

II. EXPERIMENTAL OBJECTIVES

- 1) Record EOG and compare eye movements during real and simulated tracking of a pendulum.
- 2) Record EOG and compare eye movements during real and during simulated tracking of an object in the vertical plane.
- 3) Record and compare the “saccadic” eye movements when reading three different ways; silently (easy,) silently (challenging) and aloud (challenging).

III. MATERIALS

- 2 x BIOPAC Electrode Lead Set (SS2L)
- BIOPAC Disposable Electrodes (EL503,) 6 electrodes per subject
- BIOPAC Electrode Gel (GEL1) and Abrasive Pad (ELPAD)
- *Optional:* BIOPAC Adhesive Tape (TAPE 2)—use to tape wires to reduce cable strain
- Pendulum: Can be made by attaching any object (i.e. 50 gm force calibration weight) to approx. 61 cm (24 inches) of string.
- Pen or other real object for vertical tracking
- Passages for reading:
 - Passage 1 – easily understandable (i.e., entertainment article)
 - Passage 2 – challenging material (i.e., scientific article)

Note A sample reading passage in printable PDF format is available in the lesson Help menu.

- 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 Electrode Lead Sets (SS2L)** in as follows:
 - Horizontal lead — CH 1
 - Vertical lead — CH 2
3. Turn ON the MP36/35 unit.

Setup continues...

Detailed Explanation of Setup Steps



Fig. 10.6 MP3X (top) and MP45 (bottom) equipment connections

4. Gently clean and abrade skin.
5. Attach six electrodes to **Subject's** face as shown in Fig. 10.7.

IMPORTANT

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



Fig. 10.7 Proper electrode placement

- 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.
- Attach one electrode above the right eye and one below, such that they are aligned vertically.
- Attach one electrode to the right of the right eye and one to the left of the left eye, so they align horizontally.
- The other two electrodes are for ground, and alignment is not critical.

6. Clip CH 1 Electrode Lead Set (SS2L) in the horizontal placement, following the color code (Fig. 10.8).

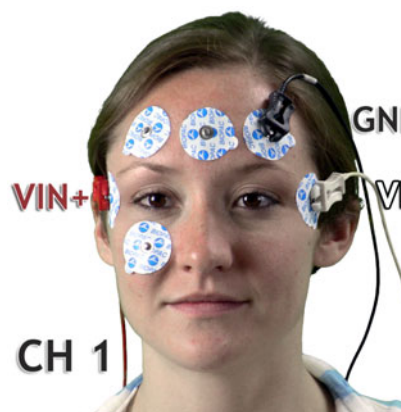


Fig. 10.8 Horizontal (CH 1) Lead Placement

- Drape the electrode lead cables behind the ears, as shown, to give proper cable strain relief.
- Connect the electrode cable clip to a convenient location to help relieve cable strain.
- Electrodes must lay flat on skin.

7. Clip CH 2 Electrode Lead Set (SS2L) in the vertical placement, following the color code (Fig. 10.9).

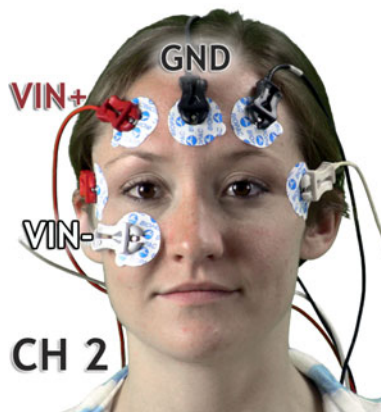
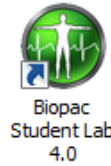


Fig. 10.9 Vertical (CH 2) Lead Placement

Setup continues...

8. **Start** the Biopac Student Lab Program.
9. Choose lesson “**L10 – Electrooculogram (EOG) I**” and click **OK**.
10. Type in a unique **filename** and click **OK**.
11. *Optional*: Set Preferences.
 - Choose File > **Lesson Preferences**.
 - Select an option.
 - Select an option 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.

