

Experiment HP-23: Lie Detection and Facial Recognition using Eye Tracking

Background

Did you know that when a person lies there are several “tells”, or signs, that a trained professional can use to judge whether the person is being truthful or not? The accuracy of detecting a lie is about 65% for an expert interrogator. But that job may soon fall to a machine rather than a person.

Research being carried out at various universities and research institutes had shown that when a person is lying about certain things, there are minute movements in the eye that are not there if the person is telling the truth. Testing has shown a lie detection accuracy rate of about 83%, way above what a person can do, even those who are fully trained experts.

Our eyes usually give us away when we lie due to their movement. Regular eye movement under questioning usually means we are being truthful, but if that movement changes suddenly and drastically then it's probably going to be due to a lie being told. This is what an eye tracking system looks for when monitoring a person's eyes during questioning about events that have happened or people they may know or have seen.

Researchers have previously monitored parameters such as GSR, heat changes in the body, heart rate and facial movement, but none seem to be as reliable for detecting lies as eye movement. It has been demonstrated that people who are good at lying know how to control their movements and even their heart rate when telling a lie. However, it's much more difficult to keep your eye movements in check, suggesting that eventually using eye tracking systems and software will become the ultimate lie detector that no one can beat.

Researchers may soon be able to tell whether a suspect is lying about recognizing someone they know. Using eye tracking technology, they found that people's eyes moved in a different pattern when looking at faces they recognized rather than ones they have never seen before.

The lead author of one of the studies, Ailsa Millen, states that: "Criminal accomplices often deny that they know other members in their networks. However, if a co-conspirator denies recognition in this way, their eye movements when viewing photos of those suspects, may reveal this type of lie."

Researchers recorded the eye movements of participants while looking at digital color photographs of familiar and unfamiliar faces. Familiar faces included people the participants know in real life, famous celebrities and those only seen briefly before the experimental trials. Sometimes the participants lied about whether they recognized the photos, sometimes they told the truth. It has been found that people's eye movements were different when looking at photographs of faces they knew well compared to those they did not know, despite verbal responses denying recognition. When a participant looked at a face they recognized their eyes moved in a different pattern with fewer fixations. There is substantial evidence to suggest that this pattern is involuntary, which means it would be very hard to control or fake.

Experiment HP-23: Lie Detection and Facial Recognition using Eye Tracking

Equipment Required

PC Computer with 2 monitors (preferable)

IXTA, USB cable, IXTA power supply

EM-220 Event marker

iWire-B3G and electrodes

iTRAX – Eye Tracking System

Start the Software

1. Click on LabScribe
2. Click Settings → Human Psychophysiology → LieDetection-FacialRecognition
3. Once the settings file has been loaded, click the **Experiment** button on the toolbar to open any of the following documents:
 - Appendix
 - Background
 - Labs
 - Setup (opens automatically)

Event Marker Setup

1. Locate the EM-220 event marker ([Figure HP-23-S1](#)), in the iWorx kit.
2. Plug the connector to the EM-220 event marker into the EM1 Channel input on the back of the IXTA ([Figure HP-23-S2](#)).



Figure HP-23-S1: The EM-220 event marker.



Figure HP-23-S2: The IXTA with the EM-220 event marker.

3. Locate the iWire-B3G and attach the red, black and green leads ([Figure HP-23-S4](#)).
4. Use an alcohol swab to clean and scrub the areas where the electrodes will be placed ([Figure HP-23-S3](#)). Let the areas dry before attaching the electrodes.

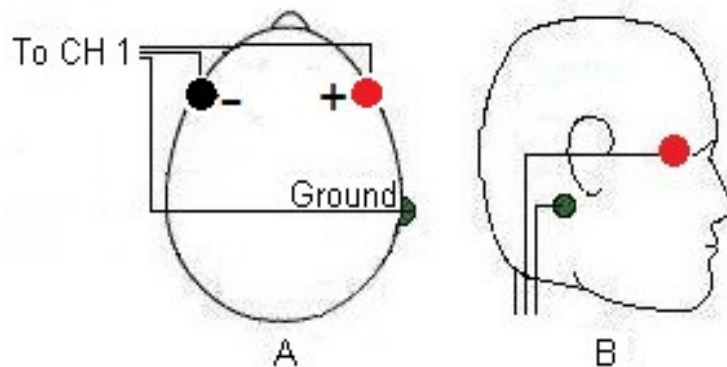


Figure HP-23-S3: Placement of electrodes for recording an electroculogram (EOG).

