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II. EXPERIMENTAL OBJECTIVES

1) To record an EEG from an awake, resting subject with eyes open and eyes closed.
2) To identify and examine alpha, beta, delta, and theta components of the EEG complex.

III. MATERIALS

- BIOPAC electrode lead set (SS2L)
- BIOPAC Disposable Electrodes (EL503,) 3 electrodes per subject
- BIOPAC Electrode Gel (GEL1) and Abrasive Pad (ELPAD) *or* Skin cleanser or alcohol prep
- Lycra® swim cap (such as Speedo® brand) *or* supportive wrap (such as 3M Coban™ 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 8, 7, Vista, XP, Mac OS X 10.5 – 10.8)

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)—Electrode Check (MP3x only. For MP45, plug into CH 1.)
3. Turn **ON** the BIOPAC MP36/35 unit.

Setup continues…

Detailed Explanation of Setup Steps

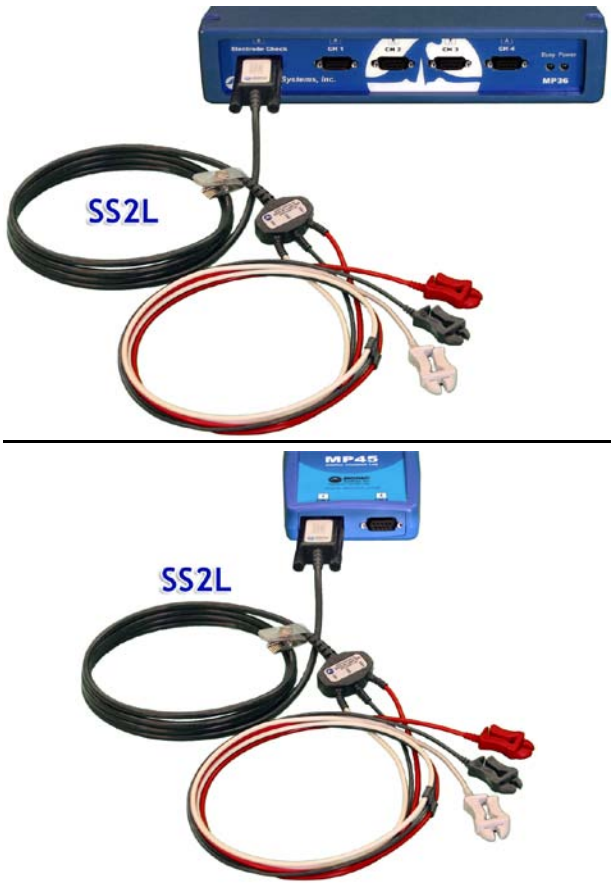


Fig. 3.2 MP3X (top) and MP45 (bottom) hardware connections

4. Position electrodes on the scalp.
   Fig. 3.3 shows a sample configuration.

IMPORTANT
Good electrode contact with scalp is crucial for obtaining a meaningful EEG recording.

Fig. 3.3

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.
- 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 area to ensure the electrode makes contact with the scalp.
- Gently abrade skin at the electrode sites.
- Apply some gel to the electrode. *(A fair amount of gel must be used to obtain a good electrode to scalp connection.)*
- Apply pressure to the electrodes for about 1 minute after the initial placement.
- **Subject** must remain still. Blinking and other movement will affect the recording 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. 3.3.

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

6. Place cap/wrap on **Subject's** head to press electrodes into scalp (Fig. 3.4).

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.

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

Setup continues…

Fig. 3.4

7. Get **Subject** in proper seating position (Fig. 3.5).
8. Wait five minutes to allow **Subject** to relax, and for electrodes to establish proper contact.

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

Fig. 3.5 Positioning

9. **Start** the Biopac Student Lab Program.
10. Choose "**L03 – Electroencephalography (EEG) I"** and click **OK**.
11. Type in a unique **filename** and click **OK**.

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.

12. ***Optional***: Set Preferences.
    - Choose File > **Lesson Preferences**.
    - Select an option.
    - Select the desired setting and click **OK**.

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 recordings may be omitted based on instructor preferences.

