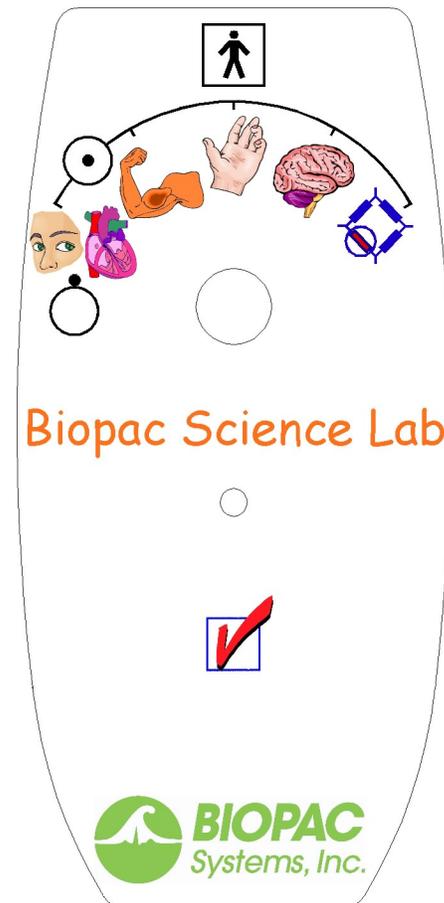


Physiology Lessons
for use with the
Biopac Science Lab MP40

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

Lesson 6 EEG 2

Electroencephalography: Alpha Rhythms in the Occipital Lobe



Lesson Revision 12.19.05

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Lesson 6 ELECTROENCEPHALOGRAPHY 2 Alpha Rhythms in the Occipital Lobe

I. SCIENTIFIC PRINCIPLES

As noted in EEG 1, the cerebrum, the largest part of the brain, is comprised of right and left hemispheres. Each hemisphere has an outer cerebral cortex (cortex = *bark*) divided into a frontal lobe, a parietal lobe, a temporal lobe, and an occipital lobe. Each lobe has unique functions (Fig. 6.1), but each lobe also shares functions with other lobes and other parts of the brain.

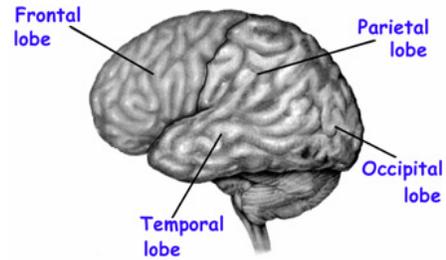


Fig. 6.1

Electrical activity in the cerebral cortex is continuous from the formation of the cerebrum *in utero* to death. However, as the brain changes in size, shape, and function during its lifelong development, recognizable patterns of electrical activity displayed in an electroencephalogram also change. For example, EEGs recorded from the parieto-occipital regions of the brain of 3- to 4-month-old infants display waveforms with average frequencies of about 4 Hz; 12-month-old, 6 Hz; 3-year-old, 8 Hz; 14-year old, 10 Hz.

Waveform amplitude and frequency also vary with the mental and physical state of the individual. The alpha rhythm, characterized by frequencies of 8–13 Hz and amplitudes of 20–200 μV , is the prominent EEG wave pattern of an adult in a relaxed, inattentive (not thinking about anything in particular) state, with eyes closed. Low frequency/larger amplitude alpha waves are dominant in forms of meditation associated with calm, lucid, mental states (the “alpha state”).

Another condition that can alter the mean frequency and/or amplitude of the alpha rhythm is a change in the rate and depth of breathing. When a person hyperventilates (breathes rapidly and deeply), too much carbon dioxide is eliminated from the blood, causing the blood and the cerebrospinal fluid that bathes the brain to become too alkaline. These changes increase the overall electrical activity of the brain including the amplitude of alpha waves.

Other determinants of alpha wave frequency and/or amplitude include:

1. *Gender*: Females tend to have higher mean frequencies of alpha waves than males, although the differences are small.
2. *Memory*: Frequency may affect the speed of “remembering” and may be approximately 1 Hz higher during memory tests for high-scoring subjects than for subjects who scored lower.
3. *Personality*: Amplitudes tend to be higher in subjects who are extroverted.
4. *Mental stress*: Amplitudes vary with the difficulty of mental tasks performed with eyes closed.
5. *Biorhythms*: Amplitudes increase when subjects are less alert and tend to be higher from 1:30 pm–4:30 pm.
6. *Desynchronization*: When the subject opens the eyes and becomes attentive to external stimuli, amplitudes diminish and frequency increases as the alpha rhythm is replaced by the beta rhythm. The “beta state” is associated with normal waking consciousness: attention directed toward the external environment.

