Biopac Student Lab® Lesson 9
ELECTRODERMAL ACTIVITY & POLYGRAPH Procedure
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II. EXPERIMENTAL OBJECTIVES

1) To become familiar with procedures for recording electrodermal activity.

2) To observe and record changes in respiratory rate, heart rate, and skin resistance associated with somatic and special sensory stimuli.

3) To observe and record changes in respiratory rate, heart rate, and skin resistance associated with cognitive behavior and emotion.

4) To analyze a 3-channel polygram recorded under various experimental conditions to gain a better understanding of polygraphy and its potential for use and misuse.

III. MATERIALS

- BIOPAC Disposable Electrodes (EL503,) 3 electrodes per Subject
- BIOPAC Electrode Lead Set (SS2L)
- BIOPAC EDA setup
    o Disposable setup: EDA Lead (SS57L) and EDA Electrodes (EL507 x 2)
    o Reusable setup: EDA Transducer (SS3LA/L) and Electrode gel (GEL101)
- BIOPAC Respiratory Transducer (SS5LB or older SS5LA or SS5L)
- BIOPAC PAPER1 or nine sheets of different colored paper. Recommended: 8-1/2"x 11" sheets in white, black, green, red, blue, yellow, orange, brown, pink
- Biopac Student Lab System: BSL 4 software, MP36 or MP35 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**.
2. Turn **OFF** MP36/35 unit.
3. **Plug the transducers in** as follows:
   Respiratory Transducer (SS5LB) — CH 1
   Electrode Lead Set (SS2L) — CH 2
   EDA (SS3LA OR SS57L) — CH 3
4. Turn **ON** the MP36/35 unit.

Setup continues…

Detailed Explanation of Setup Steps

Fig. 9.1 Hardware Connections

5. Attach the Respiratory Transducer (SS5L) around the **Subject's** chest (Fig. 9.2).

Transducer should be placed below the armpits and above the nipples.

   IMPORTANT: The tension must be slightly tight at the point of maximal expiration (chest contracted).

Fig. 9.2 SS5L Placement

If using the SS5LA, loop the nylon straps through the corresponding slots in the transducer to hold it in place when tightened (Fig. 9.3).

IMPORTANT: The SS5LA is fragile. Do not pull hard on the ends of the rubber portion.

Fig. 9.3 SS5LA

6. Place the EDA Transducer on the index and middle finger of the left hand.

   - **If using SS57L EDA Lead and EL507**

Attach two EL507 electrodes to the **Subject's** fingertips and clip the SS57L Lead, as shown in Fig. 9.4.

If electrode is dry, apply a drop of gel.

Fig. 9.4 SS57L and EL507 Setup

   - **If using SS3LA and GEL101**

   → **Clean and fill** both cavities of the EDA Transducer (SS3L/SS3LA) with isotonic gel and then **attach** to the **Subject**. (Do not abrade skin for EDA.)
   (Fig. 9.5)

- CLEAN: Each cavity of the EDA Transducer should be carefully cleaned with an abrasive pad to remove any residue from the electrode. Data quality may suffer if the transducer becomes gummed with dried gel from previous uses.

- FILL: Fresh isotonic gel (GEL101) must fill the cavity to create contact between the skin and the electrodes.

Fig. 9.5 SS3L/SS3LA attachment and connection

Position the electrodes are over the pads of the fingers and wrap the Velcro® tape so the electrodes fit snugly but not so tight that blood circulation is cut off.

7. Set up the LEAD II recording.
   a) Clean and abrade skin.
   b) Attach three electrodes on **Subject** as shown in Fig. 9.6 and 9.7.
   c) Connect the Electrode Lead Set (SS2L) to the electrodes following the color code (Fig. 9.7).

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.

Remove any jewelry on or near the electrode sites.

Place one electrode on the medial surface of each leg, just above the ankle. Place the third electrode on the right anterior forearm at the wrist (same side of arm as the palm of hand).

For optimal electrode contact, place electrodes on skin at least 5 minutes before start of Calibration.