5. Trim the electrodes and then remove the plastic disk. Apply the electrodes to one of the scrubbed areas. Attach an electrode to each of the other areas.
6. Snap the recording lead wires onto the electrodes, so that:
 - the red (+1) lead is on electrode next to the right eye.
 - The black (-1) lead is on electrode next to the left eye.
 - the green (C) lead (the ground) is on electrode below the right ear.
7. Drape the leads for the electrodes over the subject's shoulders to the lead pedestal which hangs freely down the subject's back and over the chair. There should be no tension on the electrodes.



Figure HP-23-S4: iWire-B3G EOG cable attached to the front of the IX-TA.

Eye Tracker Setup

1. Open “External Devices” on the main menu bar ([Figure HP-23-S5](#)).

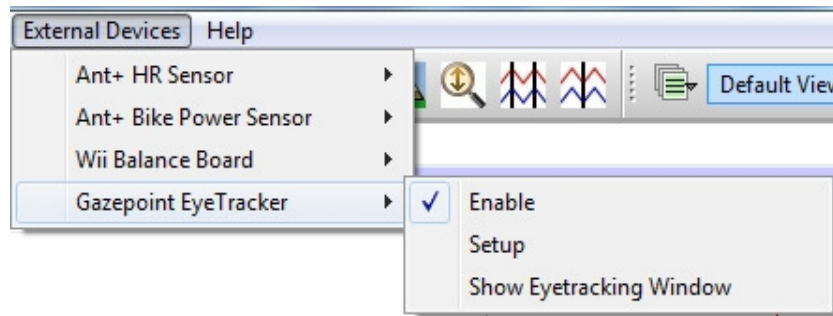


Figure HP-23-S5: External Devices set up window.

2. Enter the license information provided and set up the parameters for eye tracking ([Figure HP-23-S6](#)) and open the Setup:
 - **Gaze Duration (msec):** The amount of time, in msec, before the current time that fixation information will be displayed in the Eye Tracking window.
 - **Outlier Filter (msec):** The amount of time, in msec, that the eye has to be fixated at a single spot. If the fixation duration is less than the Outlier Filter value, then the fixation will not be displayed in the Eye Tracking window.
 - **Time Offset (msec):** This can be used to take care of any time offset between the eye tracking data and LabScribe data.
 - **Display Scaling (%):** The Eye Tracker tracks the complete screen. We want to analyze LabScribe data as well as eye tracking data. Display scaling allows for the eye tracking window to show a scaled version of the screen.
 - **Fixation Size:** The “fixation” data is shown as a circle whose radius is proportional to the fixation duration. The circle size is the radius of the circle in pixels corresponding to a 1 second fixation duration.
 - **Show Heatmap:** The heatmap corresponds to the length of time of fixation on a certain area of the image.

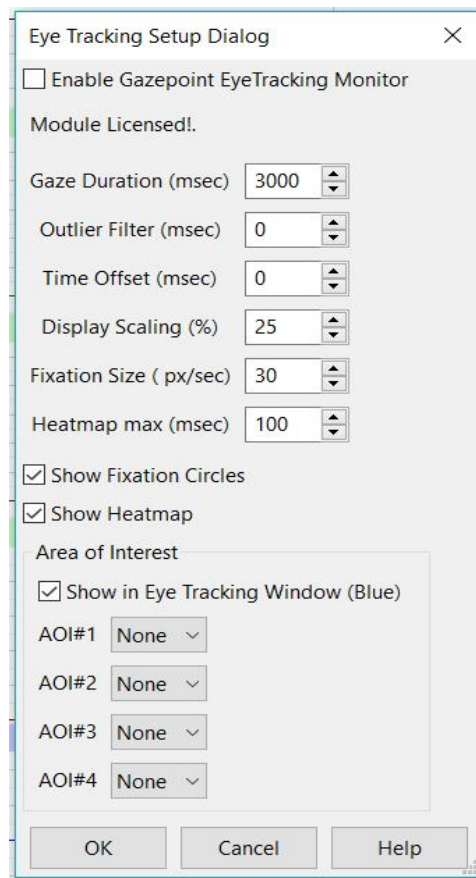


Figure HP-23-S6 Eye tracking set up dialog window.