In this lesson, you will use **electroencephalography** to examine alpha rhythms in the occipital lobe. The software will filter the raw EEG signal to display alpha rhythm and alpha-RMS.

II. EXPERIMENTAL OBJECTIVES

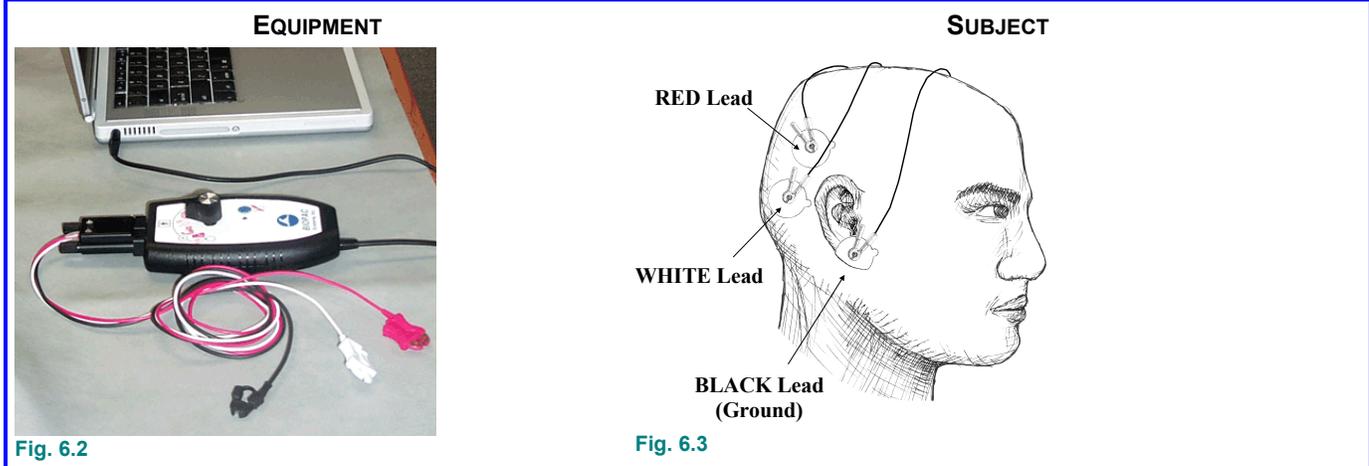
- 1) To record an EEG from an awake, resting subject under the following conditions:
 - a) relaxed with eyes closed;
 - b) performing mental arithmetic with eyes closed;
 - c) hyperventilating (breathing quickly and deeply) with eyes closed; and
 - d) relaxed with eyes open.
- 2) To examine differences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

III. MATERIALS

- 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
- *Optional:* Lycra[®] swim cap (such as Speedo[®] brand) or supportive wrap (such as 3M Coban[™] self-adherent support wrap) to press electrodes against head for improved contact
- Cot or lab pillow

IV. EXPERIMENTAL METHODS

A. Set Up



FAST TRACK

1. Turn the computer **ON**.
 2. Set the MP40 dial to **OFF**.
 3. **Attach three electrodes** to the scalp as shown above.
 4. Connect the electrode **leads** (40EL) to the electrodes, matching lead color to electrode position as shown above.
- IMPORTANT**

Clip each electrode lead color to its specified electrode position.
5. *Recommended:* To press electrodes against head for improved contact, affix a wrap or cap.

6. Ask the **Subject** to completely relax, with eyes closed, for approximately five minutes before recording.
7. **Start** the Biopac Science Lab software.
8. Choose lesson **L06-EEG-2** and click **OK**.
9. Type in a unique **file name**.
10. Click **OK**.

Details

Attach three electrodes to the subject as shown in Fig. 6.3:

- 4-5 cm behind top of ear (WHITE)
- side of head, 4-5 cm above first electrode contact (RED)
- ear lobe with adhesive folded under ear (BLACK)

Note If it is easier, you can attach the BLACK lead (ground) to the neck instead of to the ear lobe



Ideally, the room should be *reasonably quiet* to help the Subject mentally relax. A supine position with the head resting comfortably but tilted to one side is recommended. The best recordings occur when the Subject is relaxed throughout the session.