Setup continues…

- WHITE = RIGHT wrist
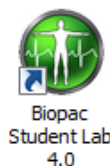- RED = LEFT ankle
- BLACK = RIGHT ankle

Fig. 9.6 Lead II Setup   **Fig. 9.7 Electrode Leads**

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

8. **Start** the Biopac Student Lab program.

9. Choose "**L09 – EDA & Polygraph"** 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 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.

Important: The Respiratory Transducer model number must be specified in Lesson Preferences or the recorded signal may be out of range or too low or too high. See Step 12 below.

11. If you will be recording "**Colored Squares**," get colored paper in the proper order.

12. *Optional*: Set Preferences.

- Choose File > **Lesson Preferences**.

- Select an option.

- Select the desired setting and click **OK**.

Ordering from top to bottom: white, black, red, blue, green, yellow, orange, brown, pink.

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
Respiratory Transducer: Specify the model as SS5LB, SS5LA, or SS5L.
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** is seated, relaxed, breathing normally, and facing away from monitor.
   - **IMPORTANT**: Subject must be at resting heart rate prior to recording.

2. Click **Calibrate.**

3. Three seconds after Calibration begins, a beep will sound. When heard, Subject will inhale once quickly and deeply, and then return to normal breathing.

4. **Wait** for Calibration to stop.

5. Verify recording resembles example data.
   - If <u>similar</u>, click **Continue** and proceed to Data Recording.
   - If necessary, click **Redo Calibration**.

END OF CALIBRATION

Detailed Explanation of Calibration Steps

Fig. 9.8 Calibration Seating

The **Subject** should sit with arms relaxed at side of body and hands apart in lap, with legs flexed at knee and feet supported.

The program needs to see a change in the EDA during calibration. The **Subject** should try to minimize chest movement, as this may cause excessive EMG artifact.

Calibration lasts ten seconds.

The Respiration channel should show variations, particularly during deep inhale/exhale. The ECG waveform should have a baseline at or near 0 mV, no excessive EMG artifact, and no excessive baseline drift before or after the deep inhale/exhale. The EDA data should increase a few seconds after the deep inhale/exhale, and then slowly return to baseline.

Fig. 9.9 Example Calibration data

If recording does not resemble Example Data...

- If no beep was heard, redo Calibration and begin deep, quick, inhale after three seconds.
- If data is noisy or flatline, check all connections to MP unit.
- If Respiration channel shows no variation:
  - Verify Respiratory Transducer has not slipped and that strap is snug.
  - Verify preference is set correctly (after Redo – see setup Step 12).
- If the ECG displays excessive baseline drift or EMG artifact:
  - Verify electrodes are making good contact with the skin and that the leads are not pulling on the electrodes.
  - Make sure Subject is in a relaxed position
- If EDA channel shows no variation, check that electrodes are making good contact with finger tips.

C. DATA RECORDING

FAST TRACK Recording	Detailed Explanation of Recording Steps
1. **Subject** faces **Director** and listens for instructions. • **Carefully review** upcoming steps.	Three recordings will be acquired* while the **Subject** is: performing mental math, being touched, looking at colored paper, and answering a series of "yes" or "no" questions. ***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** <u>must</u> be relaxed, still, and facing away from monitor. ▪ **Subject** should be at his/her resting heart rate in a relaxed mental and physical state, and should not have performed any recent physical or mental exertion. ▪ The environment must be quiet, and unrelated sensory input kept at a minimum. ▪ **Subject** should answer questions quietly, with minimal movement of the mouth. ▪ Only **Redo** a recording if it is absolutely necessary as the **Subject** would most likely habituate and elicit less of a response to a repeated procedure. ▪ Make sure to insert event markers at the right time during the recording. If an event marker is missed, manually insert it after the recording has stopped, rather than Redoing. To add a marker, right click in the marker region and choose "Insert New Event" then type in the event label. You can move the marker by holding down the "Alt" key while dragging the marker.