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's 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** is seated, relaxed, breathing normally, and facing away from monitor.
 - **Carefully review** upcoming steps.
2. Click **Calibrate**.
3. **Subject** must:
 - Complete four horizontal eye movement cycles (extreme left-extreme right-return to center) and four vertical eye movement cycles (extreme up-extreme down-return to center).
 - Wait for Calibration to stop.
4. Verify recording resembles example data.
 - If similar, click **Continue** and proceed to Data Recording.
 - If necessary, click **Redo Calibration**.

END OF CALIBRATION

Detailed Explanation of Calibration Steps

- **Subject** should sit with arms relaxed at side of body, legs flexed at knee and feet supported.
- **Subject** prepares to move eyes horizontally and vertically for Calibration procedure.
- **Subject** must try to keep head still and avoid blinking.
- Calibration lasts 20 seconds.



Fig. 10.10 Proper head positioning

The four cycles of horizontal and vertical eye movement should be clearly visible in the appropriate data channel.

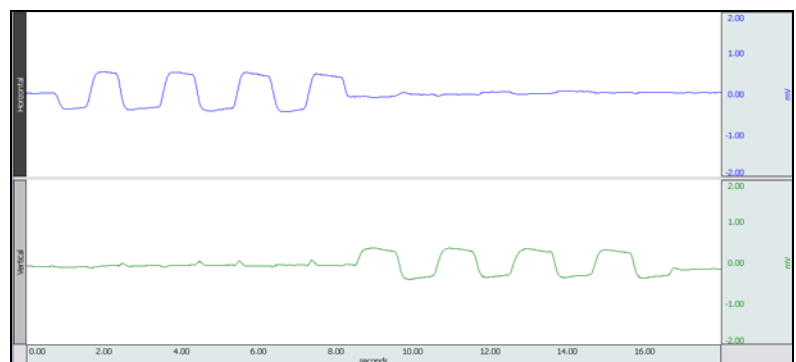


Fig. 10.11 Example Calibration data

If recording does not resemble Example Data...

- If data is flatline, check all connections to MP unit.
- If there is excessive noise or baseline drift, check that electrodes are making good contact with the skin (lying flat) and that leads are not pulling on the electrodes.
- If **Subject** blinked, resulting in a large data spike, redo the calibration.

C. DATA RECORDING

FAST TRACK Recording

1. Prepare for the recordings.

Detailed Explanation of Recording Steps

Seven data recordings will be acquired*:

- Recording 1 – 2: real and simulated pendulum*
- Recording 3 – 4: real and simulated vertical tracking*
- Recording 5 – 6: read silently (easy and challenging)*
- Recording 7: read aloud (challenging)*

*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.

For all recordings, the **Subject** is seated and relaxed, facing away from the monitor.

Hints for obtaining optimal data:

- Review recording steps in advance.
- Make sure all electrodes are making good contact with skin (lying flat) and that leads are not pulling on the electrodes.
- **Subject** must remain in a seated, relaxed state for all recordings.
- **Subject** must keep head still, move only eyes and try to avoid blinking.
- In order to record sufficient amplitude variation, eye movements should be as large as possible. When tracking a moving object, eye movements should cover a significant portion of the visual range along at least one axis. When reading, the reading material must be held as close to the **Subject** as possible, while maintaining focus.

Pendulum

2. **Prepare** for the recording.
 - **Director** holds pendulum in front of **Subject**, ready to release (Fig. 10.12).
 - **Subject** must focus on pendulum.
 - **Review** recording steps.



Fig. 10.12 Pendulum positioning

Details...

- **Subject** should be seated about 25 cm (10 inches) from pendulum—adjust as necessary to maintain focus.
- Bottom of pendulum swing should align with bottom of **Subject's** nose.
- Pendulum should be lifted approximately 45 degrees to **Subject's** right while maintaining a taut string, ready to release when recording starts.
- **Director** must hold pendulum string at a constant position.