No two people can have the same file name, so use a unique identifier, such as the subject's nickname or student ID#.

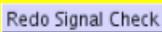
This ends the Set Up procedure.

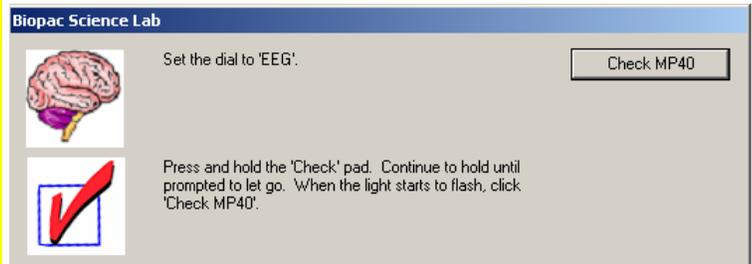
B. Check

FAST TRACK**MP40 Check**

1. Set the MP40 dial to  EEG.
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.
8. Click **Check Signal**.
9. Click **OK** and wait for the Signal Check to stop.
10. 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**.

Position Subject and MP40 as far away from the computer as possible, and face Subject away from the monitor.

Subject should be relaxed and still with eyes closed, and should remain in this state throughout Signal Check. Make sure the electrodes are making good contact with the scalp.

The eight-second Signal Check recording should resemble Fig. 6.4.

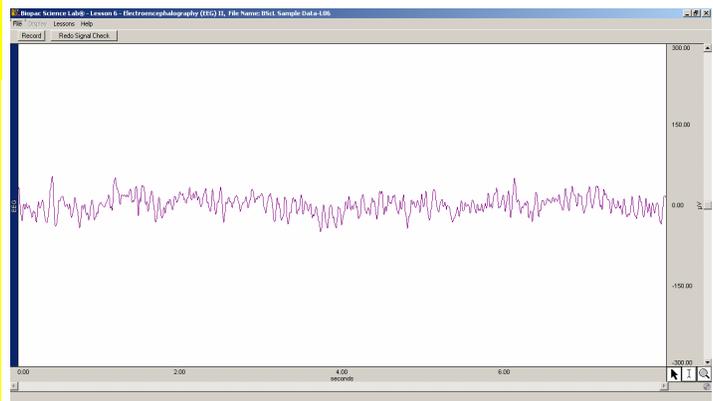


Fig. 6.4

If the recording check did not show EEG spikes, redo the Check.

C. Record

FAST TRACK

1. Prepare for the recording and have the **Subject** lie down and relax with eyes closed.

Recording continues...

Details

Watch the Help menu videos to prepare for the recording. You will record the Subject in four conditions; the Subject will perform tasks in the intervals between recordings.

Segment 1: Relaxed with eyes closed

Segment 2: Performing mental math with eyes closed

Segment 3: Recovering from hyperventilation with eyes closed

Segment 4: Relaxed with eyes open

For EEG recording with the MP40 System, it is especially important to position the Subject away from the computer monitor and to place the MP40 away from the computer (set aside or clip to subject).

In order to work efficiently, read this entire section so you will know what to do for each recording segment. The Subject should remain in a supine position and continue to relax while you review the lesson.

Tips for obtaining optimal data:

- a) Good electrode contact is essential to minimize noise and increase signal amplitude.
- b) The Subject should lie still and should not blink during the **Eyes Open** segment. Best results are obtained if the eyes remain still at all times.
- c) The Subject should not talk during any of the recording segments, and should not verbalize answers to the mental arithmetic.
- d) The alpha signal will be increased during the relaxation segment if the Subject concentrates on breathing slowly and/or relaxing muscles.
- e) For the **Mental Arithmetic** segment: the Director verbally provides a continuous arithmetic problem (e.g. $2-4*3+9...$) to Subject. Subject remains seated with eyes closed and silently solves this problem.

The math problem should be challenging but not too difficult. The point is to make the Subject really work to get the answer, not to stump the Subject or make them give up. The math problem should require a minimum of 20 seconds.

- f) Before the **After Hyperventilation** segment: the Subject should breath quickly and deeply for two minutes, as if they had just finished exercising and needed air. The Subject should not be hyperventilating during the recording.

Note During recording, the **Input values** window will appear on the right side of the graph window. The **Input values** window displays 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 displayed when data is recorded, and does not show in the **Review Saved Data** mode.



