Experiment B-18
Heart Rate and Coughing

Biology

Objectives

▪ To study the changes in heart rate at rest and after coughing.

Modules and Sensors

▪ PC + NeuLog application
▪ USB-200 module
▪ NUL-208 Heart rate & pulse logger sensor

Introduction

The heart is a muscular organ that pumps blood to the body. Besides the heart, the circulatory system consists of arteries, veins and capillaries. The blood is pumped by the contraction of the heart's walls. Blood carries oxygen and nutrients to cells in the body, and carbon dioxide to the lungs (for exhalation).

The term heart rate is used to describe the frequency of the cardiac cycle. Heart rate is determined by the number of heart beats per minute (BPM). When the body is relaxed, the parasympathetic nervous system sets a heart rate of around 60-80 BPM.

During intermittent coughing, there is a rapid pressure on the chest which is called intrathoracic pressure. This pressure is transmitted to the peripheral arteries. When the cough stops, arterial pressure falls. It is thought that the heart rate increases due to the blood pressure changes as a compensatory reflex. An increased heart rate raises the blood pressure and keeps the mean arterial pressure fixed.

In this experiment, you will measure your heart rate before and after coughing.

Procedure

Sensor setup

1. Connect the USB-200 module to the PC.

2. Connect the heart rate & pulse sensor to the USB-200 module.

> Note:
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> The following application functions are explained in short. It is recommended to practice the NeuLog application functions (as described in the user manual) beforehand.

3. Run the NeuLog application and check that the heart rate & pulse sensor is identified.

NeuLog

Settings

Note:

You can choose to see the pulse wave showing changes of blood volume/flow in the finger or earlobe with time (and calculate the heart rate) or get the value of the heart rate directly through the software. The operating mode is changed by clicking on the sensor's **Module Module** box.

4.   Click on the **Sensor's Module** box.

5.   Select the Wave button to change the sensor's mode to pulse waves.
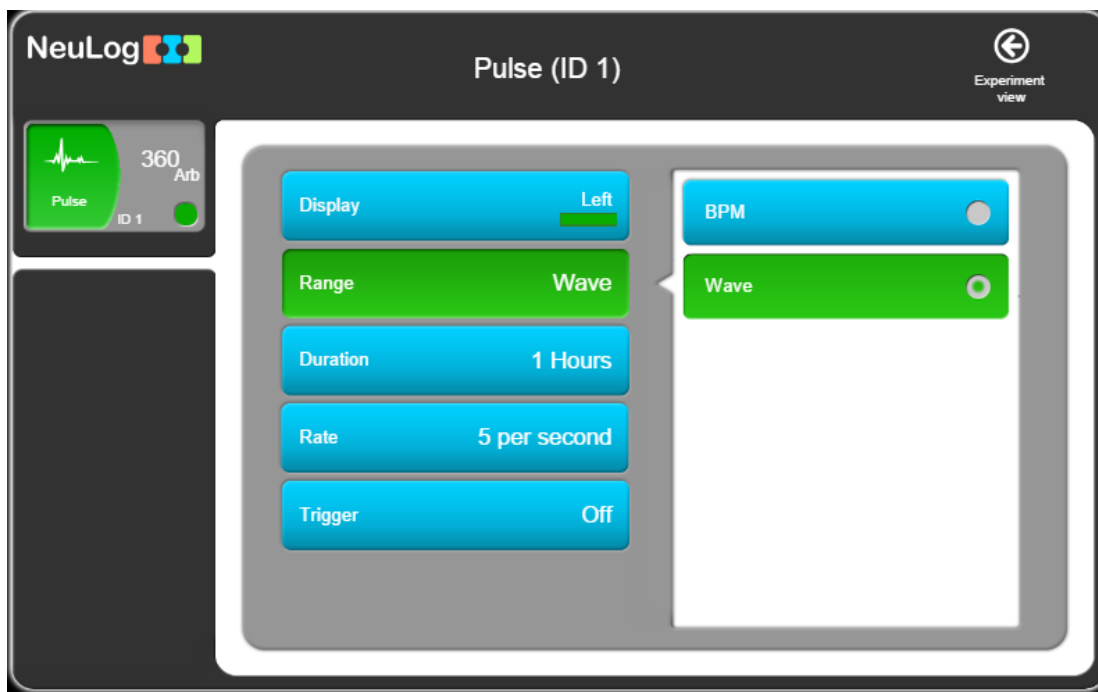
6.   Click on the ⬅ icon to go back to the graph.

