

Lesson 8 EOG 1 *Electrooculogram*

Physiology Lessons
for use with the
Biopac Science Lab MP40

PC running Windows® XP
or Mac® OS X 10.3-10.4

David W. Pittman, Ph.D.
Kara L. Bopp, Ph.D.

Department of Psychology,
Wofford College

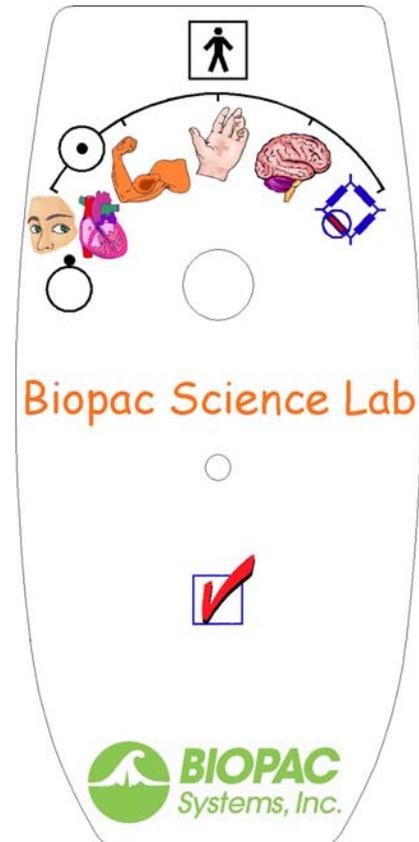
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BIOPAC Systems, Inc.
42 Aero Camino, Goleta, CA 93117
(805) 685-0066, Fax (805) 685-0067

info@biopac.com
www.biopac.com



Lesson 8 EOG 1 Electrooculogram



I. SCIENTIFIC PRINCIPLES

The movement of each eyeball in its orbit is caused by the individual contractions of six small voluntary muscles attached to the surface of the eyeball. Four of the six muscles run straight from origin to insertion, and thus are termed recti muscles (*rectus*, straight): the **superior rectus**, the **inferior rectus**, the **medial rectus**, and the **lateral rectus**. The remaining two muscles are obliquely attached to the eyeball surface and are called the **superior oblique** and the **inferior oblique** (Fig. 1). Collectively, the four recti muscles and the two oblique muscles are called **extrinsic eye muscles**.

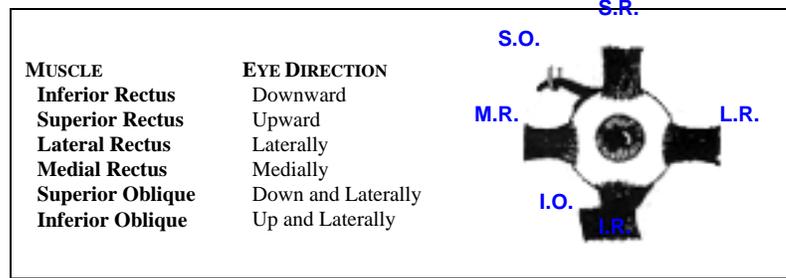


Fig. 8.1 Muscles of the (labeled for the left eye)

Contractions of the extrinsic muscles are controlled by way of motor pathways in the brain and three pairs (one right, one left) of cranial nerves. Cranial nerve III, the **oculomotor nerve**, supplies all extrinsic eye muscles except the superior oblique and the lateral rectus. Cranial nerve IV, the **trochlear nerve**, supplies the superior oblique. Cranial nerve VI, the **abducens nerve**, innervates the lateral rectus.

Position	Right Gaze		Straight Ahead <i>Both eyes</i>	Left Gaze	
	<i>Right eye</i>	<i>Left Eye</i>		<i>Right eye</i>	<i>Left Eye</i>
Upward	Superior rectus	Inferior oblique	Superior rectus, Inferior oblique	Inferior oblique	Superior rectus
Centered	Lateral rectus	Medial rectus	Central Gaze	Medial rectus	Lateral rectus
Downward	Inferior rectus	Superior oblique	Inferior rectus, Superior oblique	Superior oblique	Inferior rectus