Fig. 6.5

SEGMENT 1 — Eyes Closed

2. Click **Record** and have the **Subject** continue to relax with eyes closed.
3. Record for 10 seconds.
4. Click **Suspend**.
5. Review the data.
 - If correct, go to **Step 6**.
 - If incorrect, click **Redo**.

When you click **Record**, the recording will begin and an append marker labeled **Relaxed with eyes closed** will automatically be inserted.

Subject should be relaxed with eyes closed (seconds 0-10).

When you click **Suspend**, the recording will halt, giving you time to review the data and prepare for the next recording segment.

Your data should resemble Fig. 6.6.

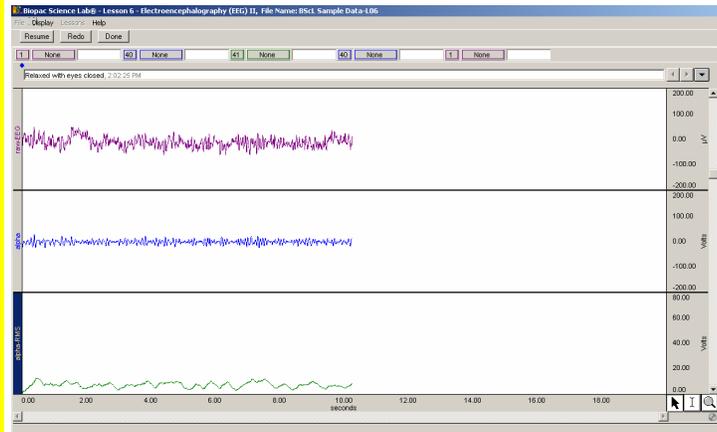


Fig. 6.6 Relaxed with eyes closed

The data would be incorrect if:

- a) The **Suspend** button was pressed prematurely.
- b) An electrode peeled up causing a large baseline drift, spike, or loss of signal.
- c) The Subject did not follow the proper procedure.
- d) The Subject had too much EMG artifact.

If data is incorrect, click **Redo** and repeat Steps 2-5; the last data segment you recorded will be erased.

Segment 2 — Mental Arithmetic

6. **Director** prepares a mental arithmetic problem while **Subject** remains relaxed with eyes closed.
7. Click **Resume**.
8. **Director** gives **Subject** a mental math problem.
9. Record for 20 seconds.
10. Click **Suspend**.

Director prepares the arithmetic problem (see **Tips** in Step 1).
Subject remains relaxed with eyes closed.

When you click **Resume**, the recording will continue and an append marker labeled **Mental arithmetic** will be automatically inserted.

Director verbally provides a continuous arithmetic problem (e.g. $2-4*3+9$...) to Subject.

Subject remains seated with eyes closed and silently solves this problem.

Subject should perform mental arithmetic as posed by the Director and keep eyes closed.

Subject is performing mental math (seconds 11-30).

When you click **Suspend**, the recording will halt, giving you time to review the data and prepare for the next recording segment.

Recording continues...

11. Review the data.

- If correct, go to **Step 12**.
- If incorrect, click **Redo**.

Your data should resemble Fig. 6.7.



Fig. 6.7 Mental arithmetic

The data would be incorrect for the reasons listed in Step 5.

If data is incorrect, click **Redo** and repeat Steps 6-11; the last data segment you recorded will be erased.

Segment 3 — After Hyperventilation

12. Director advises Subject to hyperventilate for two minutes.

WARNING

Hyperventilation can make the **Subject** dizzy and light headed. The **Subject** should be sitting down, and the **Director** should be watching. Stop the procedure if the **Subject** starts to feel sick or dizzy.

Director advises Subject to hyperventilate (see **Tips** in Step 1).

Subject should hyperventilate for two minutes with eyes closed.

It is important that you resume recording as quickly as possible after the Subject has hyperventilated. However, it is also important that you do not click **Resume** while the Subject is hyperventilating or you will capture EMG artifact.

13. Click **Resume**.

When you click **Resume**, the recording will continue and an append marker labeled **After hyperventilation** will be automatically inserted.

14. Record for 10 seconds while **Subject** is recovering from hyperventilation.

Subject should be in a relaxed state with eyes closed, recovering from hyperventilation (seconds 31-40).

15. Click **Suspend**.

When you click **Suspend**, the recording will halt, giving you time to prepare for the next recording segment.

