

II. EXPERIMENTAL OBJECTIVES

- 1) To observe and record skeletal muscle tonus as reflected by a basal level of electrical activity associated with the muscle in a resting state.
- 2) To record maximum clench strength for right and left hands.
- 3) To observe, record, and correlate motor unit recruitment with increased power of skeletal muscle contraction.
- 4) To listen to EMG “sounds” and correlate sound intensity with motor unit recruitment.

III. MATERIALS

- BIOPAC Electrode Lead Set (SS2L)
- BIOPAC Disposable Electrodes (EL503,) 6 electrodes per Subject
- BIOPAC Electrode Gel (GEL1) and Abrasive Pad (ELPAD) *or* Skin cleanser or alcohol prep
- *Optional:* BIOPAC Headphones (OUT1/OUT1A for MP3X or 40HP for MP45)
- 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) — CH 1
Headphones (OUT1 or OUT1A*) — back of unit
**OUT1A is compatible with MP36 only.*
3. Turn **ON** the MP36/35 unit.

Detailed Explanation of Setup Steps



Fig. 1.4 MP3X (top) and MP45 (bottom) equipment connections

- Windows: If using MP45, the Sound Playback device must be set to MP45 via Start > Control Panel.

Setup continues...

4. Clean and abrade skin.
5. Attach three electrodes to each forearm (Fig. 1.5).
6. Clip the Electrode Lead Set (SS2L) to **Subject's** dominant arm, following the color code (Fig. 1.5).

If the skin is oily, clean electrode sites with soap and water or alcohol before abrading.

If electrode is dry, apply a drop of gel.



Fig. 1.5 Electrode placement and lead attachment

- If **Subject** is right-handed, the right forearm is generally dominant; if **Subject** is left-handed, the left forearm is generally dominant.
- For optimal electrode adhesion, place electrodes on the skin at least 5 minutes before the start of Calibration.
- The pinch connectors work like a small clothespin and will only latch onto the nipple of the electrode from one side of the connector.



Fig. 1.6 Proper Seating Position

- The dominant arm should rest on thigh to relax the muscles in the shoulder and upper arm.
- Optional: Subject may hold a small object, such as a rubber ball, while performing this procedure

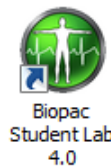


Fig. 1.7 Positioning

Setup continues...

8. **Start** the Biopac Student Lab Program.
9. Choose lesson “**L01 – Electromyography (EMG) I**” and click **OK**.
10. Type in a unique **filename** and click **OK**.

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



No two people can share 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.

To change the preference, see next step.

11. **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

Calibration establishes the hardware's internal parameters (such as gain, offset, and scaling) and is critical for optimal performance. **Pay close attention to Calibration.** *For a video example of proper Calibration procedure,* click the **Calibration** tab in the Lesson Set Up Journal.

FAST TRACK Calibration

1. Click **Calibrate**.
2. Two seconds after Calibration begins, **clench** fist as hard as possible for two to three seconds, then **release**.
3. **Wait** for Calibration to stop.
4. 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



Fig. 1.8 Clench Fist for Calibration

The program needs a reading of the maximum clench to perform an auto-calibration.

Calibration lasts eight seconds.

Data should show a zero baseline and a clear burst when **Subject** clenched.

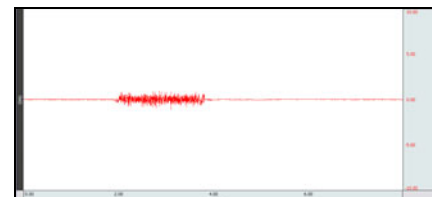


Fig. 1.9 Example Calibration data

If recording does not resemble the Example Data

- If the data is noisy or flatline, check all connections to the MP unit.
- Verify electrodes are making good contact and that leads are clipped to the correct color position with minimal cable strain.

C. DATA RECORDING

FAST TRACK Recording

1. Prepare for the **Dominant arm** recording.
 - Electrodes must be attached to **Subject's** dominant arm.
 - **Subject's** hand must be relaxed.
 - **Review** recording steps.

Dominant arm

2. Click **Record**.
3. Perform a series of four Clench -Release-Wait cycles.
 - Hold clench for two seconds, release for two seconds.
 - Begin with a weak clench, then increase grip so the fourth clench is at maximum.
4. Click **Suspend**.
5. Verify recording resembles the example data.
 - If similar, click **Continue** and proceed to next recording.
 - If necessary, click **Redo**.
 - If all required recordings have been completed, click **Stop** and proceed to Step 11.

Nondominant arm

6. Prepare for the **Nondominant arm** recording.
 - Clip electrode leads to **Subject's** nondominant arm.
 - **Subject's** hand must be relaxed.
 - **Review** recording steps.
7. Click **Record**.

Recording continues...

Detailed Explanation of Recording Steps

Two data recordings* will be acquired in this lesson:

- a. Recording 1 records **Dominant arm**.
- b. Recording 2 records **Nondominant arm**.

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.

- Completely relax the grip between clenches.
- Allow at least two seconds between clenches.
- Two channels will be presented during the recording, CH 1 = Raw EMG, and CH 2 = Integrated EMG (a moving average of the raw signal).