END OF SETUP

B. CALIBRATION

The Calibration procedure establishes the hardware's internal parameters (such as gain, offset, and scaling) and is critical for optimal 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.

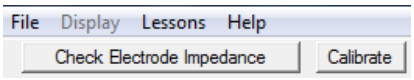
3. Click **Calibrate**.
4. During Calibration **Subject** must:
   - Remain seated, relaxed and still, with eyes closed.
   - Wait for Calibration to stop.
5. Verify recording resembles the example data.
   - If similar, click **Continue** and proceed to Data Recording.
   - If necessary, click **Redo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



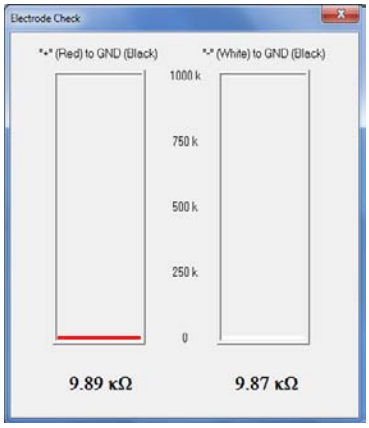


Fig. 3.6

To use:

- Make sure the SS2L is plugged into the MP unit's Electrode Check input.
- Click Check Electrode Impedance button.
- Ideally, both readings should be similar and below 10 k ohm. (See Fig. 3.6.)
- When finished, be sure to remove the SS2L from the Electrode Check input and plug into the CH 1 input before continuing (right).

Calibration lasts eight seconds.

The baseline should be relatively stable around 0 uV.

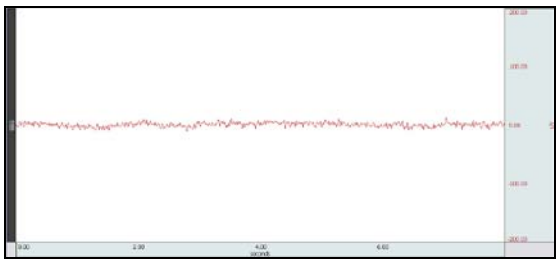


Fig. 3.7 Example Calibration data

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 – 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.

2. Click **Record**.
   - **Subject** remains seated, relaxed and still, with eyes closed.
   - Record for 20 seconds.
   - **Director** presses F4 and cues **Subject** to open eyes.
   - Record for an additional 20 seconds.
   - **Director** presses F5 and cues **Subject** to close eyes.
   - Record for an additional 20 seconds.

3. Click **Suspend**.
4. Verify recording resembles the example data.
   - If similar, click **Continue** and proceed to the optional recording section, or click **Done** to finish.
   - If necessary, click **Redo**.

Recording continues…

Detailed Explanation of Recording Steps

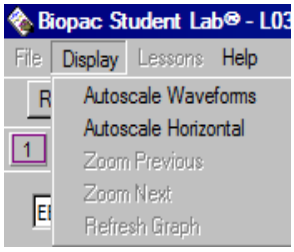
This lesson will record the "raw" (full bandwidth) EEG while the **Subject** is relaxed with eyes closed, eyes opened, and eyes closed again. The alpha, beta, delta and theta channels are simultaneously recorded, but are hidden by default. Hidden channels may be displayed during the recording by holding down the "Alt" (PC) or "Option" (Mac) key when clicking on the channel button.

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

Hints for obtaining optimal data:

- **Subject** should be seated and relaxed to keep muscles still, especially facial muscles. (Do not talk.)
- **Subject** must try not to blink during "Eyes Open" portion of recording.
- **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.



The **Director** instructs **Subject** to change the eye condition for 20-second intervals, and inserts an event marker at each change.

First 20 seconds (secs. 0 – 20)

Subject is relaxed, with eyes closed for the first 20 seconds.

Next 20 seconds (secs. 21 – 40)

Director presses **F4** to insert a marker labeled "Eyes Open" and cues **Subject** to open eyes and try not to blink for the next 20 seconds.

After another 20 seconds (secs. 41 – 60)

Director presses **F5** to insert a marker labeled "Eyes Closed" and cues **Subject** to close eyes for the next 20 seconds.