3. Set up the Area of Interest (AOI) if there is a specific location on the image you wish the subject to focus on. Note that some experiments will just want to see where the subject is focusing rather than knowing when the subject focuses on the “designated” area.
 - Choose AOI#, click the drop down to have the AOI shown as a circle or rectangle
 - Open the image that the subjects will be looking at in an image editing program such as Paint, Photoshop, Lightroom
 - Hover over the AOI, note the X and Y pixel coordinates – and enter these in the boxes to the right of AOI#
 - When you choose to “Show the EyeTracking Window” - the image the subject is looking at will be shown on one monitor with the AOI in blue. The actual image the subject will be looking at on the second monitor will not show the AOI.

NOTE: If you want to know when the subject looks at a specific location, you must set the AOI.

4. To acquire eye tracking data, the GazePoint module has to be enabled in LabScribe and the GazePoint application has to be running.

5. Calibrate the GazePoint Eye Tracking sensor ([Figure HP-23-S7](#)).

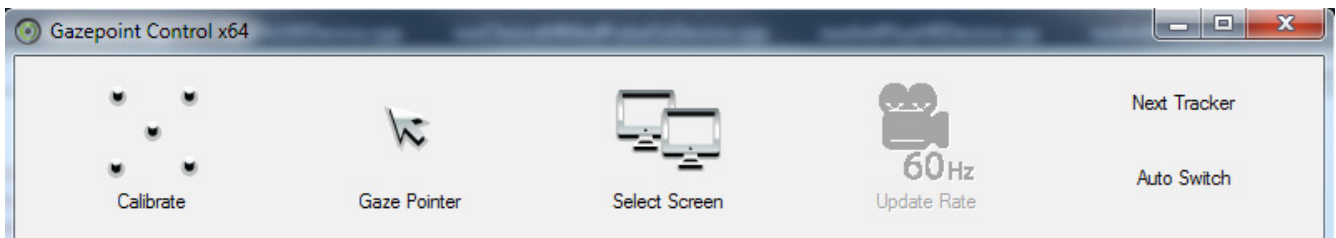


Figure HP-23-S7: Eye tracking calibration window.

5. Choose the screen that the subject will be using. Then calibrate the Eye Tracker.
6. Refer to the GazePoint manual for more instructions to calibrate the system.
7. The image window in LabScribe should be moved over to a second monitor if using multiple monitors. Note that 2 monitors is preferable in this experiment especially when looking at AOI data.
8. Enable the Eye Tracking window by choosing External Devices → GazePoint Eye Tracker → Show Eye Tracking Window ([Figure HP-23-S8](#)).

