

II. EXPERIMENTAL OBJECTIVES

- 1) To record an EEG from an awake, resting subject under the following conditions:
 - a) Relaxed with eyes closed;
 - b) Performing mental arithmetic with eyes closed;
 - c) Hyperventilating (breathing quickly and deeply) with eyes closed;
 - d) Relaxed with eyes open.
- 2) To examine differences in the level of alpha rhythm activity during mental arithmetic and hyperventilation compared to the control condition of eyes closed and relaxed.

III. MATERIALS

- BIOPAC Electrode Lead Set (SS2L)
- BIOPAC Disposable Electrodes (EL503,) 3 electrodes per subject
- BIOPAC Electrode Gel (GEL1) and Abrasive Pad (ELPAD)
- *Optional:* BIOPAC Skin Prep Gel (ELPREP) or alcohol prep
- Lycra® swim cap (such as Speedo® brand) *or* supportive wrap (such as 3M Coban¹ Self-adhering Support Wrap) to press electrodes against head for improved contact
- Biopac Student Lab System: BSL 4 software, MP36, MP35 or MP45 hardware
- Computer system (Windows or Mac)

IV. EXPERIMENTAL METHODS

A. SETUP

FAST TRACK Setup

1. Turn the computer **ON**.
 - If using an MP36/35 unit, turn it **OFF**.
 - If using an MP45, make sure USB cable is connected and Ready light is **ON**.
2. **Plug the equipment in** as follows:
Electrode Lead Set (SS2L) to CH 1
3. Turn **ON** the BIOPAC MP3X unit.

Setup continues...

Detailed Explanation of Setup Steps



Fig. 4.2 MP3X (top) and MP45 (bottom) hardware connections

4. Position electrodes on the scalp.
Fig. 4.3 shows a sample configuration.

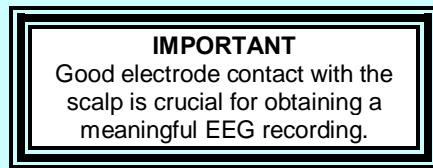


Fig. 4.3

Guidelines for electrode placement:

- The placement of the scalp electrodes can vary (within limits) depending on your instructor's or **Subject's** preference.
- Keep the electrodes on one side (right or left) of the head.
- Apply some gel to the electrode. (*A fair amount of gel must be used to obtain a good electrode to scalp connection.*)
- The third electrode is the *ground* electrode and is placed over the Mastoid region (behind the ear).

Hints for obtaining optimal data:

- As much as possible, move (part) the hair away from the electrode adhesion area to ensure the electrode makes contact with the scalp.
- Clean electrode sites with ELPREP Skin Prep Gel or alcohol before abrading.
- Gently abrade skin at the electrode sites.
- Apply a drop of gel to the electrode.
- Apply pressure to the electrodes for about one minute after the initial placement.
- **Subject** must remain still. Blinking and other movement will affect the recordings of all four rhythms.
- Despite your best efforts, electrode adhesion may not be strong enough to record data; try another **Subject** or different electrode placement.

5. **Clip** the Electrode Lead Set following the color code in Fig. 4.3.
6. Place cap/wrap on **Subject's** head to press electrodes into scalp (Fig. 4.4).

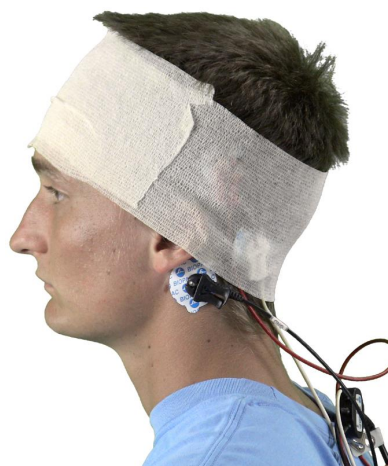
The pinch connectors work like a small clothespin, but only latch onto the nipple of the electrode from one side of the connector.

Drape the electrode cables over the head so that they are not pulling on the electrodes.

The cap or wrap should be snug but not uncomfortably tight.

Setup continues...

7. Get **Subject** in proper seating position (Fig. 4.5).
8. Wait five minutes to allow **Subject** to relax, and for electrodes to establish proper contact.



Place a Lycra® swim cap or supportive wrap on **Subject's** head to press electrodes against the scalp with a constant pressure. **Subject** should not press electrodes against scalp.

Fig. 4.4

Subject should be seated and relaxed. Ideally, the room should be *reasonably quiet* to help **Subject** mentally relax.



Fig. 4.5 Positioning

9. **Start** the Biopac Student Lab Program.
10. Choose lesson “**L04 – Electroencephalography (EEG) II**” and click **OK**.
11. Type in a unique **filename** and click **OK**.
12. **Optional:** Set Preferences.
 - Choose File > **Lesson Preferences**.
 - Select an option.
 - Select the desired setting and click **OK**.