Count and touch

FAST TRACK Recording	Detailed Explanation of Recording Steps
2. Click **Record**.	
3. Five seconds into recording, **Director** asks **Subject** to say full name.	The 5-second wait intervals are important to re-establish the baseline. **Recorder** <u>must</u> insert an event marker at the precise moment that **Subject** answers each question. Each event marker has a pre-assigned label:
4. **Recorder** presses **F2** and waits five seconds.	**F2**—Name
5. **Director** asks **Subject** to count backwards from 10.	**F3**—Count from 10
6. **Recorder** presses **F3** and waits five seconds.	**F4**—Count from 30
7. **Director** asks **Subject** to count backwards from 30 by subtracting increasing odd numbers: (30, 29, 26, 21, etc.)	**F5**—Face touched
8. **Recorder** presses **F4** and waits five seconds.	
9. **Director** touches **Subject** on side of face.	
10. **Recorder** presses **F5** and waits five seconds.	
11. Click **Suspend**.	**Suspend** will halt the recording, allowing time to review the data.
12. Verify recording resembles the example data.	

Recording continues…

- If <u>similar</u>, click **Continue** and proceed to the next recording.

All three channels should show variations in the data and all four event markers should be present. Use the horizontal scroll bar to look at different portions of the recording.
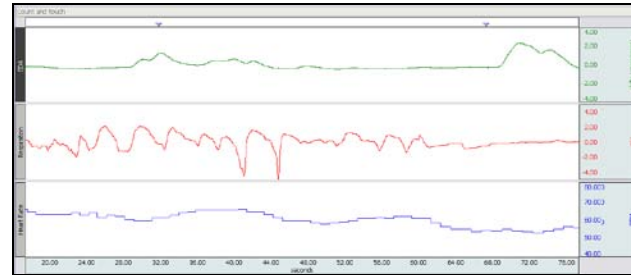

Fig. 9.10 Example Count and touch data

<u>If recording does not resemble Example Data...</u>

- If data is noisy or flatline, check all connections to MP unit.
- If Respiration channel shows no variation:
  o Verify Respiration Transducer has not slipped and that strap is snug.
  o Verify preference is set correctly (after Redo – see setup Step 12).
- If the ECG displays excessive baseline drift or EMG artifact:
  o Verify electrodes are making good contact with the skin and that the leads are not pulling on the electrodes.
  o Make sure Subject is in a relaxed position
- If EDA channel shows no variation, check to make sure electrodes are making proper contact with finger tips.

- If necessary, click **Redo**.

- If all required recordings have been completed, press **Done**.

Click **Redo** and repeat Steps 2 – 12 <u>only if absolutely necessary</u> as the **Subject** would most likely habituate and elicit less of a response to the repeated procedure.

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

Colored squares

13. **Director** arranges colored paper in specified sequence.
    - **Subject** faces **Director**.
    - **Recorder** prepares to insert event markers at color changes.
    - **Carefully review** upcoming steps.

Arrange colors in this sequence: White, black, red, blue, green, yellow, orange, brown, pink. This ordering is important as pre-assigned event marker labels will be inserted.

Recorder must listen for **Director's** instructions to **Subject** in order to know when to press F9 to place event markers.

14. Click **Record.**

15. Director holds colored paper in front of Subject.

The paper should be held close enough to the **Subject** to cover a significant part of the field of view.

16. **Director** instructs **Subject** to concentrate on each colored square for about 10 seconds, and then lowers paper for five seconds before presenting next color.

The 5-second time intervals between paper presentations are important to re-establish the baseline.

17. **Recorder** inserts an event marker (F9 key) each time paper color is changed.

18. Click **Suspend**.

Recording continues…

Fig. 9.11

19. Verify recording resembles the example data.

    - If <u>similar</u>, click **Continue** and proceed to the next recording.

    - If necessary, click **Redo**.

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

All three channels should show variations in the data and all nine event markers should be present. Use the horizontal scroll bar to look at different portions of the recording.
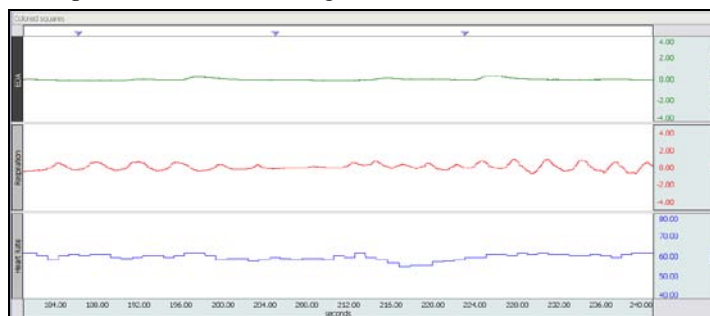

Fig. 9.12 Example Colored squares data

The data could be <u>different</u> for the reasons detailed on Page 6.