7.   Click on the **Run Experiment** icon and set the:

Experiment duration to 10 seconds
Sampling rate to 100 per second

NeuLog

Note:

The experiment will be done in BPM mode but in order to determine the position of the sensor's clip on the finger we will first look at the heart rate as pulse waves.

Testing and measurements

Caution:

Do not participate in this experiment if you suffer from a physical condition that could be affected by deliberate coughing.

8. Put the sensor's clip on your finger (the little finger is preferred). Make sure that the infrared LED transmitter and the phototransistor receiver (located on the clip) are placed steadily on your finger.

   The LED emits infrared light to the finger; the phototransistor receiver detects this light beam and measures the change of blood volume through the finger's blood vessels.


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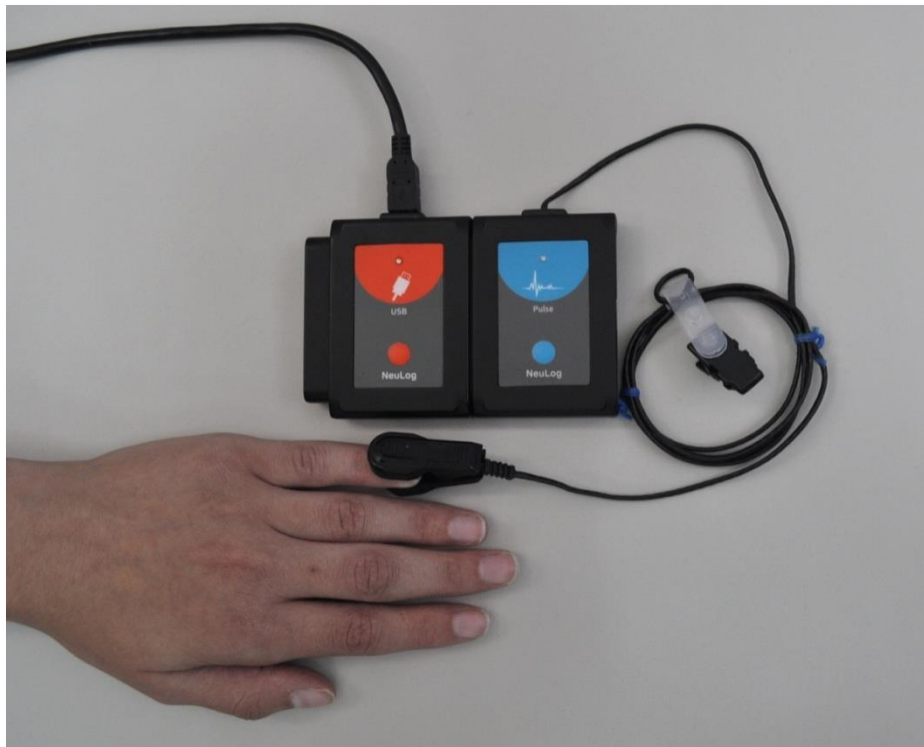
9.   Keep your hand steady during the measurement and avoid high intensity lights.

10.   Click on the **Record** icon [●] to start the measurement.

11.   Click on the **Zoom fit** icon [🔍] and observe the waves.

12.   See if the waves look repetitive. If they do not, try to change the position of the sensor's clip or a different finger.

