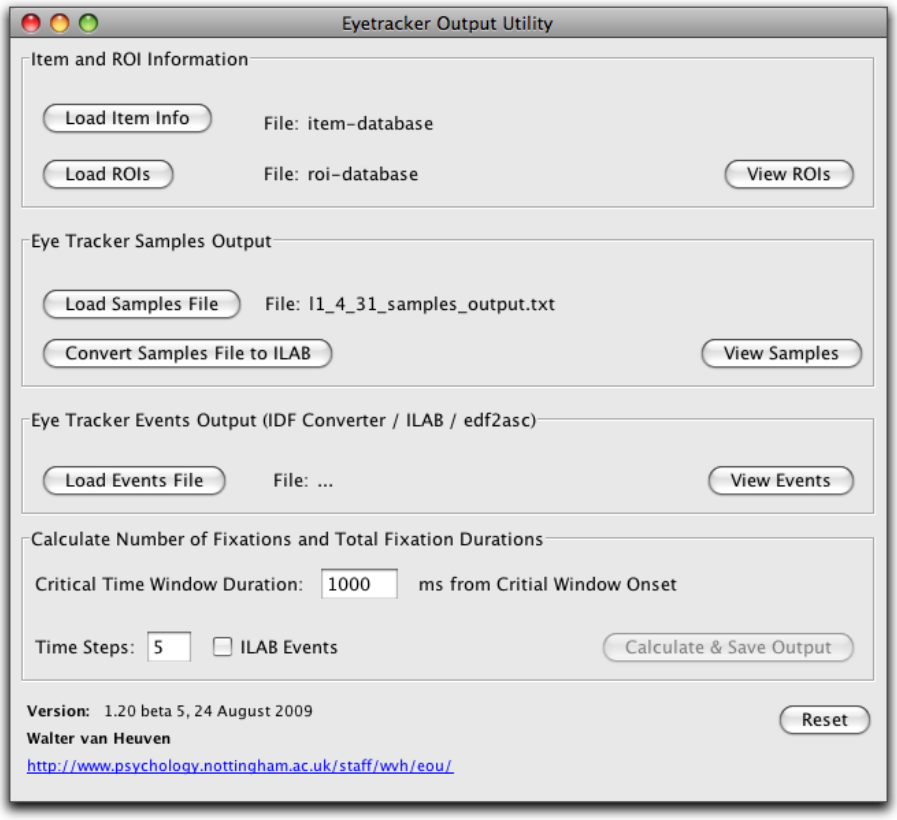

Figure 14. Name of the Sample file is shown and button "View Samples" is enabled.

Click on the button "View Samples" to view the gaze data.

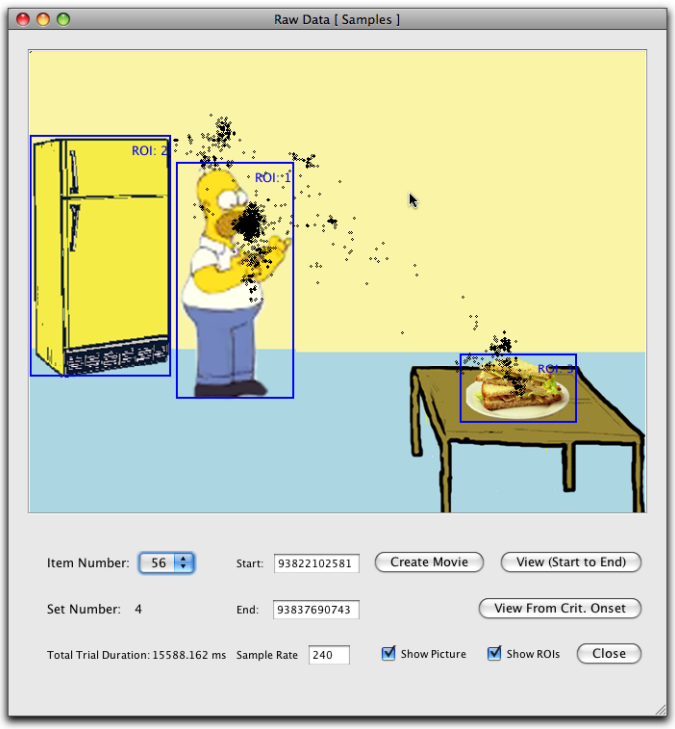

Figure 15. Raw gaze data.

Data can be viewed from trial onset or from critical window onset. Furthermore, the program can create a realtime QuickTime movie of gaze data. Please note that the created QuickTime movies can be very large. To reduce the movie size considerably you can use the QuickTime player with a QuickTime Pro license to compress the movie (e.g., use the "Export for Web" option in the QuickTime player).