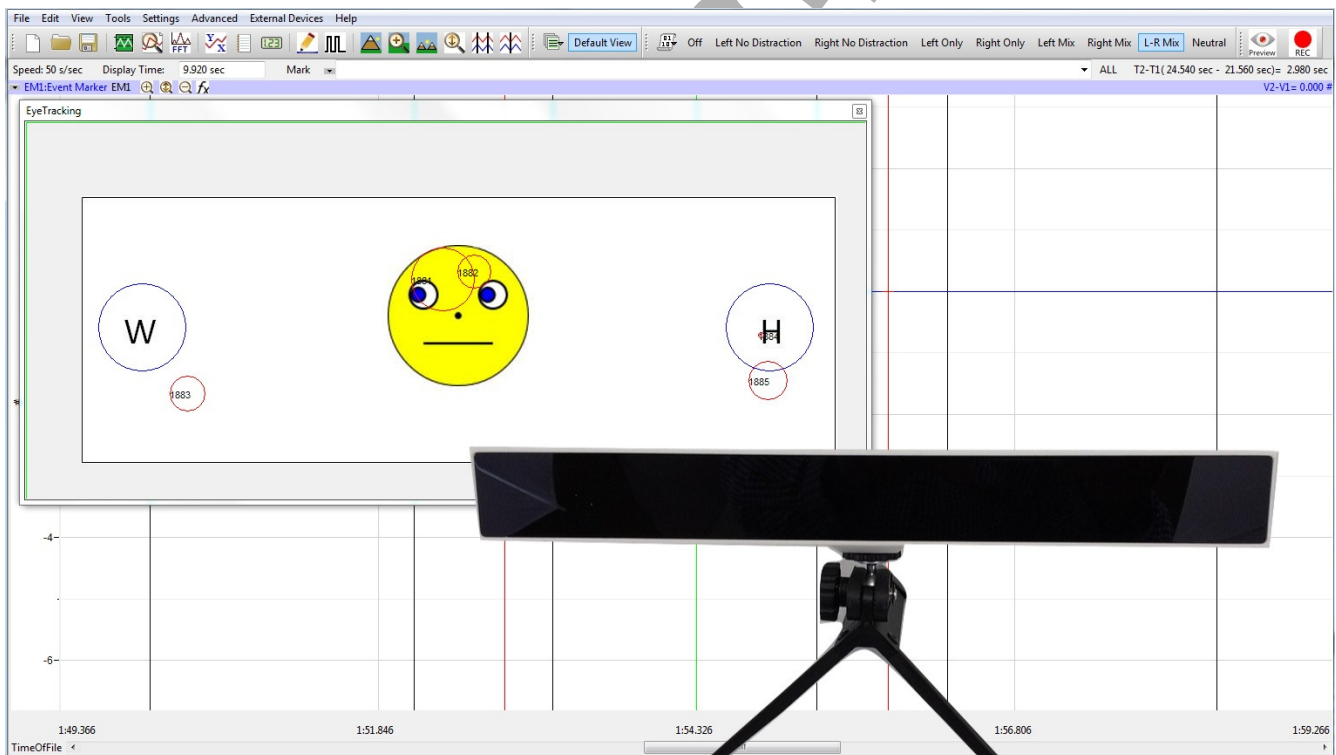


Figure HP-23-S8: Eye tracking window and GazePoint Eye Tracker.

Experiment HP-23: Lie Detection and Facial Recognition using Eye Tracking

NOTES:

1. The subject will be shown a series of male and female faces.
2. Some of these faces should be very recognizable to the subject, some will not be.
3. If the subject recognizes the face shown in the image, he or she should click the event marker.
4. If the subject does not recognize the face, do not click the event marker.

Exercise 1: EOG, Reaction Time and Truthful Facial Recognition

Aim: To measure the reaction time of a subject to a male or female facial image.

Approximate Time: 15 minutes

Procedure

1. Read all instructions carefully before beginning to record.
2. Information for the subject:
 - Instruct the subject to sit in a chair and face the computer screen.
 - Watch the computer screen and press the event marker **only** when the subject recognizes the face ([Figure HP-23-L1](#)).

Warning: *In this exercise, it is important to press and release the button of the event marker as soon as the face is recognized. Do NOT click the marker if you do not know who the person is. ([Figure HP-23-L2](#))*

3. Click on the Record button. Press the mark button to mark the recording.
4. Choose **Faces** from the Sequences list ([Figure HP-23-L2](#)).
5. Instruct the subject to press the event marker as soon as (and only if) he or she recognizes the person ([Figure HP-23-L3](#)).
6. 20 images will appear for the subject.
7. After the twentieth image, a gray square will appear. Click Stop to halt recording.
8. Select Save As in the File menu, type a name for the file.
9. Click on the Save button to save the data file.