13.   Click on the **Arrows** icon [⟳].

14. Click on the **Sensor's Module** box to change sensor's mode to BPM (beats per minute).
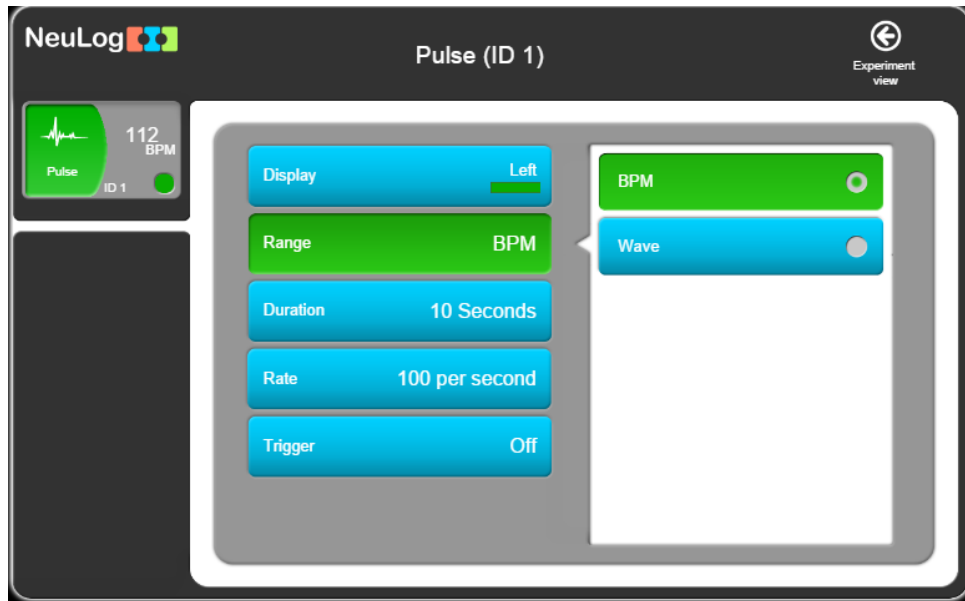
15. Click on the ⊖ icon to go back to the graph.

16. Click on the **Run Experiment** icon and set the:

    Experiment duration to 30 seconds
    Sampling rate to 5 per second

17. Observe the heart rate values that already appear on the module window. Since heart rate values refer to beats per minute, it may take a few seconds for them to stabilize.