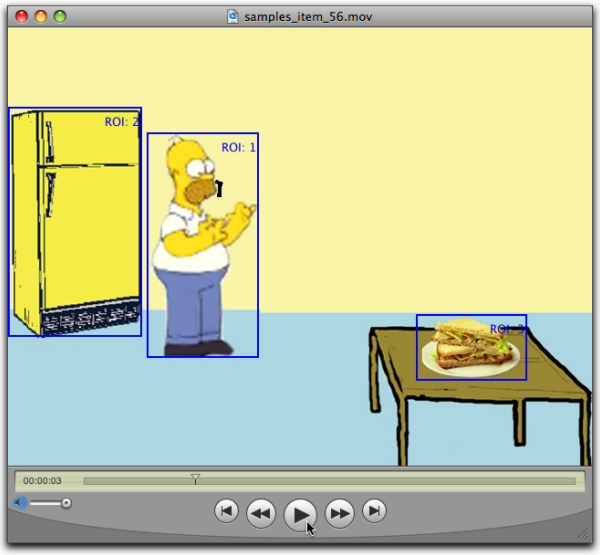

Figure 16. Quicktime movie of gaze data.

You can also convert the gaze data (samples) to a file that you can import in ***ILAB*** so that you can use ***ILAB*** to find fixation, saccade, and blink events. ***ILAB*** is a program for postexperimental eye movement analysis that runs in ***MatLab***. (***ILAB*** website: http://www.brain.northwestern.edu/ilab/).

Gitelman D.R. (2002) ILAB: a program for postexperimental eye movement analysis. *Behavioral Research Methods, Instruments and Computers*, 34(4): 605-612.

Note that the ILAB compatible file contains either 3 columns for Tobii and SMI data (X, Y, codes) or 4 columns (X, Y, pupil data, codes) for EyeLink data.

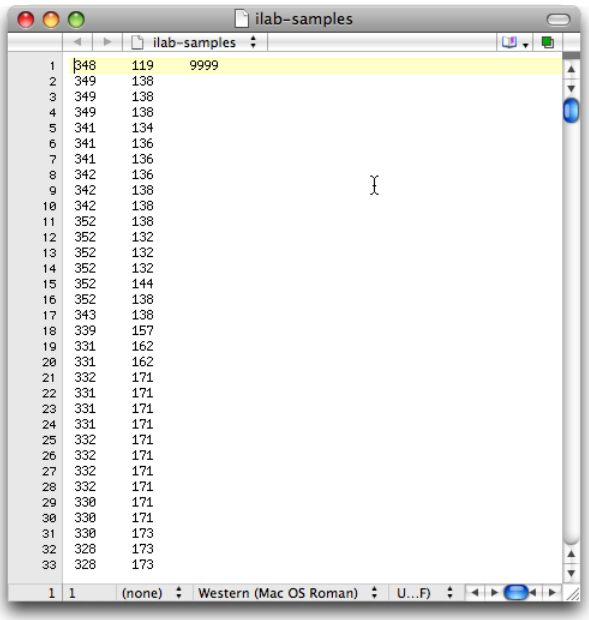

Figure 17. Example of an ***ILAB*** compatible file created by the ***Eyetracker Output Utility***.

2.3.1 Use ILAB to convert samples to fixation information

Below you can find the steps to read the file and calculate the location and duration of fixations. The example below involves data from a Tobii system (50 Hz, 21 trials).

1) File menu -> Convert to Text File...

```
Choose a column delimiter                                          Tab

Enter the number of columns                                        3

Enter column number for Horizontal Eye Data                        1

Enter column number for Vertical Eye Data                          2

Enter column number of Pupil Data or 0 for none                    0

Enter column number for trial starts and stops or 0 for none       3

Enter the data sampling rate in Hz                                 50

Enter the subject ID (or leave blank)

Enter the file creation date (or leave blank)

Enter the file creation time (or leave blank)

Enter a description (or leave blank)
```

2) Properties Window

```
- Click on Edit Trial Codes

- TRIAL CODES

 Start       1:21, 9999

 Target      1:21, 9999

 End         150


 Press on "OK" button

 # Trials, Start Codes, Target, and Stop Codes should now be the same


- Select a Coordinate System: Cortex-640x480


Press on the "OK" button
```

3) Analysis -> Fixations...

Press on the "OK" button

4) Analysis -> Save results as text...

Fixations checkbox should be selected. Press then on the "OK" button to save the data as an Excel file.

5) Convert the Excel file to a tab-delimited text file

Open the Excel file in Excel and then select File->Save As...