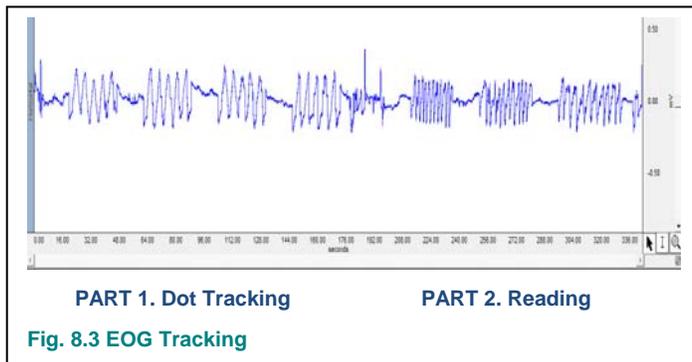
Fig. 8.2 Nine cardinal directions of gaze

When a normal person gazes at an object, the fixation point of the gaze is projected onto corresponding sensory areas in the foveas of the retinas. The occipital lobe cortex integrates the sensory information from each retina, producing normal, single binocular vision. If there is a disruption in the alignment of the eyes, there is a loss of retinal correspondence and the result may be **diplopia** or **double vision**. Nine cardinal directions of gaze in concerted eye movement and the extraocular muscles moving the eyes to the gaze position are shown in (Fig. 8.2).

When a person maintains visually focused on a moving object without moving the head, such as in watching the swinging pendulum of a clock, each eye must move precisely and in concert with the other for the brain to receive the sensory information required to produce a clear, single image of the moving object. The eyeball movement involves the extraocular muscles, their cranial nerves, and motor control centers in the brain. For example, as the clock pendulum swings from left to right, the left eye moves medially (medial rectus/cranial nerve III), and the right eye moves laterally (lateral rectus/cranial nerve VI). When the pendulum swings back, the eye movements are reversed. Visual sensory information regarding the change of position of the moving pendulum is used by the brain to grade the contractions of extraocular muscles so as to maintain the visual fixation point as the pendulum slows and speeds up during its swing. The oscillating, or back and forth voluntary movements of the eyes, are a form of **smooth pursuit movements** in which the eyes maintain a visual fix on an object moving within the visual field.

Coordinated voluntary eye movements are initiated and controlled in the motor cortex of the frontal lobes. Cortical activity associated with motor control of the extraocular muscles can be detected and recorded using conventional electroencephalographic techniques. **Electrooculography (EOG)** is the measurement and interpretation of **electrooculograms**, which are the electroencephalographic tracings obtained while the subject, without moving the head, moves their eyes from one fixation point to another within the visual field.

An EOG recorded from temporal electrodes placed at the lateral margin of the orbits of a subject visually tracking the movement of a dot in an oval pattern is shown in (Fig. 8.3). The sinusoidal nature of the tracing disappears when the dot stops and the subject fixates on a center point, and hence the visual tracking, is stopped.



Other changes in the EOG may be recorded when a subject is asked to silently read a brief paragraph, words in each sentence are read, the eyes move quickly and in a jerky manner from one fixation point (a word) to another. Quick, jerky, voluntary movements of the eyes are called **saccades** (saccade – jerky). When the reading is silent, the eyes move more quickly from left to right as the lines are read. When the lines are read aloud, the auditory input slows eye movement to allow time for each seen word to be spoken.

EOG is commonly used to assess visual defects involving neuromuscular control of the eyes, such as in diagnosis and treatment success of sixth nerve palsy (paralysis of the lateral rectus). Similar eye movement/cranial nerve tests using other cardinal gazes (Fig. 8.2) may be employed in diagnosis and assessment of eye disorders. In addition, recent applications include the use of EOG in the design of robotics, such as motorized wheelchairs and other devices that can be guided or otherwise controlled by movement of the subject's eyes.

In this lesson, you will record horizontal eye movement and study saccades and fixation.