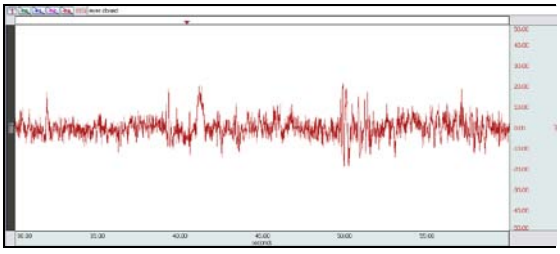


Fig. 3.8 Example data

Verify recording shows variation between the "Eyes Open" and "Eyes Closed" recordings.

Note: To check the data, it may be necessary to show one or more of the hidden frequency bands. To activate, hold down the Alt (PC) or Option (Mac) key when clicking on the channel button.

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 – 4 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 acquire as many recordings 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.

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

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

- Continue the entire lesson from Setup Step 4.

6. 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

V. DATA ANALYSIS

FAST TRACK Data Analysis

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

   - Note Channel Number (CH) designations.

Channel	*Displays*
CH 1	**EEG** (hidden*)
CH 40	**alpha**
CH 41	**beta**
CH 42	**delta**
CH 43	**theta**

   - Note measurement box settings:

Channel	*Measurement*
CH 40	**Stddev**
CH 41	**Stddev**
CH 42	**Stddev**
CH 43	**Stddev**
SC	**Freq**

2. Set up your display window for optimal viewing of the channels 40 – 43.

3. Use the I-Beam cursor to select the first "**Eyes closed**" data.

   A

Data Analysis continues…

Detailed Explanation of Data Analysis Steps

If entering **Review Saved Data** mode from the Startup dialog or lessons menu, make sure to choose the correct file.

Fig. 3.9 Example data

The EEG channel is hidden but can be easily brought into view. (See Step 2.)

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 them.

Brief definition of measurements:

Stddev: Standard deviation is a measure of the variability of data points. The advantage of the Stddev measurement is that extreme values or artifacts do not unduly influence the measurement.

Freq: Converts the time segment of the selected area to frequency in cycles/sec.

The "selected area" is the area selected by the I-beam tool (including endpoints).

Useful tools for changing view:

Display menu: Autoscale Horizontal, Autoscale Waveforms, Zoom Back, Zoom Forward

Scroll Bars: Time (Horizontal); Amplitude (Vertical)

Cursor Tools: Zoom Tool

Buttons: Overlap, Split, Show Grid, Hide Grid, +, -

Hide/Show Channel: "Alt + click" (Windows) or "Option + click" (Mac) the channel number box to toggle channel display.

This is the data from the time 0 to the first event marker.

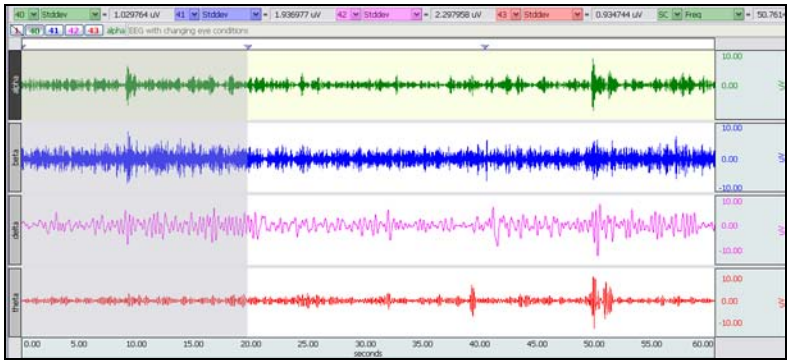


Fig. 3.10 First Eyes Closed data

4. Repeat Step 3 using "**Eyes open**" data.

   A

   This is the data between the first and second event markers.

5. Repeat Step 3 using the second "**Eyes closed**" data.

   A

   This is the data between the second event marker and the end of the file.

6. **Zoom** in on a 3 – 4 second section of the first "**Eyes closed**" data.

7. Use the **I-beam** cursor to select an area that represents one cycle in the **alpha** wave (Fig. 3.11).

   B

   Accurate Frequency calculation requires a selected area of only one cycle.