If a mistake is made in the paper ordering (see Step 13,) manually change the event marker labels rather than redoing the recording.

If an event marker is missing, manually enter it at the approximate location rather than redoing. See Step 1 "Hints." for more information.

Click **Redo** and repeat Steps 13 – 19 <u>only if absolutely</u> necessary as the **Subject** would most likely habituate and elicit less of a response to the repeated procedure.

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

Yes-No Questions

20. **Subject** faces the **Director** and listens for instructions.

    - **Subject** remains seated and relaxed.

    - **Carefully review** upcoming steps.

21. Click **Record.**

22. **Director** asks **Subject** ten prepared questions and notes **Subject's** response.

Each question-answer should take about 10 seconds.

Subject may answer truthfully or dishonestly.

23. **Subject** responds "yes" or "no."

24. **Recorder** inserts event markers by pressing:

    - **F6** when question is asked

    - **F7** if answer is "Yes"

    - **F8** if answer is "No"

The 5-second time interval between **Subject** answering the question and **Recorder** asking the next question is important to re-establish the baseline.

25. **Director** waits five seconds after question is answered before asking next question.

Recording continues…

Questions:

a)	Are you currently a student?	**Y N**
b)	Are your eyes blue?	**Y N**
c)	Do you have any brothers?	**Y N**
d)	Did you earn an "A" on the last physiology exam?	**Y N**
e)	Do you drive a motorcycle?	**Y N**
f)	Are you less than 25 years of age?	**Y N**
g)	Have you ever traveled to another planet?	**Y N**
h)	Have aliens from another planet visited you?	**Y N**
i)	Do you watch "Survivor"?	**Y N**
j)	Have you answered all of the preceding questions truthfully?	**Y N**

26. Click **Suspend**.

27. Verify recording resembles example data.

    - If <u>similar</u>, click **Continue** to proceed to optional recording section, or **Done** to finish the lesson.

All three channels should show variations in the data and all event markers should be present. Use the horizontal scroll bar to look at different portions of the recording.

Fig. 9.13 Example Yes-No data

The data could be <u>different</u> for the reasons detailed on Page 6.

If an event marker is missing, manually enter it at the approximate location rather than redoing. See Step 1 "Hints" for more information.

    - If necessary, click **Redo**.

Click **Redo** and repeat Steps 20 – 26 <u>only if absolutely</u> necessary as the **Subject** would most likely habituate and elicit less of a response to the repeated procedure.

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

28. Ask **Subject** whether or not each question was answered honestly and note this in the Data Report.

    📑 C

Recording continues…

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 or transducers 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.

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

After clicking **Done**, a 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 – 7, and then proceed to Calibration.

30. Carefully remove all transducers and electrodes.

If using the SS57L EDA transducer, remove the electrode pinch connectors and peel off all electrodes. Discard the electrodes. (BIOPAC electrodes are not reusable.)

If using the SS3LA EDA transducer, clean the electrode gel from each cavity.

Wash the electrode gel residue from the skin, using soap and water.

END OF RECORDING

V.   DATA ANALYSIS

FAST TRACK Data Analysis	Detailed Explanation of Data Analysis Steps

FAST TRACK Data Analysis

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

   - Note Channel Number (CH) designations:

Channel	Displays
CH 3	**EDA**
CH 40	**Respiration**
CH 41	**Heart Rate**

Detailed Explanation of Data Analysis Steps

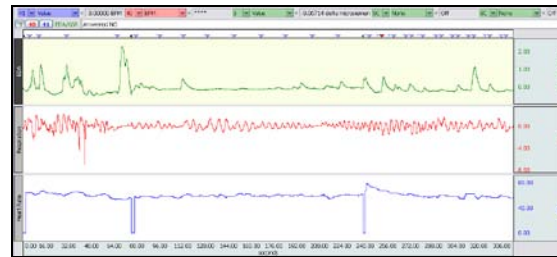Enter **Review Saved Data** from the **Lessons** menu.