Recording continues...

3. Click **Record**.
 - **Director** releases pendulum.
4. **Subject** tracks pendulum with eyes only.
5. Wait for pendulum to stop swinging.
6. Click **Suspend**.
7. Verify recording resembles the example data.
 - If similar, click **Continue** and proceed to the next recording.

There should be cyclical variation in the data and the amplitude should progressively decrease. The Horizontal data should display greater amplitude variation than the Vertical data.

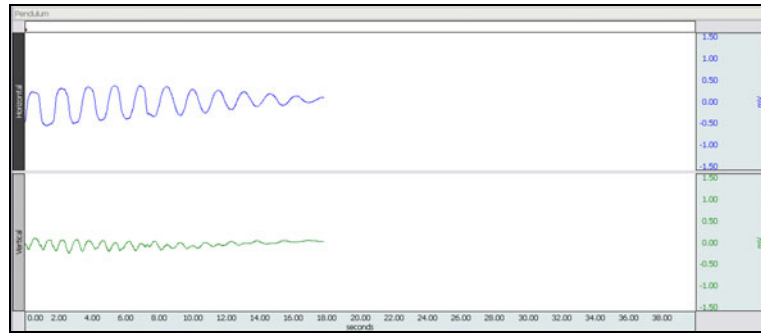


Fig. 10.13 Example Pendulum data

If recording does not resemble Example Data...

- If data is flatline, check all connections to MP unit.
- If there is excessive noise or baseline drift, check that electrodes are making good contact (lying flat) and that leads are not pulling on the electrodes.
- If there is not sufficient amplitude variation, make sure that the horizontal range of the pendulum swing covers a large portion of the **Subject's** visual range.
- If **Subject** blinked, resulting in a large data spike, redo the recording.

Click **Redo** and repeat Steps 2 – 7 if necessary.

Note that once **Redo** is clicked, the most recent recording will be erased.

- If necessary, click **Redo**.
- If all required recordings have been completed, click **Done**.

Simulate Pendulum

8. **Prepare** for the recording.
 - **Subject** prepares to simulate eye-tracking an imaginary pendulum.
 - **Subject** places eyes at the 2 o'clock position
 - **Review** recording steps.
9. Click **Record**.
10. **Subject** tracks an imaginary pendulum with decreasing swing cycles.
11. **Director** observes horizontal channel until there is little or no eye movement.
12. Click **Suspend**.

This simulates the starting position of the pendulum.

Subject must try to visualize the pendulum movement of the previous recording and track the imaginary pendulum with the eyes only. The initial swing should take up a large portion of the **Subject's** visual range along the horizontal axis and each successive swing should be reduced in amplitude until the eyes are still.

Recording continues...

13. Verify recording resembles the example data.

- If similar, click Continue and proceed to the next recording.

- If necessary, click **Redo**.

Vertical Tracking

14. **Prepare** for the recording

- **Director** positions a pen about 25 cm (10 inches) from **Subject**.
- **Subject** tracks pen.
- **Director** moves pen vertically up and down to determine the limits of the **Subject's** visual range.
- **Review** recording steps.

Recording continues...

There should be cyclical variation in the Horizontal data and the amplitude should progressively decrease.

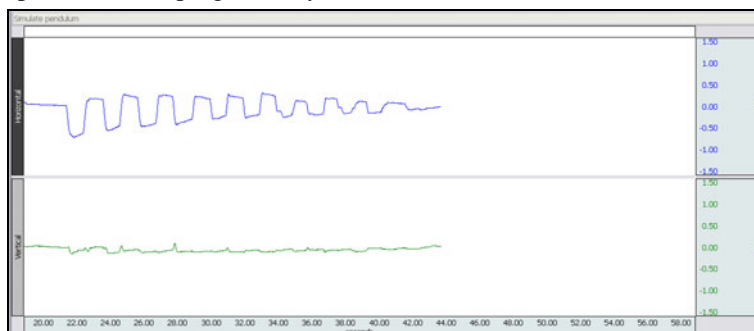


Fig. 10.14 Example Simulated Pendulum data

Data would be different for reasons detailed in Step 7.