END OF SETUP

Start Biopac Student Lab by double-clicking the Desktop shortcut.



No two people can have the same filename, so use a unique identifier, such as **Subject's** nickname or student ID#.

A folder will be created using the filename. This same filename can be used in other lessons to place the **Subject's** data in a common folder.

This lesson has optional Preferences for data and display while recording. Per your Lab Instructor's guidelines, you may set:

Grids: Show or hide gridlines.

Lesson Recordings: Specific data recordings may be omitted based on instructor preferences.

B. CALIBRATION

The Calibration procedure establishes the hardware's internal parameters (such as gain, offset, and scaling) and is critical for optimum performance. **Pay close attention to Calibration.**

FAST TRACK Calibration

1. **Subject** remains relaxed with eyes closed during Calibration.
2. Check Electrode Impedance. (Optional*)

***Only functional if your MP hardware is compatible with the Electrode Check feature.** If your MP hardware is not compatible, this feature will not be available. Please contact BIOPAC Technical Support for more information on how to enable Electrode Check functionality.

IMPORTANT

Certain subjects may not fall below the 10 K ohm reading. This reading is subject to individual variations in skin conductivity and electrode placement.

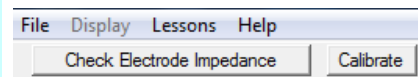
3. Click **Calibrate**.
4. During Calibration **Subject** must:
 - Remain seated, relaxed and still, with eyes closed.
 - Wait for Calibration to stop.
5. Verify recording resembles the example data.
 - If similar, click **Continue** and proceed to Data Recording.
 - If necessary, click **Redo Calibration**.

END OF CALIBRATION

Detailed Explanation of Calibration Steps

This step is optional and not applicable to MP45 hardware.

Use **Check Electrode Impedance** to check the **Subject's** skin conductivity. This opens the Electrode Checker panel and displays skin resistance in K ohms.



To use:

- Remove the Lead Set (SS2L) from CH1 and plug into the 'Electrode Check' input.
- Click -Check Electrode Impedance button.
- Ideally, both readings should be similar and below 10 k ohm. (See Fig. 4.6).
- When finished, be sure to remove the SS2L from the -Electrode Check input and plug into the CH 1 input before continuing.

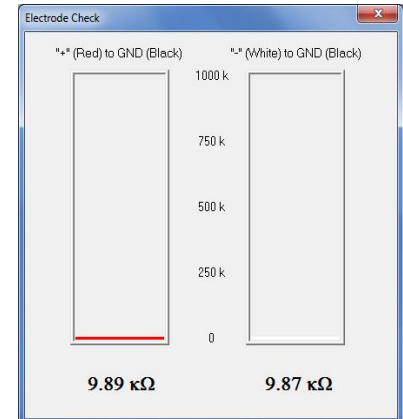


Fig. 4.6

Calibration lasts eight seconds.

The baseline should be relatively stable around 0 uV.

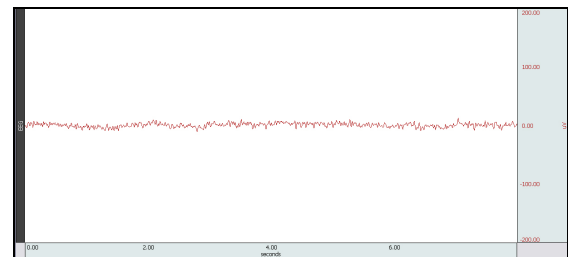


Fig. 4.7 Example Calibration data

If the data shows excessive baseline drift or large spikes, make sure the electrodes are making good contact with the scalp and that the cables are not pulling on the electrodes.

Click **Redo Calibration** and repeat Steps 3 to 5 if necessary.

C. DATA RECORDING

FAST TRACK Recording

1. Prepare for the recording.
 - **Subject** remains seated, relaxed, and still, with eyes closed.
 - **Review** recording steps.

Detailed Explanation of Recording Steps

Subject will perform four tasks*; **Subject** will perform tasks in the intervals between recordings.

Recording 1: Relaxed with eyes closed

Recording 2: Performing mental math with eyes closed

Recording 3: Recovering from hyperventilation with eyes closed

Recording 4: Relaxed with eyes open

To work efficiently, read this entire section before recording, or review onscreen **Tasks** to preview recording steps in advance.

*IMPORTANT

This procedure assumes that all lesson recordings are enabled in Lesson Preferences, which may not be the case for your lab. Always match the recording title to the recording reference in the journal and disregard any references to excluded recordings.