II. EXPERIMENTAL OBJECTIVES

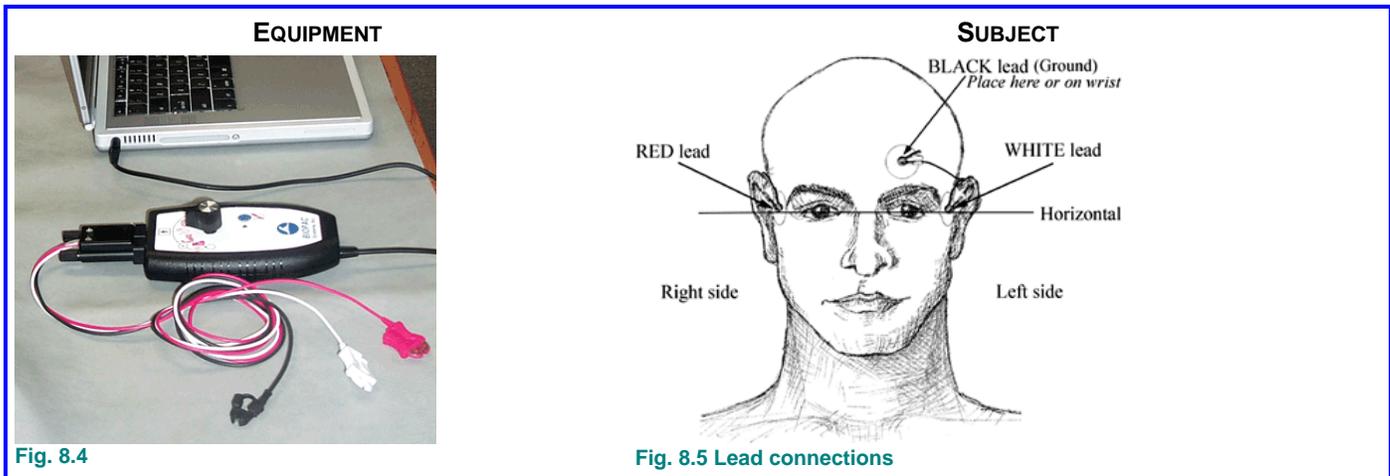
- 1) Record an EOG on the horizontal plane and compare eye movements under the following conditions: horizontal tracking of a dot (control), horizontal tracking of a dot while a portion of the path is obscured with and without a guideline (experimental). The dependent variables measured are the speed of eye movements and time spent paused between movements.
- 2) Measure eye movements during silent reading of easy, intermediate, and difficult language levels. The dependent variables measured are the duration of saccades and fixation times.

III. MATERIALS

- Computer system (running Windows XP or Mac OS X)
- Biopac Science Lab system (MP40 and software)
- Electrode lead set (40EL lead set)
- Disposable vinyl electrodes (EL503), three electrodes per subject
- PowerPoint presentation with horizontal dot tracking and reading stimuli.

IV. EXPERIMENTAL METHODS

A. Set Up



FAST TRACK

1. Turn the computer **ON**. Follow the directions to the right to log in and connect to the Internet.

2. Set the MP40 dial to  **OFF**.

3. **Plug the equipment in** as follows:

Electrode leads (40EL) → MP40

4. **Attach three electrodes** to the subject as shown above in Figure 8.5.

IMPORTANT For accurate recordings, attach the electrodes so they are horizontally aligned.

5. Connect the electrode **leads** (40EL), matching lead color to electrode position as shown above.

IMPORTANT

Clip each electrode lead color to its specified electrode position.

6. **Start** the Biopac Science Lab software.

7. Choose lesson **L08-EOG-1** and click **OK**.

8. Type in a unique **file name**.

9. Click **OK**.

Details

Log into the computer with this user name .PSY150 and password Psychology1. Once the computer starts you will need to click on the textbox at the bottom right of the screen to log onto AirTerrier. Enter your MyWofford user name and password. This will connect you to the network which will allow you to send your data file and notes to yourself through email and to print to the student use laser printer located in the Psychology Suite (Milliken 231).

Attach three electrodes to the subject as shown in Fig. 8.5:

- Attach one electrode to the right temple.
- Attach one electrode to the left temple, such that it is horizontally aligned with the right electrode.
- The other electrode is for ground, and it can be placed anywhere on the forehead, as optimum for the subject's comfort and minimal cable strain.
- You may wish to wrap the cords behind your ears.

Click on the BSL icon at the bottom left task bar.

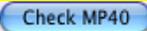
No two people can have the same file name, so use your myWofford network id (for example: lefebvrej). Your data will be automatically saved to a folder using this name.

This ends the Set Up procedure.