The ***Eyetracker Output Utility*** can read this file (see Section 2.4), visualize the fixations, and calculate the number of fixations and total fixation durations in regions of interest within particular time windows (see Section 2.5).

2.4 Load Events file

Click on the button "Load Events File".

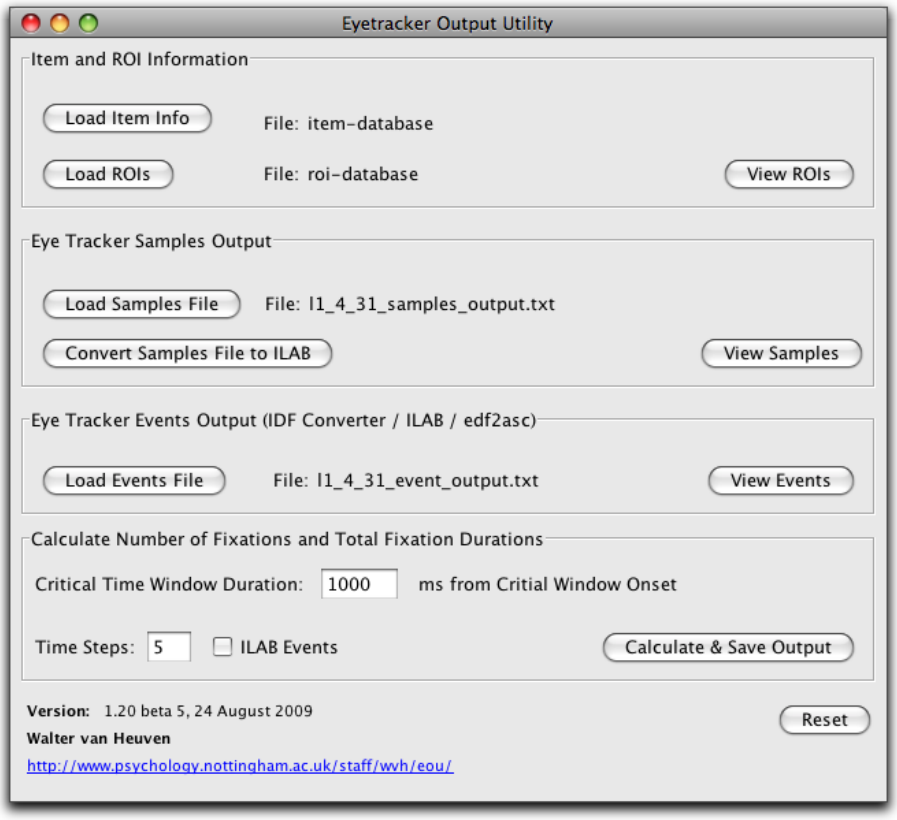

Figure 18. Name of the Event file is shown and button "View Events" is enabled.

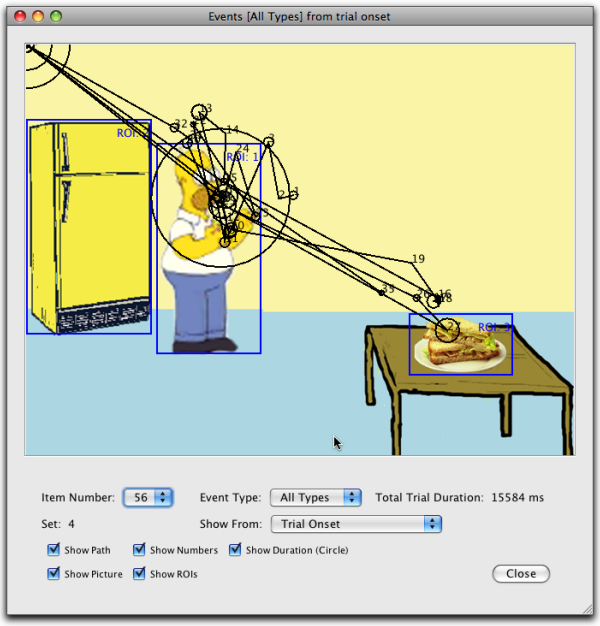

Figure 19. Event data.

Note that "All Types" events includes fixations, saccades, and blinks (coordinates: 0,0).

You can also only view the fixations from the critical window onset.