18. Click on the **Record** icon to start the measurement.

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19. Your graph should be similar to the following. If you see sudden changes to extreme values during the measurement, repeat it until you get a stable one.
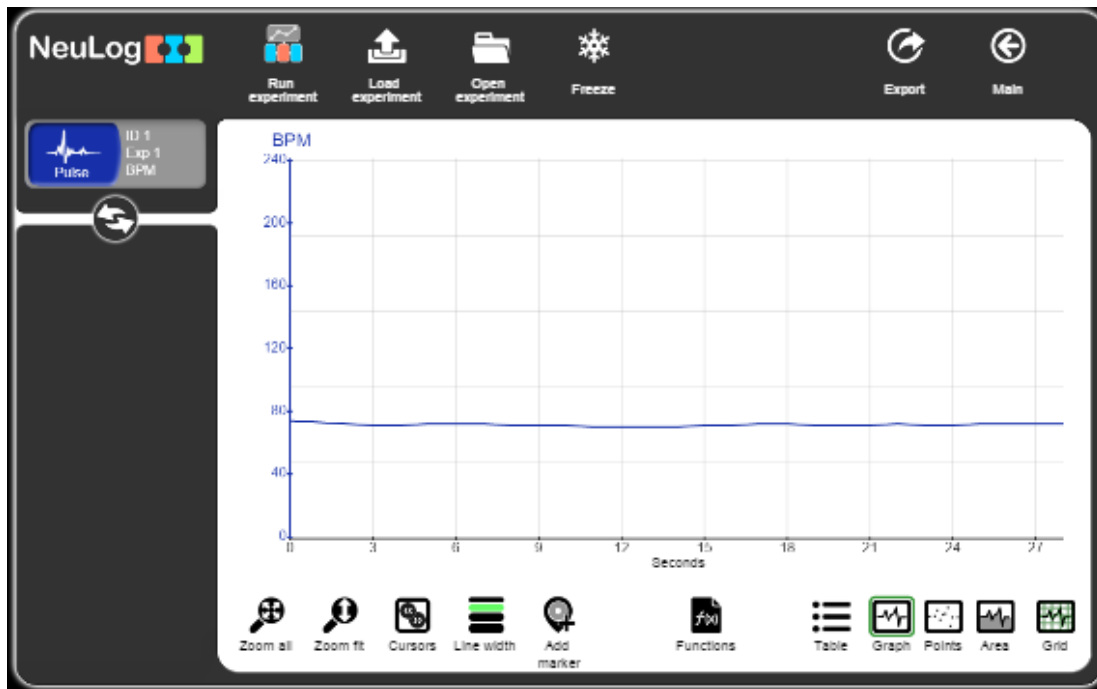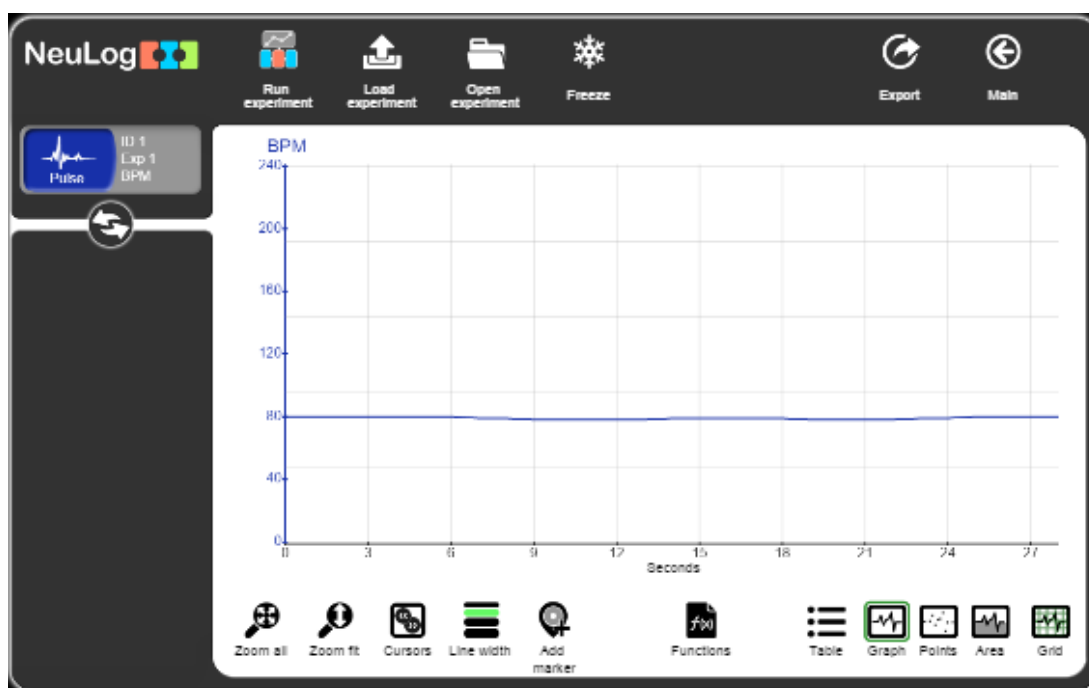

20. Click on the **Export** Icon and then on the **Save value table (.CSV)** button to save your graph.

21. Click on the icon to go back to the graph.

22. Take off the sensor's clip.

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23. Click on the **Experiment's module box** on the left of the screen. You will see the minimum and maximum values.

Highest sample value: 74
Lowest sample value: 70
Average value: 71.41

24. Put the sensor's clip on your finger again; cough four times and then click on the **Record** icon ⏺ to start the second measurement (if you need to repeat the measurement, ask another student to replace you).

25. Your graph should be similar to the following:

26. Click on the **Export** Icon ⏷ and then on the **Save value table (.CSV)** button to save your graph.

27. Click on the ⏴ icon to go back to the graph.

28. Take off the sensor's clip.

29. Click on the **Experiment's module box** on the left of the screen. You will see the minimum and maximum values.

Highest sample value: 80
Lowest sample value: 78
Average value: 79.07

30. We can see that after coughing, the heart rate substantially increased from 71.4 BPM to 79 BPM.

Summary questions

1. What were the changes in heart rate before and after coughing among your group?

2. Explain the function and mechanism of coughing.

3. Point out another activity that increases the heart rate.