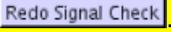
B. Check

FAST TRACK

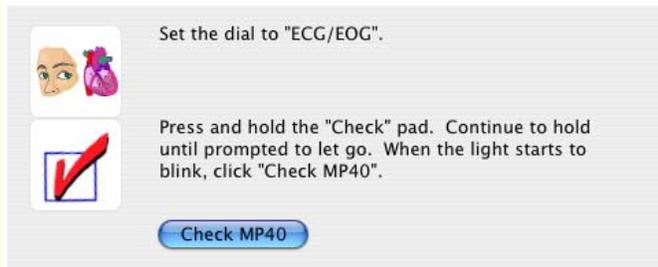
MP40 Check

1. Set the MP40 dial to  EOG.
2. Press and hold the  **Check** pad on the MP40.
3. Click  when the light is flashing.
4. Wait for the MP40 Check to stop.
5. Let go of the  **Check** pad.
6. Click **Continue**.

Signal Check

7. Position the **Subject** according to the directions to the right. Refer to the photo on the front page of these instructions for an example of positioning and holding your head still during the recording.
8. Make sure that the distance to the screen for calibration is the same distance to the stimulus presentation screen.
9. Click **Check Signal** and click **OK**.
10. Track the onscreen dot from right to left until the Signal Check stops.
11. Review the data.
 - If correct, go to the Record section.
 - If incorrect, click .

Details



Continue to hold the pad down until prompted to let go.

The MP40 check procedure will last five seconds.

The light should stop flashing when you let go of the **Check** pad.

When the light stops flashing, click **Continue**.

Have the Subject adjust the seating position such that the eyes are in line with the center of the computer screen. The subject should ideally be 12 inches from the screen.

You may wish to put your elbows on the table (or on your leg) so you can rest your chin on the palms of your hand in order to keep your head stable.

You must keep the same distance between your head and the screen for both the calibration and the testing. It is important to NOT MOVE YOUR HEAD and only move your eyes.

Subject should follow the dot with eyes only, trying not to move or blink.

The 14-second Signal Check recording should resemble Fig. 8.6.



Fig. 8.6 Signal Check recording data

If the recording shows large spikes or baseline drift, the Subject likely blinked and should click **Redo Signal Check**.

C. Record

In order to work efficiently, read this entire section before starting the lab so you will know what to do before the recording has begun.

FAST TRACK

1. Prepare for the recording. Use the directions to the right to open the stimulus file.
2. Position the **Subject** such that the eyes are in line with the center of the stimulus presentation computer screen, using the same distance from the Signal Check.

Part 1 — Control test – follow oval.

3. Follow the directions for the horizontal dot tracking experiment.
4. Click **Record**.
5. **Subject** tracks movement until dot stops
6. **Advance** to the next slide and complete all tracking stimuli until you reach the slide containing directions for the reading portion of the experiment.
7. Click **Suspend**.
8. Review the data.
 - If correct, go to **Step 9**.

- If incorrect, click **Redo**.

Details

Click on the Windows Start Menu and choose “Documents”. Select the folder BScL Lessons. Right-click on the EOGstimulus PowerPoint file and choose Show. Read the instructions slide. When you are ready to begin, press the

Windows Start button  on the keyboard and select the Biopac Science Lab program.

Refer to the photo on the front page of these instructions for an example of positioning and holding your head still during the recording.

It is very important that the subject keeps their head still during the EOG recording and only moves their eyes.

When you click **Record**, the recording will begin. The subject should remain still while the experimenter clicks on the PowerPoint Slide Show to resume the stimulus presentation. The experimenter advances to the first stimulus slide.

The Subject should be seated and relaxed and should track movement with eyes only, trying not to move head or blink.

Before and after each stimulus, the subject should not move their head but should stare at the red fixation dot at the center of the screen until the next stimulus. The slides will automatically advance. After the final stimulus, switch back to the Biopac Science Lab (press windows keyboard button) and click **Suspend**. The recording will halt and you can review the data.

On the Biopac program click the Display menu, then autoscale horizontal. Your data should resemble Fig. 8.7 below.