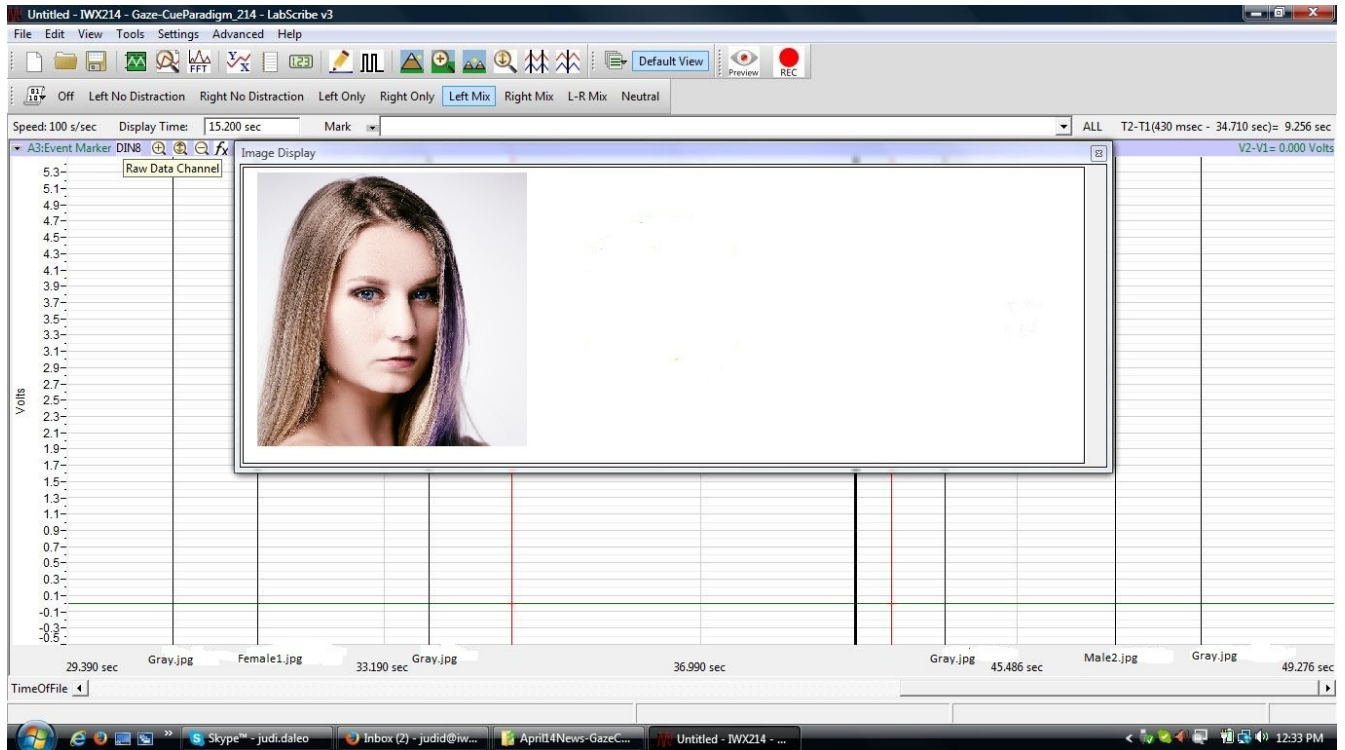


Figure HP-23-L2: Sample image that will appear for the LieDetection testing.