Data should show four EMG “bursts” of increasing amplitude.

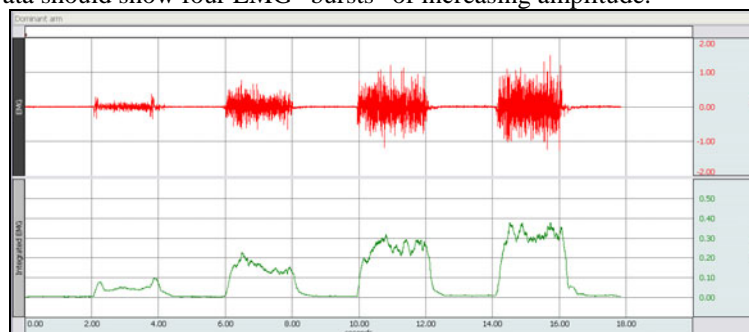


Fig. 1.10 Example data – Dominant arm

If recording does not resemble the Example Data

- If there is not enough variation between the clenches, repeat recording and start with a weaker clench.
- If the data is noisy or flatline, check all connections to the MP unit.
- Verify electrodes are making good contact and that leads are clipped to the correct color position with minimal cable strain.

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

Disconnect the lead set (SS2L) from the electrodes on the “dominant” forearm and connect to electrodes on “nondominant” forearm. Refer to Fig. 1.5 for proper electrode lead attachment.

8. Perform a series of four Clench-Release-Wait cycles.
 - Hold clench for two seconds, release for two seconds.
 - Begin with a weak clench, and then increase grip so the fourth clench is at maximum.
9. Click **Suspend**.
10. Verify recording resembles the example data.
 - If similar, click **Continue** to proceed to the optional recording section, or click **Stop** to end the recording.
 - If necessary, click **Redo**.

Perform four cycles of Clench-Release-Wait, holding for two seconds and waiting for two seconds after releasing before beginning the next cycle. Try to increase the strength in equal increments so that the fourth clench is at maximum force.

- Completely relax the grip between clenches.
- Allow at least two seconds between clenches.

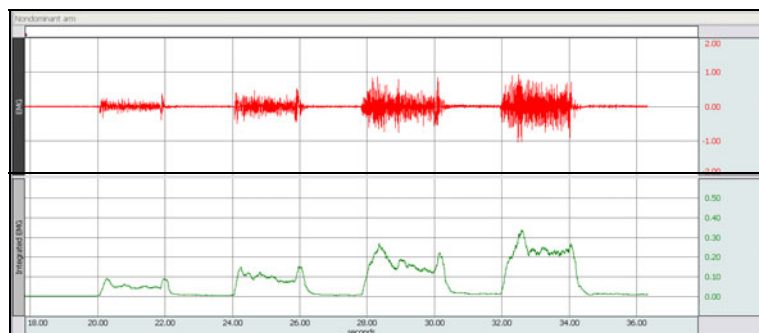


Fig. 1.11 Example data– Nondominant arm

The data description is the same as outlined in Step 4.

Click **Redo** and repeat Steps 7 – 10 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 **Stop** 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.

Recording continues...

- To listen to the EMG signal, proceed to Step 11.
- To skip listening to the EMG signal and end the recording, proceed to Step 14.

11. Click **Listen** to record EMG data and hear it through the headphones.
12. Increase grip force and notice how the volume increases.
13. Click **Stop** when finished.
 - Click **Redo** to hear EMG again.
14. Click **Done** to end the lesson.
15. Choose an option and click **OK**.
16. Remove the electrodes.

END OF RECORDING

Listening to the EMG is optional.

Listening to the EMG is optional and can be a valuable tool in detecting muscle abnormalities, and is performed here for general interest. Data on screen is not saved.

The EMG signal will be audible through the headphones as it is being displayed on the screen. The screen will display two channels:

CH 1 EMG and CH 40 Integrated EMG

The signal will run until **Stop** is clicked. If others in lab group would like to listen to the EMG signal, pass the headphones around before clicking **Stop** or click **Redo** and then **Stop** when done.

This will end listening to the EMG.

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

- Repeat Setup Steps 4 – 7 and then proceed to Calibration.

Remove 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 electrodes may leave a slight ring on the skin for a few hours, which is quite normal.

V. DATA ANALYSIS

FAST TRACK Data Analysis

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

- Note Channel Number (CH) designations:

Channel Displays

CH 1 EMG

CH 40 Integrated EMG

- Note measurement box settings:

Channel Measurement

CH 40 Mean

2. Set up your display window for optimal viewing of “**Dominant arm**” recording.

3. Use the I-Beam cursor to select an area on the plateau of the first EMG clench data (Fig. 1.13).



A

4. Repeat Step 3 on each successive EMG cluster.



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.

The data window should resemble Fig. 1.12.