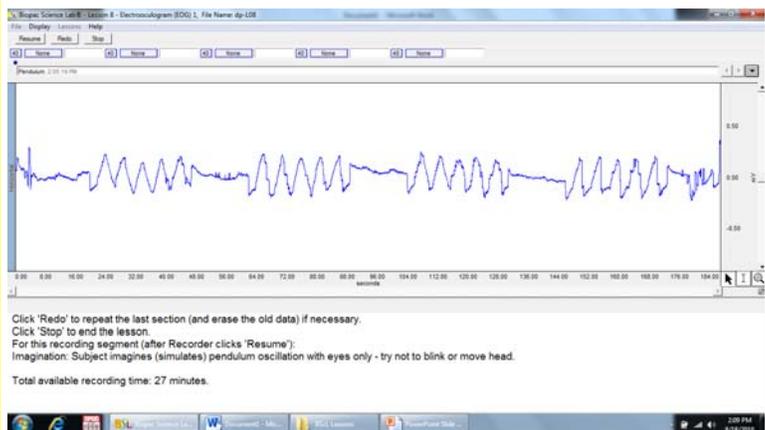


Fig. 8.7 Tracking the dot movement in an oval path.

If data is incorrect, click **Redo** and repeat Steps 3-7; the last data segment you recorded will be erased.

Part 2 — Read Silently Easy, Intermediate, & Difficult Text Passages

9. Follow the directions for the reading portion of the experiment.

10. Click **Resume**.

11. **Subject** advances the slide to the fixation point and silently reads the text when it appears. **Advance** the slide to the next fixation point when you complete the text.

12. After all three passages are read, the **Experimenter** returns to the Biopac program and clicks **Suspend**.

13. Review the data.

- If correct, Click **STOP**, Click **YES**.
- If incorrect, click **Redo**.
The data would be incorrect if it did not show saccades. If data is incorrect, click **Redo** and repeat Steps 11-13; the last data segment you recorded will be erased.

14. Click **Dot Plot**.

Stare at the center crossbars until the green dot appears. The green dot should now be under the control of your eyes. Look left and right to move dot. If you lose control of the dot, return to staring at the center crossbars until the dot returns to the center.

15. After you have experienced the Dot Plot, click stop and then **Done**.

16. Choose an option and click **OK**.

17. Remove the electrodes.

Click on the PowerPoint slide show and read the instructions for Part 2. Subject should remain seated, in a relaxed state and should try not to move or blink during the recording. Subject should place their finger on the enter key in preparation to advance the stimuli.

When you are ready to begin, the Experimenter should press

the Windows Start button  on the keyboard and select the Biopac Science Lab program and click **Resume**, the recording will begin.

Return to the PowerPoint slide show and advance to the first fixation point and wait for the text. Each set begins with a center fixation point and will automatically advance to the reading passage after 15 seconds. The Subject should read each passage silently. After completing the passage the subject should press enter to advance to the next fixation point. At the end of Part 2, press the Esc key to end the PowerPoint show

If all went well, your data should resemble Fig. 8.8.

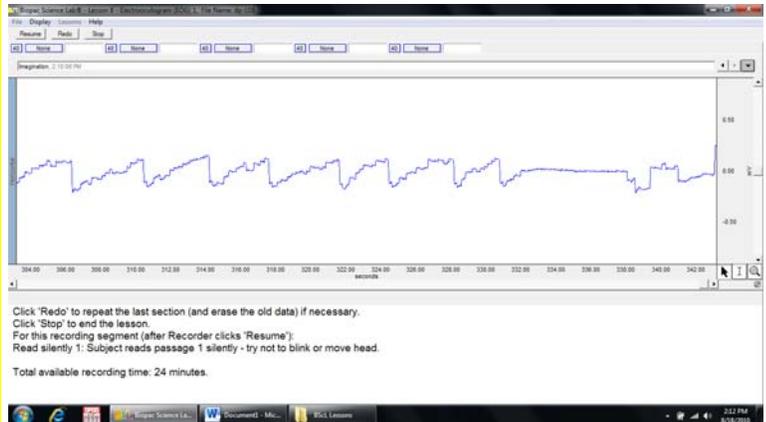


Fig. 8.8 Reading silently 1

Click 'Dot Plot' to explore microsaccadic eye movement. Subject should focus on the center of the black cross. After five seconds, a dot will appear. Continue to focus on the center of the cross.

- Subject should maintain fixed focus on center of display.
- Colored dot position represents point of focus.
- Fixed focus would hold the colored dot in center of cross.

Note that this is a demonstration only.

When you click **Done**, a dialog will be generated. Make your choice, and continue as directed. **Your data is automatically saved in a folder named your subject ID entered at the start of the experiment. Write down the computer id (sticker below computer screen) so you can return to the same computer for data analysis.**

Unclip the electrode leads and peel off the electrodes.