Click **Redo** and repeat Steps 8 – 13 if necessary.

Note that when **Redo** is clicked, the most recent recording will be erased.

Director holds pen centered with the eyes - adjust as necessary to maintain focus (Fig. 10.15). **Subject** must pick a focal point on the pen and track its movement **WITHOUT** moving head.

Director determines (and mentally notes) the upper and lower edges of the **Subject's** visual field by moving the pen up and down until **Subject** indicates it is out of view.

Director returns pen to a center position (eyes looking straight ahead) and the recording is ready to begin.

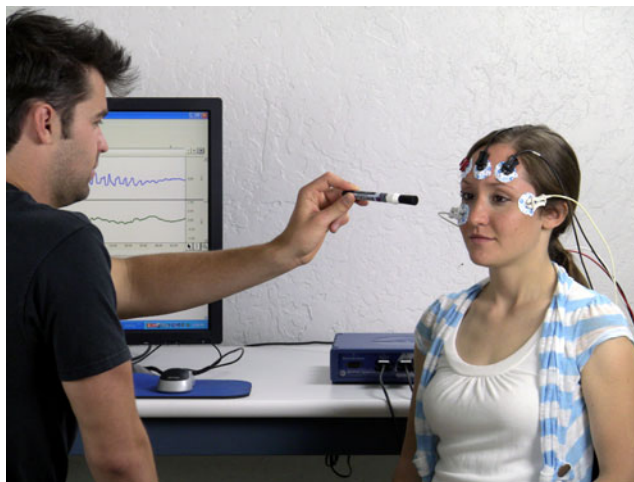


Fig. 10.15 Vertical tracking positioning

15. Click **Record**.
16. **Subject** tracks pen while **Director** moves it from center to upper and lower edges of visual field.
 - Repeat for a total of five cycles.
17. Click **Suspend**.
18. 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**.

Simulate Vertical Tracking

19. **Prepare** for the recording.
 - **Subject** centers eyes and prepares to simulate vertical eye-tracking.
 - **Review** recording steps.
20. Click **Record**.
21. **Subject** tracks an imaginary pen moving vertically through visual field for five cycles.
22. **Director** observes vertical channel until there is little or no eye movement.
23. Click **Suspend**.

Recording continues...

Subject must track pen movement with the eyes only, trying not to move head or blink.

Director moves the pen through five vertical tracking cycles as follows:

- From center to upper then lower edges of visual field and then back to center.

The five cycles should be clearly visible in the Vertical channel data.

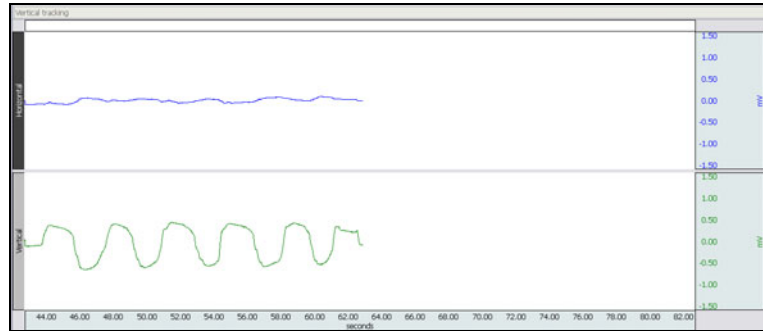


Fig. 10.16 Example Vertical Tracking data

If recording does not resemble Example Data...

- If data is flatline, check all connections to MP unit.
- If there is excessive noise or baseline drift, check that electrodes are making good contact (lying flat) and that leads are not pulling on the electrodes.
- If there is not sufficient amplitude variation, make sure that the vertical range of the pen covers the **Subject's** visual range.
- If **Subject** blinked, resulting in a large data spike, redo the recording.