16. Review the data.

- If correct, go to **Step 17**.
- If incorrect, click **Redo**.

Your data should resemble Fig. 6.8.

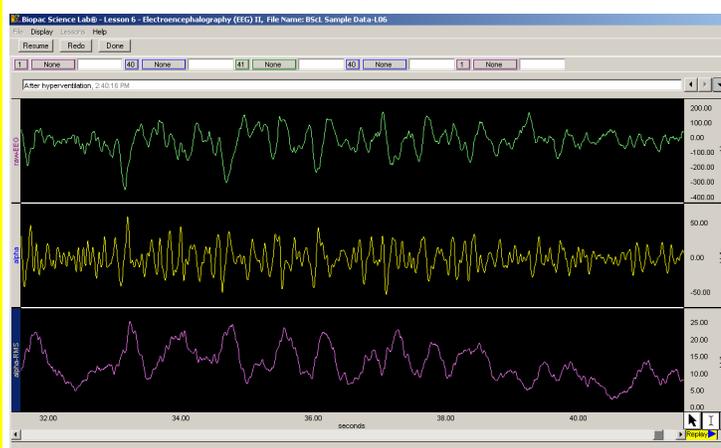


Fig. 6.8 Recovering from hyperventilation, eyes closed

Recording continues...

The data would be incorrect for the reasons listed in Step 5.

Note It is normal to have some baseline drift after hyperventilation, as shown in Fig. 6.8.

If data is incorrect, click **Redo** and repeat Steps 12-16; the last data segment you recorded will be erased.

Segment 4 — Eyes Open

17. **Director** advises **Subject** to open the eyes and continue to relax.

18. Click **Resume**.

19. Record for 10 seconds.

20. Click **Suspend**.

21. Review the data.

- If correct, go to **Step 22**.
- If incorrect, click **Redo**.

Director should advise Subject to open the eyes and remain relaxed.

When you click **Resume**, the recording will continue and an append marker labeled **Eyes open** will be automatically inserted.

Subject should be in a relaxed state with eyes open and try to not blink (seconds 41-50).

When you click **Suspend**, the recording should halt.

Your data should resemble Fig. 6.9.

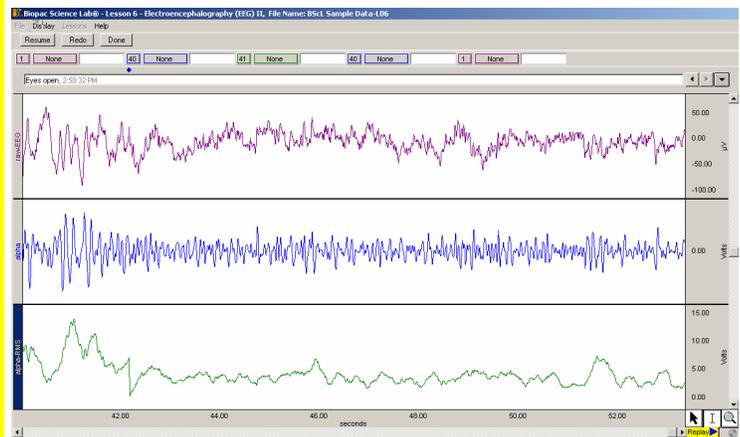


Fig. 6.9 Relaxed, eyes open

The data would be incorrect for the reasons in Step 5.

If data is incorrect, click **Redo** and repeat Steps 17-21; the last data segment you recorded will be erased.

Optional: You can record additional segments by clicking **Resume** instead of **Done**. A time marker will be inserted at the start of each added segment.

A pop-up window with options will appear. Click **Yes** (or **No** if you want to redo the last segment).

When you click **Yes**, a dialog with options will be generated. Make your choice, and click **OK**.

- If you choose **Analyze current data file**, go to the Analyze section for directions.

Disconnect the lead clips and peel off the electrodes.

22. *Optional:* Click **Resume** to record additional segments.

23. Click **Done**.

24. Click **Yes**.

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

26. Remove the electrodes.

END OF RECORDING

V. ANALYZE

FAST TRACK

1. Enter the **Review Saved Data** mode and choose the correct file.

Note Channel Number(CH) designations:

Channel	Displays
CH1	EEG
CH40	Alpha
CH41	Alpha RMS

2. Set up your display window for optimal viewing of the entire recording.

3. Set up the measurement boxes as follows:

Channel	Measurement
CH1	Stddev
CH40	Stddev
CH41	Mean
CH40	Freq

Analysis continues...