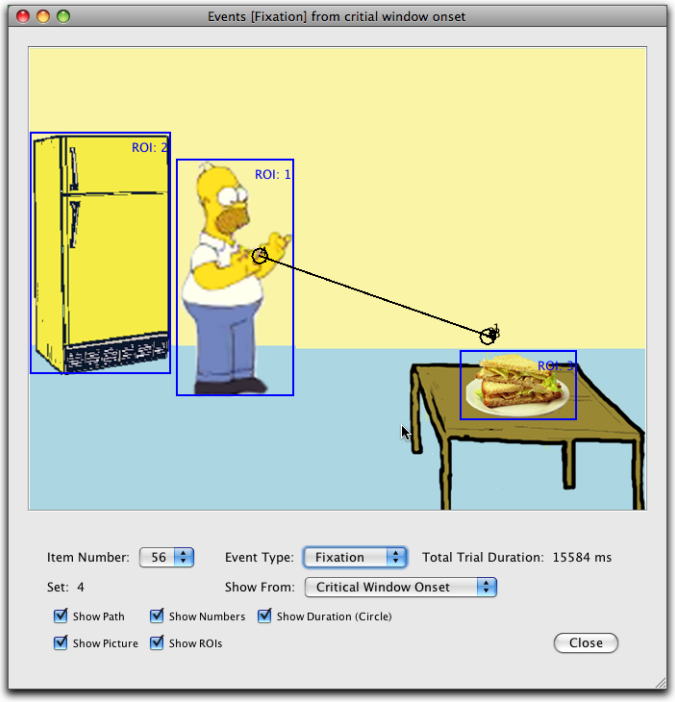

Figure 20. Event data from critical window onset.

2.5 Calculate number of fixations and total fixation durations in ROIs

Enter the Critical Time Window duration in the main window (e.g., 1000 ms) from the Critical Window Onset (see *Item Information* file, page 2). The Critical Time Window duration can also be set to the total duration of the item by using -1 for the Critical Time Window. This requires that the start time and end time of the items are defined in the *Item Information* file.

The program can also calculate the number of fixations and total fixation durations within the Critical Time Window by using a number of time steps (e.g., 2 or 5). If the Critical Time Window duration is 1000 ms and there are 5 time steps the calculations will be based on 5 time windows of 200 ms (0-200, 200-400, 400-600, 600-800, 800-1000).

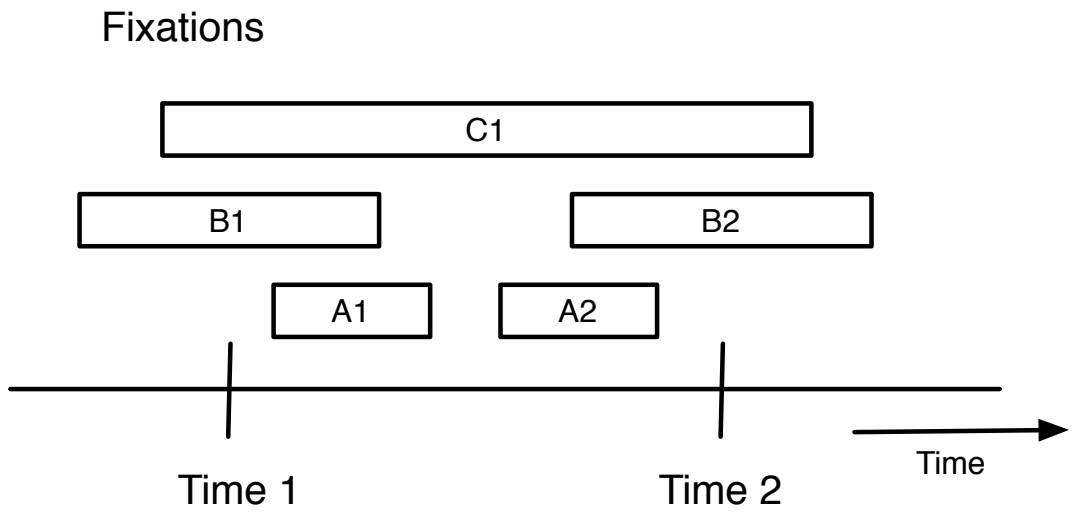

Figure 21. Fixation types for time window: Time 1 - Time 2.

The program includes in the calculations of the number of fixations and fixation durations in a time window (e.g., Time 1 - Time 2) fixations of type A (A1 and A2 both within the time window), type B (B1 starts before Time 1 and B2 ends after Time 2), and type C (fixation C1 start before Time 1 and ends after Time 2). The output file contains total durations for each time window and corrected total fixation durations per time window per region of interest (ROI). Corrected fixation durations take into account the duration of the time window (e.g., fixation duration fixation type B1 is in time window T1-T2 shorter, and for fixation time C the total duration is corrected to the length of the time window. Furthermore, the output also contains the percentage of fixations and percentage of corrected total durations for each ROI.