Click **Redo** and repeat Steps 14 – 18 if necessary.

Note that once **Redo** is clicked, the most recent recording will be erased.

Subject tracks the imaginary pen with eyes only, imagining the pen moving to the upper then lower edges of visual field, then returning to center. This upper/lower cycle should be repeated five times.

24. Verify recording resembles the example data.

- If similar, click **Continue** and proceed to the next recording.

- If necessary, click **Redo**.

Read Silently (Easy)

25. **Prepare** for the recording

- **Director** holds reading material centered in front of **Subject** as close as possible, while maintaining focus (Fig. 10.18).
- **Review** recording steps.

26. Click **Record**.

27. **Subject** reads material silently and announces when finished.

28. Click **Suspend**.

Recording continues...

The five cycles should be clearly visible in the Vertical channel data.

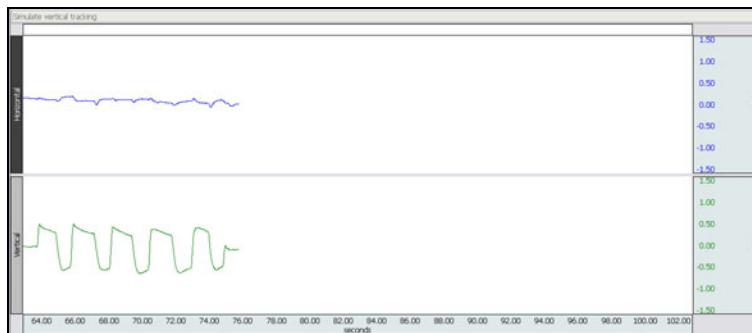


Fig. 10.17 Example Simulated Vertical Tracking data

Data would be different for reasons detailed in Step 18.

Click **Redo** and repeat Steps 19 – 24 if necessary.

Note that when **Redo** is clicked, the most recent recording will be erased.

This passage should be easy to read. The upper passage will be used for this recording. You may hide the lower passage by folding the paper in half.

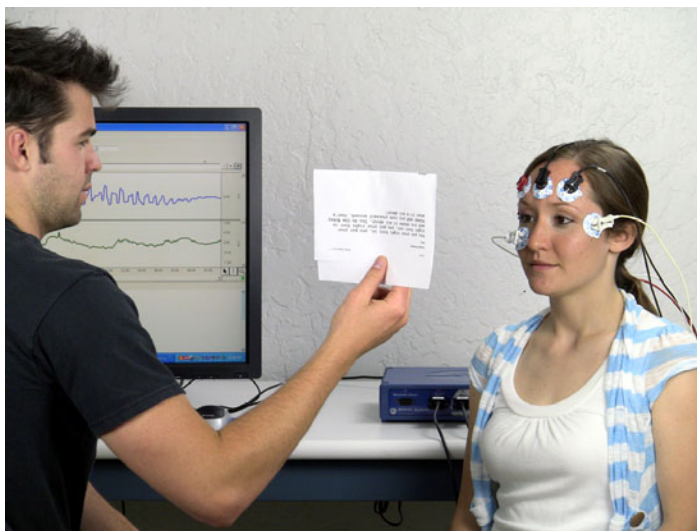


Fig. 10.18 Reading material positioning

Details...

- **Subject** must be able to read entire passage without moving head.
- **Subject** must keep head still, move only eyes, and try to avoid blinking.
- **Director** must hold the reading material as still as possible.

29. 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**.

Read Silently (Challenging)

30. **Prepare** for the recording.

- **Director** holds reading material centered in front of **Subject** as close as possible, while maintaining focus.
- **Review** recording steps.

31. Click **Record**.

32. **Subject** reads material silently and announces when finished.

33. Click **Suspend**.

34. 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**.

Recording continues...

There should be a visible “saw tooth” pattern in the Horizontal data.