Hints for obtaining optimal data:

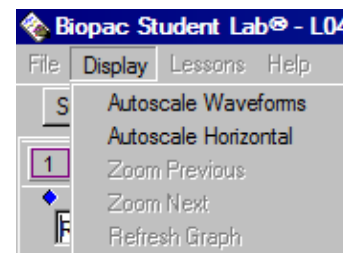
- **Subject** must try not to blink during *“Eyes Open”* portion of recording.
- **Subject** should not talk during any of the recordings, and should not verbalize answers to the mental arithmetic.
- The alpha signal will be increased during the relaxation recording if **Subject** relaxes mentally; i.e. thinks of a relaxing place.

Relaxed with eyes closed (Control)

2. Click **Record**.
 - **Subject** remains seated, relaxed and still, with eyes closed.

Subject should try to relax mentally; i.e. think of a relaxing place.

Note: **Display > Autoscale Waveforms** and **Autoscale Horizontal** are available DURING recordings to allow scale changes if necessary.



Note The graph window will reduce to fit the **Input values** window on the right side of the display. The **Input values** window shows the alpha-RMS value in a thermometer-like bar display, and can be used as a visual aid to determine fluctuations in alpha-RMS activity. It is only updated during the recording.



Fig. 4.8 Input Values

3. Record for 10 seconds.
4. Click **Suspend**.

Recording continues...

5. Verify recording resembles the example data.
 - If similar, click **Continue** and proceed to the next recording.
 - If necessary, click **Redo**.
 - If all required recordings have been completed, click **Done**.

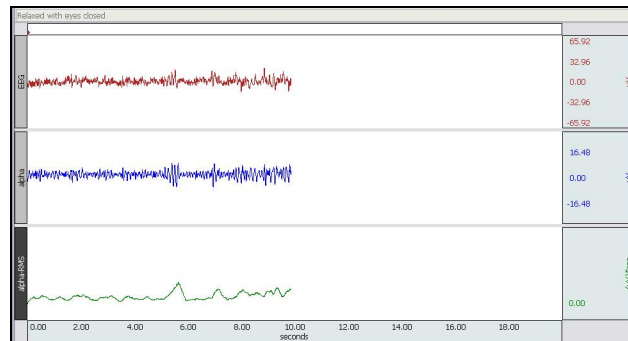


Fig. 4.9 Example Relaxed, Eyes Closed data

If recording does not resemble the Example Data

- If the data is noisy or flatline, check all connections to the MP unit.
- If there is excessive baseline drift or large spikes:
 - Check that electrodes are making good contact with the scalp, cap or wrap is snug and that the cables are not pulling on the electrodes.
 - **Subject** must remain as still as possible.
 - Try relaxation techniques, such as slow breathing or relaxing muscles.

Click **Redo** and repeat Steps 2 to 5 if necessary. Note that once **Redo** is clicked, the most recent recording will be erased.

Mental Arithmetic

6. **Director** prepares a math problem.
 - **Subject** remains seated and relaxed, with eyes closed.
 - **Review** recording steps.
7. Click **Record**.
8. **Director** verbalizes math problem to **Subject**.
 - **Subject** solves the problem silently with eyes closed.
 - Record for 20 seconds.
9. Click **Suspend**.
10. If the **Subject** indicates the math problem was given too quickly, **Redo** the recording.
11. Verify recording resembles the example data.
 - If similar, click **Continue** and proceed to the next recording.
 - If necessary, click **Redo**.
 - If all required recordings have been completed, click **Done**.

Subject remains relaxed with eyes closed. **Director** prepares a math problem. The problem should be challenging but not too difficult; the point is to make **Subject** really work for the answer, not to stump **Subject**. For example:

2 minus 41 times 31 plus 91 double that1 double again1 divide by 4...

Director provides arithmetic problem at a rate that the **Subject** can solve silently.

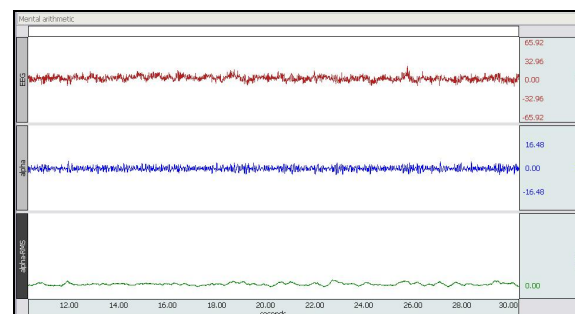


Fig. 4.10 Mental Arithmetic, Eyes Closed

The data may be different for the reasons outlined in Step 5.

Click **Redo** and repeat Steps 7 to 11 if necessary. Note that once **Redo** is clicked, the most recent recording will be erased.

Recording continues...

After Hyperventilation

12. **Subject** is seated.

- **Review** recording steps.
- **Subject** hyperventilates for two minutes with eyes closed.

WARNING

Hyperventilation can make **Subject** dizzy and light headed. **Subject** should be seated with **Director** watching. Stop the procedure if **Subject** starts to feel sick or dizzy.