END OF RECORDING

V. ANALYZE

FAST TRACK

1. Enter the **Review Saved Data** mode.

Note Channel Number (CH) designation:

Channel	Displays
CH40	Horizontal Eye Movements – upward lines represent eye movement to the right and downward lines represent eye movement to the left

2. Check to make sure that the measurement boxes above the data window are set-up as follows:

Channel	Measurement
CH 40	Delta T
CH 40	P-P
CH 40	Slope

3. Set up your display window for optimal viewing of the first data segment. Use the magnifying glass icon at the bottom right of the data window to draw a square around the first fixation point (flat line) and stimulus 1 set. Your screen should look like Fig. 8.10.

The following tools help you adjust the data window:

- Autoscale horizontal – shows the entire data set
- Autoscale waveforms – formats the data to fit vertically
- Zoom Tool – magnifying glass icon at the bottom right of the data window to draw a square of area to zoom in.
- Zoom Previous under the display menu

Details

When you return to analyze your data you must use the same computer where you recorded your data. After starting the BSL program, choose **Review Saved Data** from the **Lessons** menu. You will need to click the “look in” box and select libraries, then documents, then BScL Lessons, then Data Files. Open your user name folder and select the file with your username-L08.

The data window should come up the same as Fig. 8.9.

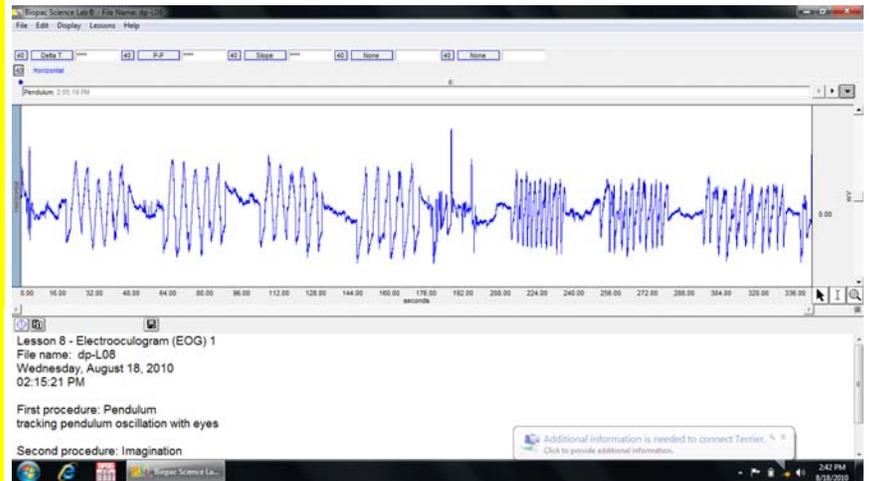


Fig 8.9

The measurement boxes are above the marker region in the data window. Each measurement has three sections: channel number, measurement type, and result. The first two sections are pull-down menus that are activated when you click on them.

Brief definition of measurements:

Delta T: The Delta Time measurement is the difference in time between the end and beginning of the selected area, which is the duration of the selected area.

P-P. The p-p (peak-to-peak) measurement shows the difference between the maximum amplitude value in the selected range and the minimum amplitude value in the selected range.

Slope: uses the endpoints of the selected area to determine the difference in magnitude divided by the time interval; slope indicates the relative speed of eye movement.

The “selected area” is the area selected by the I-beam tool.

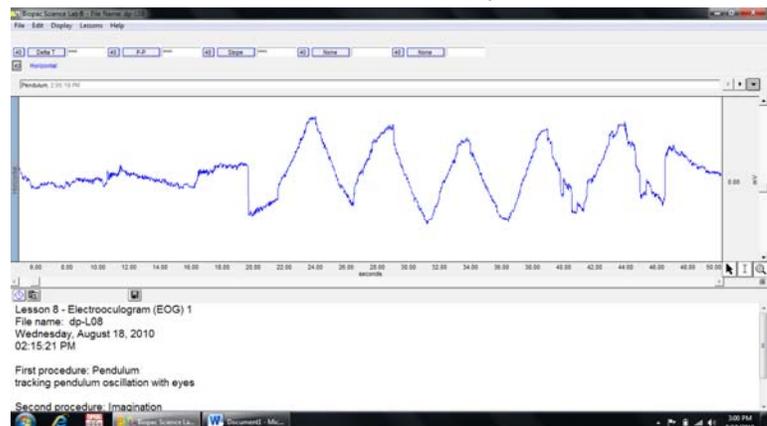


Fig 8.10. Optimal viewing of first data segment.