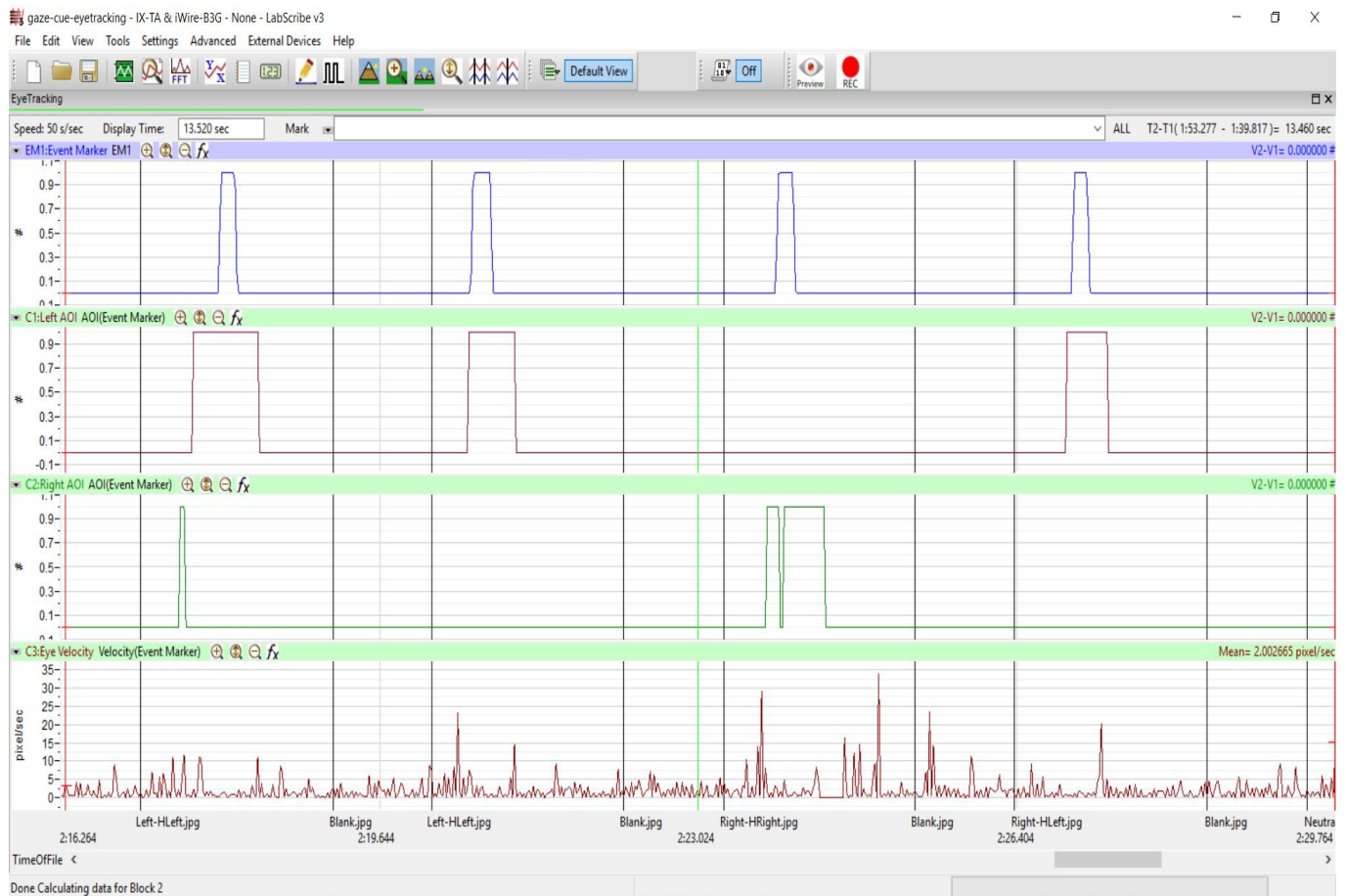


Figure HP-23-L3: Example of four visual cues, each followed by the subject's responses, are displayed on the Main window.

- The visual cues are made automatically by the sequences
- The “Event Marker” channel shows when the subject clicks the event marker to **ONLY** signal recognition. He or she should **NOT** click the event marker if the person is not recognized
- The “AOI-Left” and “AOI-Right” channels will show when the subject “locked” onto the image if you set up the AOI
- The Velocity channel shows the eye movement velocity as the eye moves to and focuses on the target
- The light green line on the screen shows exactly when the specific image was shown.

Data Analysis

NOTE: Make sure to “Show the Eye-Tracking Window” before starting data analysis.

1. Scroll to the beginning of the data recorded for Exercise 1 to display the first trial on the Main window.

2. Use the Display Time icons to adjust the Display Time of the Main window to show 4 or 5 responses for when the sequence was running. This data can also be selected by:
 - Placing one cursor before the beginning of the first image cue and the second cursor after the mark made by the 4th or 5th gray image (mark will state: gray); and
 - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the trials to the width of the Main window.

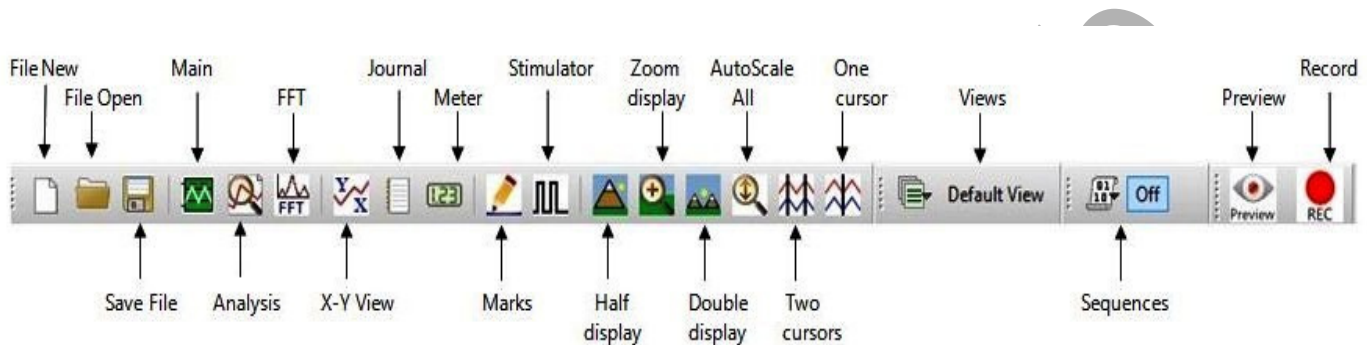


Figure HP-23-L4: The LabScribe toolbar.