Fig. 9.14 Example data

The measurement boxes are above the marker region in the data window. Each measurement has three sections: channel number, measurement type, and value. The first two sections are pull-down menus that are activated when you click them.

   - Note measurement box settings:

Channel	Measurement
CH 41	**Value**
CH 40	**BPM**
CH 3	**Value**

Brief definition of measurements:

   Value: Displays the amplitude value at the selected point. If an area is selected, the value is the endpoint of the selected area.

   BPM: The Beats or Breaths Per Minute measurement first calculates the difference in time between the beginning and end of the selected area (seconds,) and divides this value into 60 seconds/minute.

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

2. Set up your display window for optimal viewing of the first 5 seconds of the recording.

   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.

3. Using the I-Beam cursor, choose a point at the 2-second mark and record the heart rate and EDA values (Fig. 9.15).

   📑 A

4. Using the I-Beam cursor, select an area from the start of one inhale to the start of the next inhale (Fig. 9.16,) and record the respiration rate (BPM).
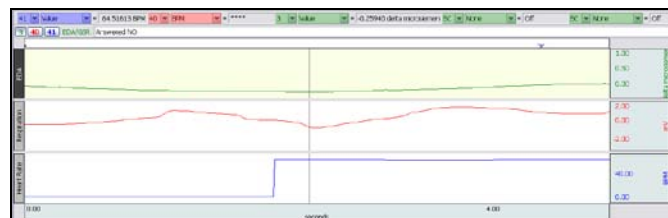
   📑 A

Fig. 9.15 Measurement at 2 second mark

The respiration transducer records chest expansion (inhalation) as positive values and chest deflation (exhalation) as negative values. Therefore, the start of inhalation is recorded as the beginning of the ascending positive waveform.

Note This measurement may be difficult to perform, depending on your data, because small dips in chest expansion can occur within the normal cycle and when the **Subject** answers questions. It may help to zoom further out on the data or to first scroll to better data to get an idea of the expected respiration rate.

Data Analysis continues…

Fig. 9.16 One respiratory cycle

5. Scroll to view a 10-second interval beginning at the first event marker inserted **in Data Recording Step 4.**

This 10-second interval in the Respiration data (CH 40) should show the **Subject's** response to the first instruction of the recording.

6. Find the point of maximal EDA within this 10-second recording and record the heart rate and EDA values at this point.

    A
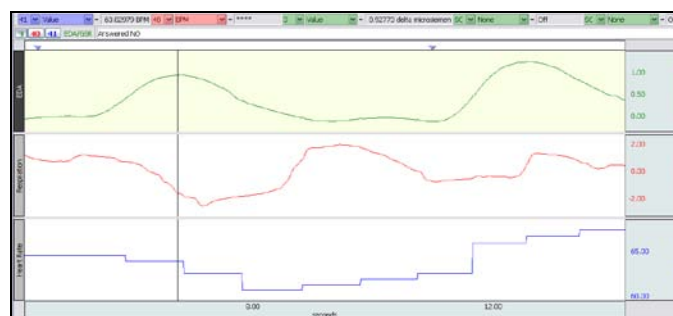
Fig. 9.17 Point of maximal EDA

7. Using the I-Beam cursor, select an area from the start of one inhale to the start of the next inhale, closest to the point used in Step 6, and record the respiration rate (BPM).

    A

8. Repeat Steps 6 – 7 for each condition in "**Count and touch**" recording of your data.

    A
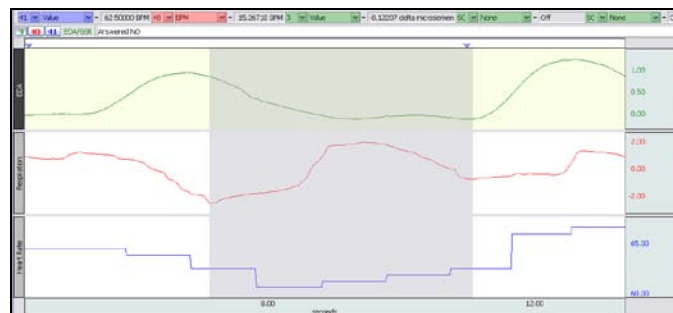
Fig. 9.18 Measurement of respiration rate

9. Perform Steps 5 – 7 for "**Colored squares**" data.

    B

10. Perform Steps 5 – 7 for "**Yes-No questions**" data, using a 5-second interval beginning at the "A" marker.

    C

Measurements should be taken in the interval that begins when the **Subject** started to answer.