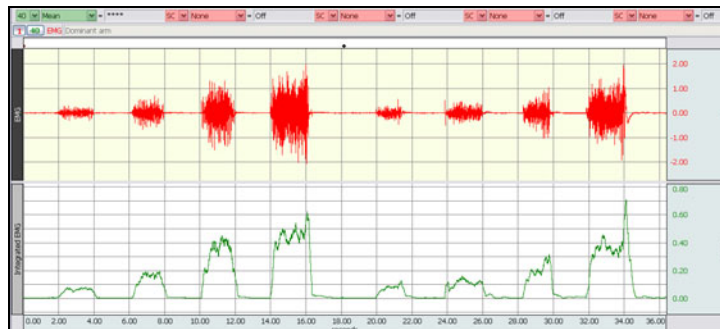


Fig. 1.12 Example data

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:

Mean: Displays the average value in the selected area.

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

Record measurement data individually by hand or choose **Edit > Journal > Paste measurements** to paste the data to your journal for future reference.

Note:

The append event markers  mark the beginning of each recording. Click on (activate) the event marker to display its label.

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.

Fig. 1.13 below shows an EMG data selection in the first recording.

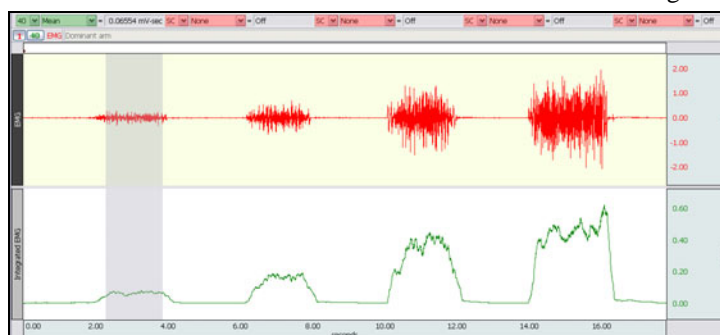


Fig. 1.13 EMG data selection

5. Scroll to the second recording.
6. Repeat Steps 3 and 4 for “**Nondominant arm**” data.
7. Scroll to the first recording.
8. Use the I-Beam cursor to select the area between the first and second clenches (Fig. 1.14).



C

9. Repeat Step 7 between each successive clench.
10. Scroll to the second recording.
11. Repeat Steps 7 – 8 for “**Nondominant arm**” data.



C

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

END OF DATA ANALYSIS

The second recording begins at the append event marker labeled “**Nondominant arm**” and includes four clenches from **Subject’s** nondominant arm.

Tonus is the resting state, and is represented by the area between clenches (clusters). Fig. 1.14 below shows the selected area between clenches.

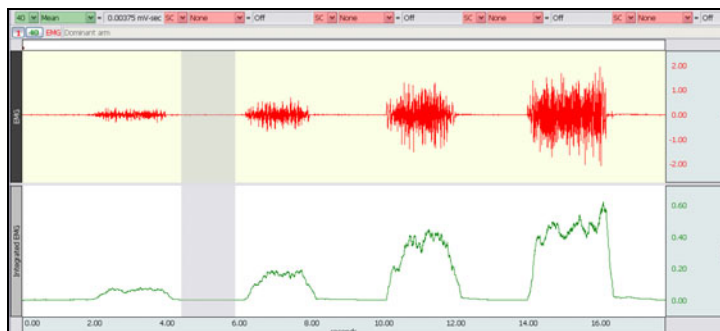


Fig. 1.14 Selection between clenches to measure tonus

An electronically editable **Data Report** can be found 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 LESSON 1

Complete the Lesson 1 Data Report that follows.

ELECTROMYOGRAPHY I

• *Standard and Integrated EMG*

DATA REPORT

Student's Name: _____

Lab Section: _____

Date: _____

I. Data and Calculations

Subject Profile

Name: _____

Height: _____

Gender: Male / Female

Age: _____

Weight: _____

Dominant arm: Right / Left

A. EMG Measurements

Table 1.1

Clench #	Dominant arm	Nondominant arm
	40 Mean	40 Mean
1		
2		
3		
4		

- B. Use the mean measurement from the table above to compute the percentage increase in EMG activity recorded between the weakest clench and the strongest clench of Dominant arm.

Calculation: _____

Answer: _____ %

C. Tonus Measurements

Table 1.2

Between Clenches #	Dominant arm	Nondominant arm
	40 Mean	40 Mean
1-2		
2-3		
3-4		

II. Questions

- D. Compare the mean measurement for the right and left maximum clench EMG data.

Are they the same or different? _____ Same _____ Different

Which one suggests the greater clench strength? _____ Right _____ Left _____ Neither

Explain.

E. What factors in addition to sex contribute to observed differences in clench strength?

F. Does there appear to be any difference in tonus between the two forearm clench muscles? ____ Yes ____ No

Would you expect to see a difference? Does Subject's gender influence your expectations? Explain.

G. Explain the source of signals detected by the EMG electrodes.

H. What does the term "motor unit recruitment" mean?

I. Define skeletal muscle tonus.

J. Define electromyography.

III. OPTIONAL Active Learning Portion

A. *Hypothesis*

B. *Materials*

C. *Method*

D. *Set Up*

E. *Experimental Results*