3. Check to see if there is an offset time between the “mark” for the image and the time the actual image was shown ([Figure HP-23-L3](#)).
 - Place one cursor on the mark for any image.
 - Hold the Ctrl key and slowly drag the actual recording window until that image shows up in the Eye-Tracking window. Stop scrolling.
 - Keep the first cursor on the mark and place the second cursor on the green line that shows up when the image is actually displayed.
 - Look at T2-T1 in the upper right corner of the screen – this is your offset time.
 - Click External Devices → Setup
 - Enter the Offset Time. If the green line is to the right of the mark – the offset time is negative. If the green line is to the left of the mark – the time is positive.
 - Click OK
4. Data should be collected from the Main window; though the Analysis window can also be used. If you choose to use the Analysis window, click on the Analysis window icon in the toolbar.
5. The mathematical function T2-T1 should appear on screen. Value T2-T1 is located in the upper right corner of the recording window. ([Figure HP-23-L5](#)).
6. Use the mouse to click on and drag a cursor to the onset of the image shown, this will be represented by the vertical green line with an annotation at the bottom. Place the 2nd cursor so that it is on the beginning of the mark generated by the subject using the event marker as a response to identifying the person in the image. The value for T2-T1 is the reaction time.

7. Leave the first cursor on the green line and move the other cursor over to the beginning of the square wave when the AOI was reached. The value for T2-T1 is the time it took the subject to identify the image.
8. Leave the one cursor on the beginning of the AOI and move the second cursor to the beginning of the mark generated by the subject using the event marker. The value for T2-T1 is the delay between actually focusing on the target and the reaction by the subject.
9. Measure the velocity of the eye movement by as the subject focused on the image by placing the cursors so that one cursor is on the green line and the 2nd cursor is 500 msec from the first cursor. The value “Mean” on the Velocity channel is how fast the subject’s eyes were moving during that time period.
8. Once the reaction times in all 20 trials have been measured and recorded, determine the mean values for the subject for reaction time, focusing time, and delay. Discard the longest and shortest times from the data set, and determine the average of the remaining reaction times. Record the times for this exercise in [Table HP-23-L1](#).