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.

11. Answer the questions at the end of the Data Report

12. **Save** or **Print** the data file.
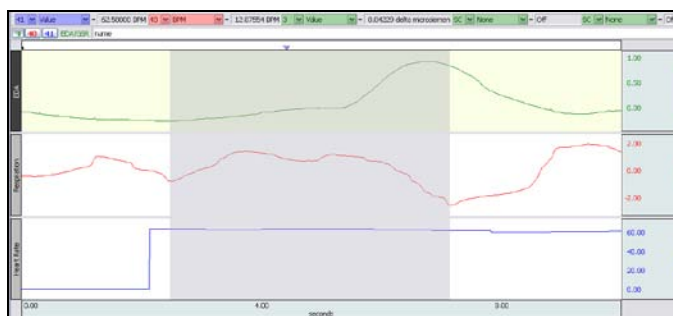
13. **Quit** the program.

END OF DATA ANALYSIS

_____

END OF LESSON 9
Complete the Lesson 9 Data Report that follows.

_____

ELECTRODERMAL ACTIVITY & POLYGRAPH

DATA REPORT

Student's Name: _____

Lab Section: _____

Date: _____

Subject Profile

Name:_____   Height:_____

Age:_____   Gender: Male / Female   Weight:_____

I.   Data and Calculations

A.   **Complete Table 9.1 with "Count and touch" data.**

Mark **I** for increase, **D** for decrease, and **NC** for no change relative to baseline. (Add or paste results into the Measurement column.)

Table 9.1 "Count and touch" Data

Procedure	Heart Rate 41 Value		Respiratory Rate 40 BPM		EDA 3 Value	
	Mark	**Meas**	**Mark**	**Meas**	**Mark**	**Meas**
Resting (baseline)						
Quietly say name						
Count from 10						
Count from 30						
Face touched						

B.   **Complete Table 9.2 with "Colored squares" data.**

Mark **I** for increase, **D** for decrease, and **NC** for no change relative to baseline. (Paste measurements in cells on right)

Table 9.2 "Colored squares" Data

Square Color	Heart Rate 41 Value		Respiratory Rate 40 BPM		EDA 3 Value	
	Mark	**Meas**	**Mark**	**Meas**	**Mark**	**Meas**
white						
black						
red						
blue						
green						
yellow						
orange						
brown						
pink						

C. **Complete Table 9.3 with "Yes-No questions" data.**

Mark **I** for increase, **D** for decrease, and **NC** for no change relative to baseline. (Paste measurements to cells on right)

Table 9.3 "Yes-No questions" Data

Question	Answer	Truth	Heart Rate 41 Value		Respiratory Rate 40 BPM		EDA 3 Value	
			Mark	**Meas**	**Mark**	**Meas**	**Mark**	**Meas**
Student?	Y N	Y N						
Blue eyes?	Y N	Y N						
Brothers?	Y N	Y N						
Earn "A"?	Y N	Y N						
Motorcycle?	Y N	Y N						
Less than 25?	Y N	Y N						
Another planet?	Y N	Y N						
Aliens visit?	Y N	Y N						
"Survivor"?	Y N	Y N						
Truthful?	Y N	Y N						

II. Questions

D. Of what practical value is the EDA information obtained from the color experiment?

E. What major physiological changes account for the electrodermal activity?

F. Give three reasons why polygraph testing of a person's sincerity and honesty may yield inconclusive results.

III. OPTIONAL Active Learning Portion

A. *Hypothesis*

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B. *Materials*

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C. *Method*

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D. *Set Up*

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E. *Experimental Results*

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End of Lesson 9 Data Report