Details

To review saved data, choose **Analyze current data file** from the Done dialog after recording data, or choose **Review Saved Data** from the **Lessons** menu and browse to the required file.

The data window should come up the same as Fig. 6.10.

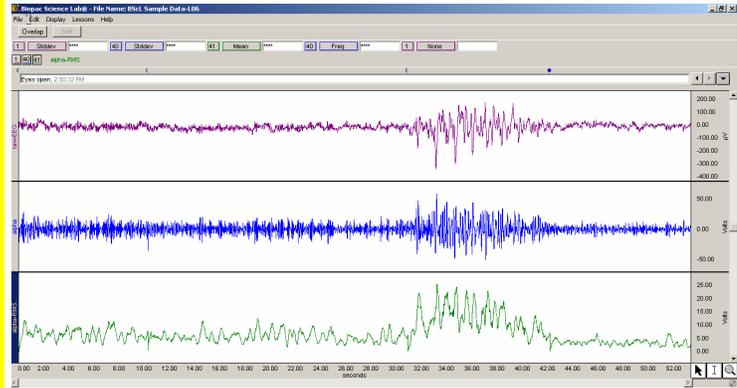


Fig 6.10

The following tools help you adjust the data window:

Autoscale Horizontal	Horizontal (Time) Scroll Bar
Autoscale Waveforms	Vertical (Amplitude) Scroll Bar
Zoom	Zoom Previous/Back

Show or **Hide Grids** by choosing File > Display Preferences.

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.

The following is a brief definition of specific measurements:

Stddev: standard deviation will be higher if there is a lot of activity and lower if there is less. The advantage of the stddev measurement is that extreme values or artifacts do not unduly influence the measurement.

Mean: displays the average value in the selected area.

Freq: converts the time segment of the selected area to frequency in cycles per second

Note The Freq measurement applies to all channels since it is calculated from the horizontal time scale.

Note The “selected area” is the area selected by the I-beam tool (including the endpoints).

- Using the I-Beam cursor, select the first data segment.



- Repeat the above measurements for each of the data segments.



- Zoom in on a small section of the Segment 1 data.

- Using the I-Beam cursor, select an area from one peak to the next in the alpha band (CH 40).



- Save or print the data file.

- Exit the program.

- Set the dial to  Off.

END OF DATA ANALYSIS

Fig. 6.11 shows an example of the selected area. The first data segment begins at the first append marker labeled **Relaxed with eyes closed**.

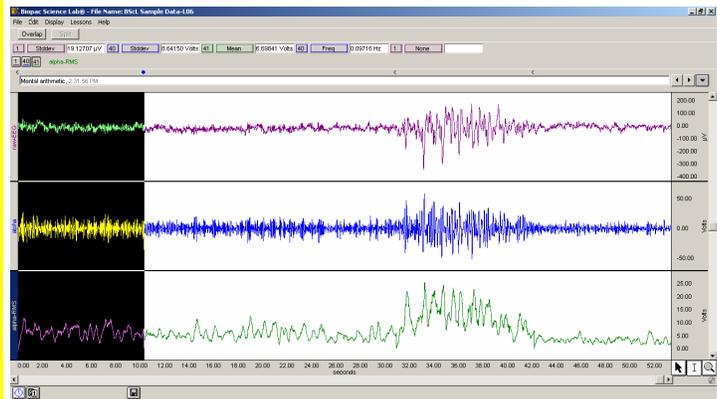


Fig. 6.11

Be sure to zoom in far enough so that you can easily measure the frequency of the alpha wave.

Fig. 6.12 shows a sample setup for measuring the frequency in the alpha band (CH 40).

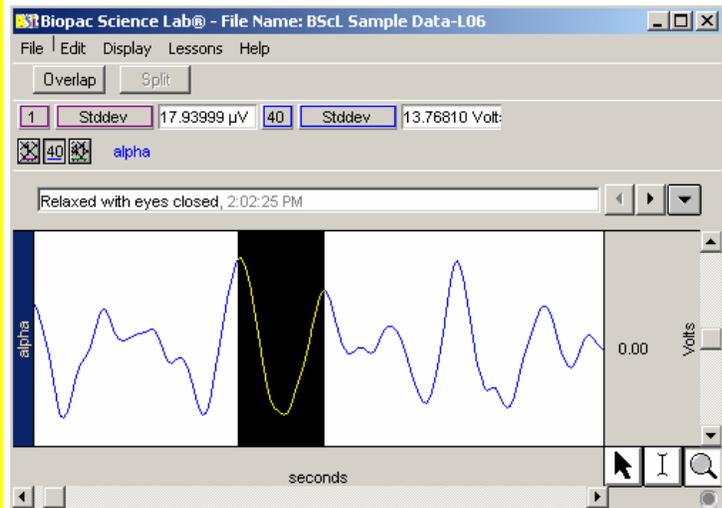


Fig. 6.12

You may save the data, save notes that are in the journal, or print the data file.