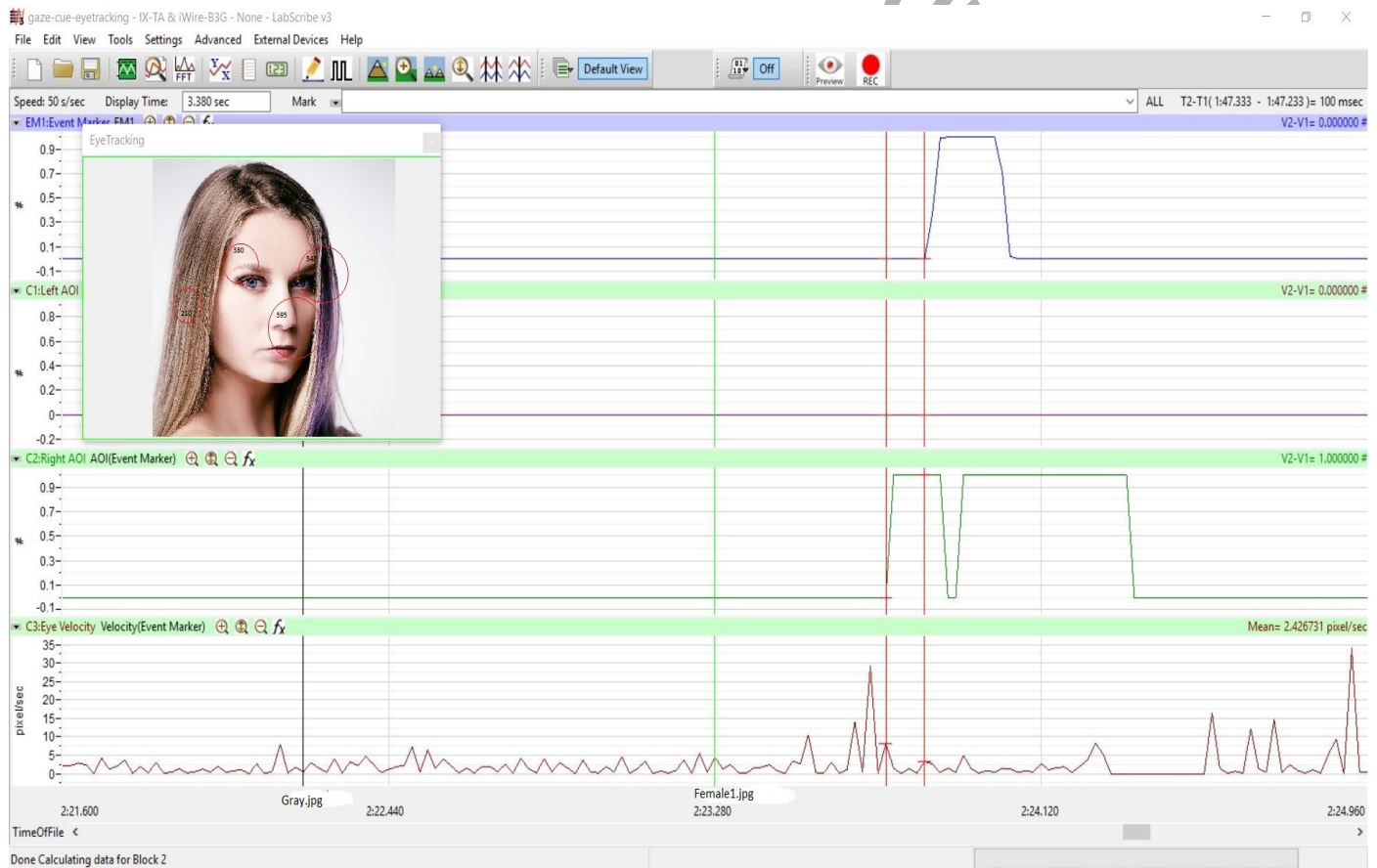


Figure HP-23-L5: A single image shown (represented by the green line). The two cursors are positioned at the beginning of the AOI and on the mark for when the subject reacted to the image. The T2-T1, 100msec, is the delay time for this reaction.

9. The heatmap can be displayed on this screen if selected in the EyeTracking setup.

10. Observe the EOG responses when the subject truthfully recognizes an individual or not. These EOG patterns should all resemble each other.
11. Compare the EOG from the image response with the EOG during facial recognition. Position the cursors so they are either side of the EOG response and measure the Max-Min on the right side of the EOG channel.

Table HP-23-L1: Reaction Times for Identifying Faces

[illegible]

Exercise 2: EOG, Reaction Time and Deceitful Facial Recognition

Aim: To measure the reaction time of a subject to a male or female facial image when lying about the image.

Approximate Time: 15 minutes

Procedure & Data Analysis

1. Follow the directions from Exercise 1, running the ***Faces2*** sequence.
 - The subject should be able to recognize all the famous images.
 - When the subject looks at an image, have them lie about knowing some of them.
 - There will be 20 famous faces shown, ask the subject to lie for at least 5 of them but not more than 15.
 - REMINDER – they should only click the event marker when they are telling the truth about recognizing the individual.
2. Click Save to save your data.
3. Use the same technique explained in Exercise 1 to measure and record the times for the subject presented with these famous facial images.
4. Enter the times for this exercise in [Table HP-23-L2](#).

Questions

1. How does the subject's mean reaction time to recognizing faces?
2. What is the difference in EOG pattern (what does it look like) when the subject is being truthful compared to lying? Compare Exercise 2 truthful and lying.
3. What is the difference in mean Max-Min value of the EOG pattern in Exercise 2 when the subject is being truthful versus lying about recognition.

Table HP-23-L2: Reaction Times for Identifying Faces - Deceit

[illegible]