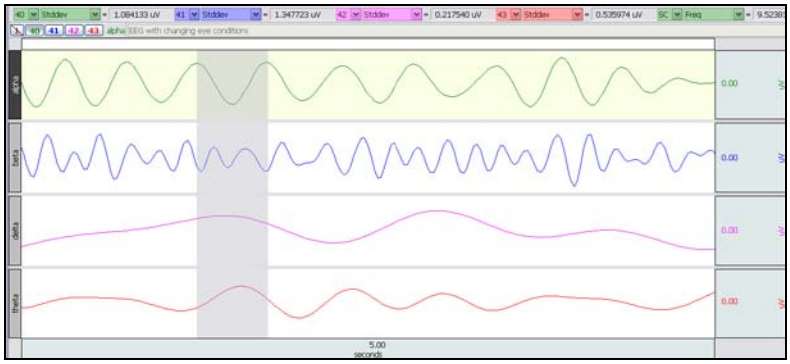


Fig. 3.11 Selected area shows one cycle of the alpha wave.

8. Repeat Step 7 for two other **alpha** wave cycles.

   B

   Make sure you stay in the first "**Eyes Closed**" data region.

9. Repeat Steps 7 – 8 using the **beta** wave data.

   B

   Click the cursor/pointer into the **beta** wave region to select this channel for "SC" measurements. (Channel label will darken.)

10. Repeat Steps 7 – 8 using the **delta** wave data.

    B

    Click the cursor/pointer into the **delta** wave to select this channel for "SC" measurements.

11. Repeat Steps 7 – 8 using the **theta** wave data.

    B

    Click the cursor/pointer into the **theta** wave to select this channel for "SC" measurements.

12. Answer the questions at the end of the Data Report.
13. **Save** or **Print** the Data Report.
14. **Quit** the program.

    An electronically editable **Data Report** is located in the journal (following the lesson summary,) or immediately following this Data Analysis section. Your instructor will recommend the preferred format for your lab.

END OF DATA ANALYSIS

END OF LESSON 3

Complete the Lesson 3 Data Report that follows.

ELECTROENCEPHALOGRAPHY I

- *EEG I*

DATA REPORT

Student's Name: _____

Lab Section: _____

Date: _____

I. Data and Calculations

Subject Profile

Name:_____ Height:_____

Age:_____ Gender: Male / Female Weight:_____

A. EEG Amplitude Measurements from Standard Deviation measurements

Table 3.2 Standard Deviation [Stddev]

Rhythm	CH Measurement	Eyes Closed	Eyes Open	Eyes Re-closed
Alpha	40 Stddev			
Beta	41 Stddev			
Delta	42 Stddev			
Theta	43 Stddev			

B. EEG Frequency Measurements from first 'Eyes closed' data

Table 3.3 Frequency (Hz)

Rhythm	CH Measurement	Cycle 1	Cycle 2	Cycle 3	Mean
Alpha	SC Freq				
Beta	SC Freq				
Delta	SC Freq				
Theta	SC Freq				

II. Questions

C. List and define two characteristics of regular, periodic waveforms.

_____

_____

_____

_____

D. Compare and contrast synchrony and alpha block.

_____

_____

_____

_____

E. Examine the alpha and beta waveforms for change between the "eyes closed" state and the "eyes open" state.

i. Does **desynchronization** of the alpha rhythm occur when the eyes are open?

ii. Does the beta rhythm become more pronounced in the "eyes open" state?

F. The amplitude measurements (Stddev) are indicative of how much alpha activity is occurring in Subject. But, the amplitude values for beta do not truly reflect the amount of mental activity occurring with the eyes open. Explain.

G. Examine the delta and theta rhythm. Is there an increase in delta and theta activity when the eyes are open? Explain your observation.

H. Define the following terms:

i. Alpha rhythm

ii. Beta rhythm

iii. Delta rhythm

iv. Theta rhythm

III. OPTIONAL Active Learning Portion

A. ***Hypothesis***

B. ***Materials***

C. ***Method***

D. ***Set Up***

E. ***Experimental Results***

End of Lesson 3 Data Report