END OF LESSON 6
Complete the Lesson 6 Data Report that follows.

The Data Report starts on the next page.

Lesson 6 ELECTROENCEPHALOGRAPHY II
Alpha Rhythms in the Occipital Lobe

These are sample questions. You should amend, add, or delete questions to support your curriculum objectives.

DATA REPORT

Student's Name: _____
 Lab Section: _____
 Date: _____

I. Data and Calculations

Subject Profile

Name _____ Age _____
 Gender: Male / Female Height _____
 Weight _____

EEG Amplitudes

A. Complete Table 6.1 with the amplitudes of the recorded data in the control and experimental conditions

Table 6.1 Amplitude results

Segment	Experimental Condition	EEG [1-Stddev]	Alpha [40-Stddev]	Alpha-RMS [41-Mean]
1	Eyes Closed (control)			
2	Eyes Closed, Mental Arithmetic			
3	Eyes Closed, After Hyperventilation			
4	Eyes Open			

EEG Frequencies

B. What is the frequency of an alpha rhythm from Segment 1 data? _____ Hz
 Does this agree with the expected values? Yes No

C. Complete Table 6.2 with the mean values of the Alpha RMS channel (CH41) from Table 6.1.

The "Control Mean" is the mean Alpha RMS from Segment 1. You will need to calculate the difference between the Experimental Mean and the Control Mean. Summarize whether the Experimental Mean was larger (+), smaller (-), or the same (=) as the Control Mean.

Table 6.2

Segment	Experimental Condition	Experimental Mean	Control Mean (Seg 1)	Calculate the Difference (Exp. - Control)	Summary (+, -, =)
2	Mental Arithmetic				
3	After Hyperventilation				
4	Eyes Open				

II. Questions

D. Refer to Table 6.1: When was the general amplitude of the EEG highest?

E. Refer to Table 6.1: When were the alpha wave levels highest?

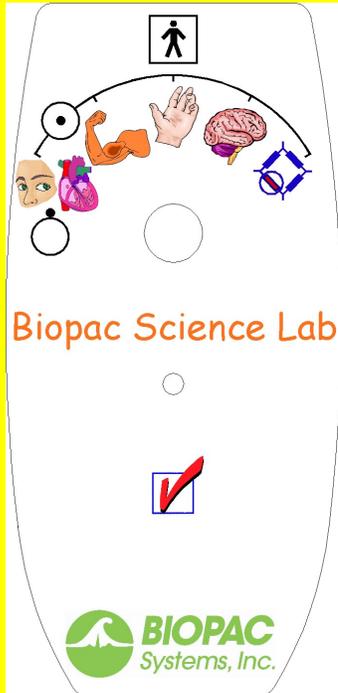
F. Refer to Table 6.1: How do your results compare with the information presented in Section 1 (Scientific Principles)?

G. Did the Subject need to concentrate during math problems? Yes No
How would the level of concentration required affect the data?

H. What might account for the amplitude difference of waves recorded from a subject tested alone in a darkened room, and subjects tested in a lab full of students?

I. Which conditions produced the lowest alpha activity?

End of Biopac Science Lab Lesson 6 Data Report



VI. ACTIVE LEARNING LAB

Design a new experiment to test or verify the scientific principle(s) you learned in the Biopac Science Lab recording and analysis segments.

- ➡ **For this lesson**, you might examine how gender, memory, personality, mental stress, biorhythms, and desynchronization influence alpha wave frequency and/or amplitude.

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 will you 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.

- See the **Set Up** section or Help > About Electrodes for electrode placement guidelines.

Run Your Experiment

D. Setup

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

E. Recording

Use the **Record**, **Resume**, and **Suspend** buttons in the Biopac Science Lab program to record as many segments as necessary for your experiment.

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

Analyze Your Experiment

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