13. As soon as **Subject** stops hyperventilating and is sitting still, Click **Record** immediately.

14. Record for 10 seconds.

15. Click **Suspend**.

16. Verify recording resembles the example data.

- If similar, click **Continue** and proceed to the next recording.
- If necessary, click **Redo**.
- If all required recordings have been completed, click **Done**.

Subject hyperventilates (by breathing rapidly and deeply through mouth) for two minutes with eyes closed.

It is important that recording be resumed as quickly as possible after **Subject** has hyperventilated. However, to avoid EMG artifact, make sure **Subject** has stopped hyperventilating prior to clicking **Record**.

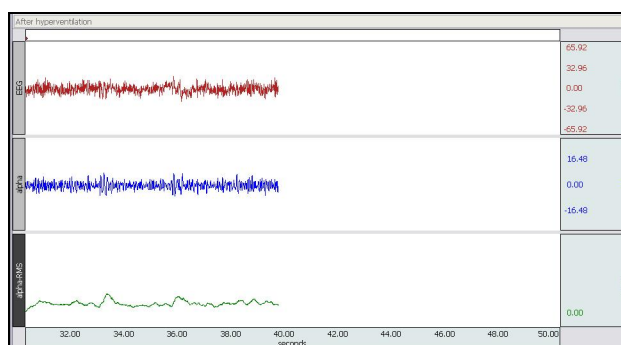


Fig. 4.11 Example after Hyperventilation, Eyes Closed data

The data may be different for the reasons outlined in Step 5, with the following exception:

- It is normal to have some baseline drift after hyperventilation.

Click **Redo** and repeat Steps 12 to 16 if necessary. Note that once **Redo** is clicked, the most recent recording will be erased.

Eyes Open recording

17. **Subject** remains seated and relaxed.

- **Review** recording steps.
- **Subject** opens eyes and avoids blinking during recording.

18. Click **Record**.

19. Record for 10 seconds.

20. Click **Suspend**.

Director instructs **Subject** to open eyes.

Recording continues...

21. Verify recording resembles the example data.

- If similar, click **Continue** and proceed to optional recording section, or click **Done** to finish.
- If necessary, click **Redo**.

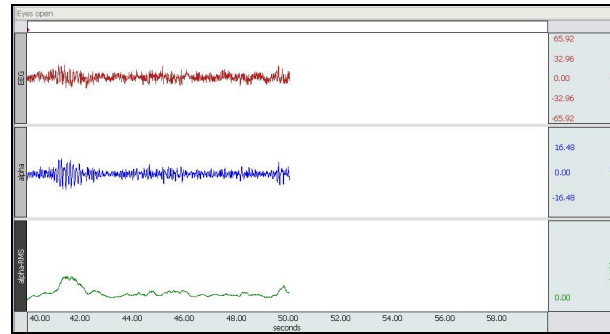


Fig. 4.12 Example Relaxed, Eyes Open data

The data may be different for the reasons outlined in Step 5, with the following exception:

- If the **Subject** blinked, it may have created a large spike in the data. If excessive, consider redoing the recording.

Click **Redo** and repeat Steps 17 ó 21 if necessary. Note that once **Redo** is clicked, the most recent recording will be erased.

OPTIONAL ACTIVE LEARNING PORTION

With this lesson you may record additional data by clicking **Continue** following the last recording. Design an experiment to test or verify a scientific principle(s) related to topics covered in this lesson. Although you are limited to this lesson's channel assignments, the electrodes may be moved to different locations on the **Subject**.

Design Your Experiment

Use a separate sheet to detail your experiment design, and be sure to address these main points:

A. Hypothesis

Describe the scientific principle to be tested or verified.

B. Materials

List the materials you will use to complete your investigation.

C. Method

Describe the experimental procedure; be sure to number each step to make it easy to follow during recording.

Run Your Experiment

D. Set Up

Set up the equipment and prepare the subject for your experiment.

E. Record

Use the **Continue**, **Record** and **Suspend** buttons to record as much data as necessary for your experiment.

Click **Done** when you have completed all of the recordings required for your experiment.

Analyze Your Experiment

- F. Set measurements relevant to your experiment and record the results in a Data Report.

22. After clicking **Done**, choose an option and click **OK**.

After clicking **Done**, dialog with options will be generated. Make a selection, and continue as directed.

If choosing the **Record from another Subject** option:

- Repeat Setup Steps 5 ó 9, and then proceed to Calibration.

23. Remove electrodes.

Remove cap or wrap, the electrode cable pinch connectors, and peel off all electrodes. Discard the electrodes. (BIOPAC electrodes are not reusable.) Wash the electrode gel residue from the skin, using soap and water. The area around the electrode sites may remain red for a few hours, which is quite normal.

END OF RECORDING