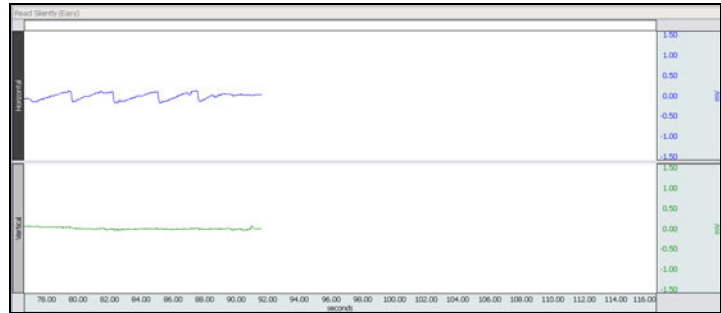


Fig. 10.19 Example Read Silently (Easy) data

If recording does not resemble Example Data...

- If data is flatline, check all connections to MP unit.
- If there is excessive noise or baseline drift, check that electrodes are making good contact (lying flat) and that leads are not pulling on the electrodes.
- If there is not sufficient amplitude variation, make sure that the reading material was held as close as possible to the **Subject's** face while maintaining focus.
- Make sure the **Director** held the reading material as still as possible.
- If **Subject** blinked, resulting in a large data spike, redo the recording.

Click **Redo** and repeat Steps 25 – 29 if necessary.

Note that once **Redo** is clicked, the most recent recording will be erased.

This passage should be more challenging than that from “**Read Silently (Easy)**.” You may hide the upper passage by folding the paper in half.

Review the “Details” listed in Step 25.

There should be a visible “saw tooth” pattern in the Horizontal data.

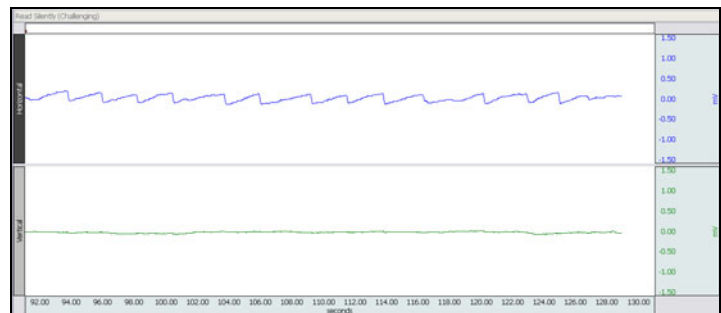


Fig. 10.20 Example Read Silently (Challenging) data

Data would be different for the reasons detailed in Step 29.

Click **Redo** and repeat Steps 30 – 34 if necessary.

Note that when **Redo** is clicked, the most recent recording will be erased.

Read Aloud (Challenging)

35. **Prepare** for the recording
 - **Director** holds reading material centered in front of **Subject** as close as possible, while maintaining focus.
 - **Review** recording steps.
36. Click **Record**.
37. **Subject** reads passage aloud.
38. Click **Suspend**.
39. Verify recording resembles example data.
 - If similar, click **Continue** to proceed to optional recording section, or **Done** to finish the lesson.
 - If necessary, click **Redo**.

Recording continues...

This passage should be the same as that used in “**Read Silently (Challenging)**.”

Review the “Details” listed in Step 25.

Subject reads passage aloud until material is complete. **Subject** should try to minimize mouth and jaw movement as this can add signal artifact to the EOG.

The Horizontal data will most likely show less of a consistent pattern than in the Read silently recordings.



Fig. 10.21 Example Read Aloud (Challenging) data

Data might be different for the reasons detailed in Step 29.

If the signal is too difficult to interpret, redo and have the **Subject** use less mouth and jaw movement.

Click **Redo** and repeat Steps 35 – 39 if necessary. Note that when **Redo** is clicked, the most recent recording will be erased.

OPTIONAL ACTIVE LEARNING PORTION

40. After clicking **Done**, choose an option and click **OK**.
41. Remove the electrodes.

END OF RECORDING

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.

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.

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.