4.  A: To select data, you must choose the I-Beam cursor located at the lower right of the data screen in between the arrow and magnifying glass tools. Measure the p-p (distance) and slope (speed) for each tracking movement right (upward line) and left (downward line) and record the values in Table 8.1 on your data sheet. Be careful to not include pauses at the top or bottom of each movement but only the increasing and decreasing lines. **Record absolute values for slope, do not record the slope as negative just record the value.** The positive / negative value of the slope simply indicates movement to the left (+) or right (-).

See Fig. 8.11 for an example of measuring the "Right1" movement.

See Fig. 8.12 for an example of measuring the "Right1" movement.

5.  A: Measure the time (Delta T) spent paused between each right / left movement. Select the relatively flat area (plateau) after each right or left movement and record the Delta T value in Table 8.1
Since we are measuring the pause before the next movement, there is no measurement for the final movement, Left5.

See Fig. 8.13 for an example of measuring the "Right2" pause.

6. After collecting all data for Stimulus 1, use the horizontal scroll bar to scroll right to the next stimulus set.
7. **Repeat steps 4-6** of the data collection process for the speed, distance, time paused for each right and left movement of stimulus 2, stimulus 3, and stimulus 4 filling in all cells in Table 8.1

Analysis continues...

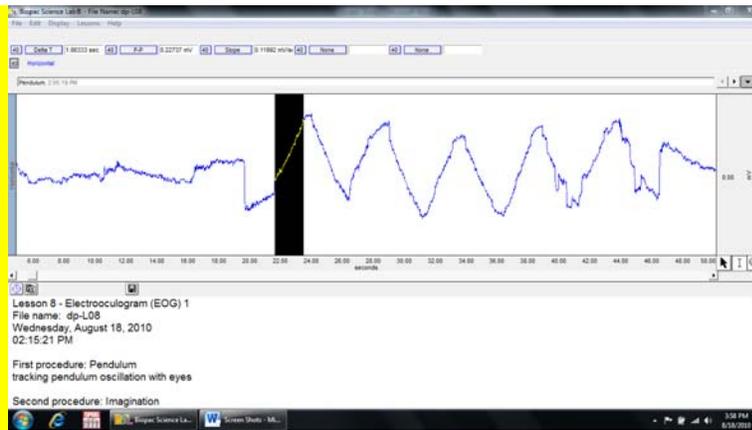


Fig 8.11 – Measuring the movement “Right1”

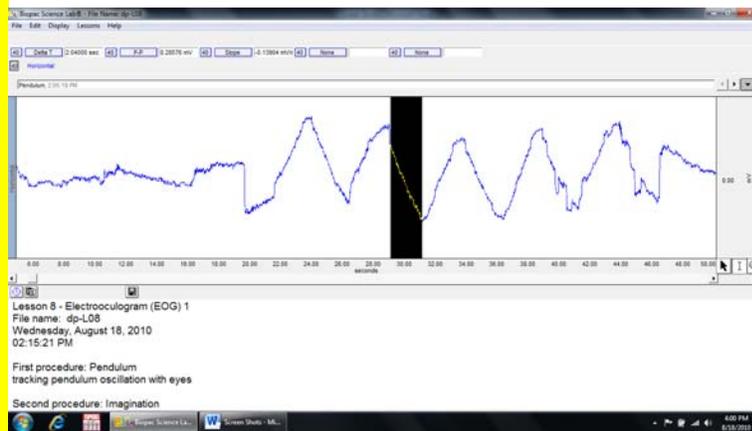


Fig. 8.12 – Measuring the movement “Left2”