Note: ROIs are numbered from 1. Fixations outside any of the ROIs are coded as 0. Furthermore, the program assumes that ROIs are not overlapping.

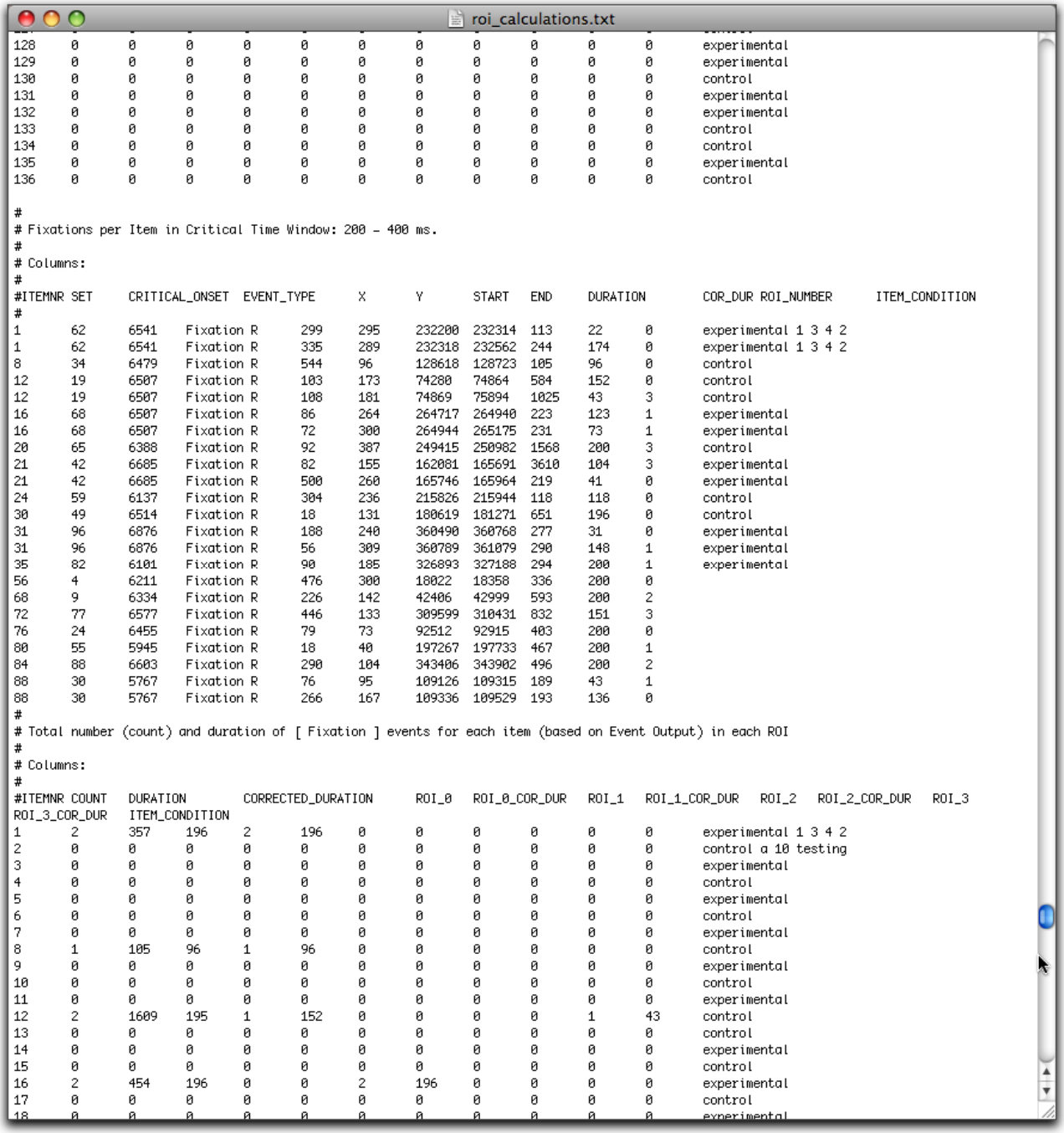

Figure 22. An example of the analyses output.

The output file is a tab-delimited text file that can be opened with for example Microsoft Excel or a simple text editor.

The ROI analysis creates four columns for each ROI:

ROI_n_FIX: total number of fixations in ROI n

ROI_n_FIXPER: percentage of fixations in ROI n

ROI_n_CORDUR: corrected total duration of the fixations in ROI n

ROI_n_CORDUR_PERC: percentage of corrected total duration of the fixations in ROI n