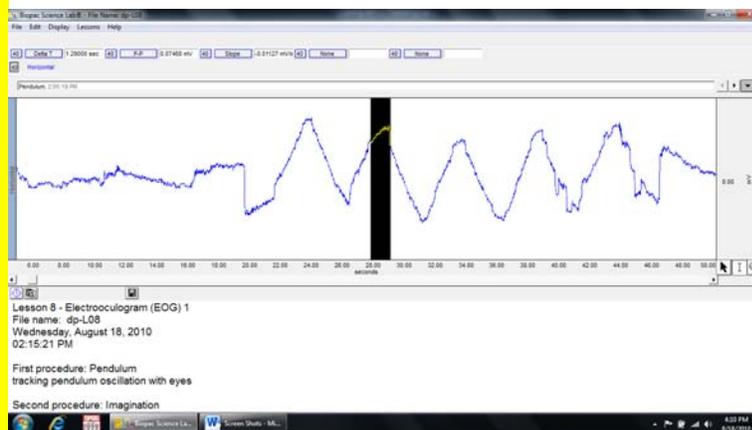


Fig. 8.13 – Measuring the “Right2” pause

8. **Scroll over to the first reading segment in Part 2. Use the magnifying glass to draw a square around the first data set to zoom in on all 11 lines as shown in Fig. 8.14.**

A saccade is a rapid movement right or left shown on the screen as a steep slope up (right) or down (left). The movement is considered a saccade if the slope exceeds 0.1 mV/s

9. **B:** Count the number of forward (upward) and backward (downward) saccades for each line 2-8 and record in Table 8.2. **Do not count the large downward saccade at the end of each line which represents moving back to the start of the next line.**

For example in Fig. 8.14, on line 2 there are 6 forward and 1 backward saccades for a total of 7 saccades recorded for that line in Table 8.2.

If you are in doubt about whether the movement is eye drift or a saccade, then select the movement and note whether the slope **exceeds 0.1 mV/s**. If the slope is < 0.1 , then it is an eye drift and not a saccade. Whether the slope is positive or negative does not matter, that simply means it was a movement to the right (+) or left (-).

Calculate the average number of saccades for each reading stimulus.

10. **B:** Measure the time (Delta T) from the start of line 2 to the end of line 8 and record in Table 8.2. *See Fig. 8.16 for an example.*
11. **B:** **Scroll to the right** to view the next reading passage and **repeat steps 9-10** of the data collection process for the intermediate and difficult text passages to fill in all cells in Table 8.2.



Fig 8.14 Reading segment 1: Easy text



Fig 8.15 Measuring the slope of a movement to determine that this example is not a saccade (slope = -0.06777mV/s which is less than -0.1). The positive / negative value of a slope simply indicates direction right (+) or left (-) of the movement and should be ignored.

For example in Fig. 8.15, a movement is selected and the slope is a value smaller than 0.1 so it is an eye drift not a saccade.

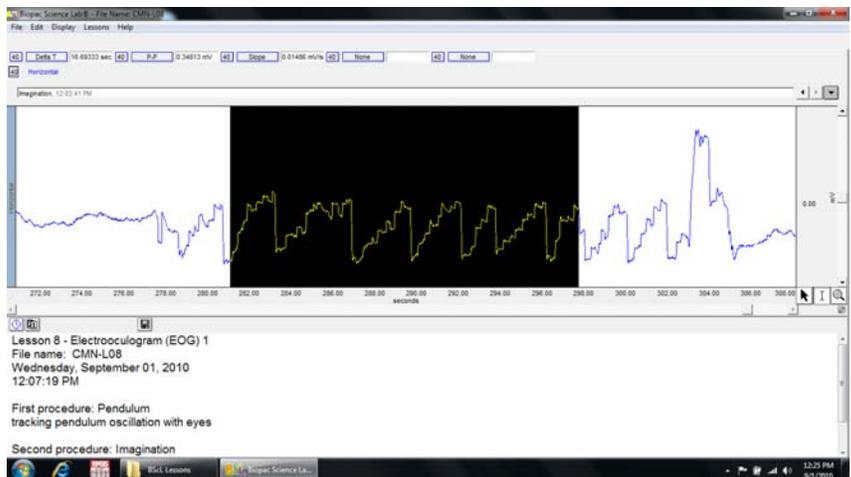


Fig 8.16 Measuring the time to read lines 2-8.

12. After you have completed all data collection (all cells are filled in on Tables 8.1 & 8.2), exit the program and enter your data online in Google docs.

13. Set the dial to  Off.

END OF DATA ANALYSIS

Add your data (gray boxes in Tables 8.1 & 8.2) to the group data sheet in Google Docs. Your professor will email you the link to the file. Enter your initials under Subject, the current year under YearTested, and your Sex (1=Female, 2=Male).