Effect of Coughing on Heart Rate

Involuntary coughing is the result of irritation of special sensory nerves in the respiratory tract. This helps to clear potentially damaging substances from the lungs (water, foreign bodies, dust, infection, mucous, etc.). Coughing can be more deleterious than helpful, causing discomfort, preventing sleep, or leading, in some cases, to dizziness or loss of consciousness (known as cough syncope).

The physiologic effects resulting from a cough are numerous. There is marked increase in intrathoracic pressure just prior to expulsion of air. When blood pressure is normal, this leads to a decrease in venous return to the right side of the heart and a decrease in cardiac output. On the other hand, a cough-induced increase in intrathoracic pressure may provide a form of “internal cardiopulmonary resuscitation” in a heart attack victim whose blood pressure is falling dangerously low. In this case, coughing can be as effective as the external chest compressions of CPR in raising blood pressure and providing better blood circulation to vital tissues.

Coughing, and the resulting wide fluctuations in intrathoracic pressure it produces, causes reflex stimulation of the autonomic nervous system. The sympathetic nervous system is an “activating system,” preparing the body for a “flight or fight response” by increasing heart rate and blood pressure. The parasympathetic nervous system acts through the vagus nerve to slow the heart and to lower blood pressure. Both the sympathetic and parasympathetic systems may be stimulated or inhibited by physiologic stimuli or medications.

The following table shows potential heart rate response to stimulation or inhibition of the sympathetic or parasympathetic nervous systems:

<table>
<thead>
<tr>
<th>Branch of Autonomic Nervous System</th>
<th>Heart Rate Response to</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stimulation</td>
</tr>
<tr>
<td>Sympathetic</td>
<td>↑</td>
</tr>
<tr>
<td>Parasympathetic</td>
<td>↓</td>
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</table>

In this experiment, you will observe the response of heart rate to coughing, and correlate this response to activity in the autonomic nervous systems.

**Important:** Do not attempt this experiment if you suffer from asthma or any condition that may be aggravated by repeated coughing.

**OBJECTIVES**

In this experiment, you will

- Obtain graphical representation of the heart rate at rest.
- Observe the change in heart rate that occurs with repetitive coughing.
- Correlate heart rate response to autonomic nervous system activity.
MATERIALS

computer
Vernier computer interface
Logger Pro

Vernier Hand-Grip Heart Rate or Vernier Exercise Heart Rate Monitor
saline solution in dropper bottle
(only for use with the Exercise HR Monitor)

PROCEDURE

Select one person from your lab group to be the subject.

1. Connect the receiver module of the Heart Rate Monitor to the Vernier computer interface. Open the file “06 Effect of Coughing” from the Human Physiology with Vernier folder.

2. Set up the Heart Rate Monitor. Follow the directions for your type of Heart Rate Monitor.

Using a Hand-Grip Heart Rate Monitor

a. The receiver and one of the handles are marked with a white alignment arrow as shown in Figure 1. Locate these two arrows.

b. Have the subject grasp the handles of the Hand-Grip Heart Rate Monitor so that their fingers are in the reference areas indicated in Figure 2. Hold the handles vertically.

c. Have someone else hold the receiver near the handles so that the two alignment arrows are pointing in the same direction and are at approximately the same height as shown in Figure 1. Note: The receiver must stay within 60 cm of the handles during data collection.

Using an Exercise Heart Rate Monitor

a. Depending upon your size, select a small or large size elastic strap. Secure one of the plastic ends of the elastic strap to the transmitter belt. It is important that the strap provide a snug fit of the transmitter belt.

b. Wet each of the electrodes (the two textured oval areas on the underside of the transmitter belt) with 3 drops of saline solution.

c. Secure the transmitter belt against the skin directly over the base of the rib cage (see Figure 3). The POLAR logo on the front of the belt should be centered. Adjust the elastic strap to ensure a tight fit.

d. Take the receiver module of the Heart Rate Monitor in your right hand. Remember that the receiver must be within 80 cm of the transmitter in the Heart Rate Monitor belt.

3. Click Collect to begin data collection. There will be a 15 s delay while data are collected before the first point is plotted on the upper graph. Thereafter, a point will be plotted every 5 s. Obtain approximately 45 s of graphed data as a baseline heart rate.

4. At approximately 60 s, begin to cough continuously (every 1–3 s). Heart rate will change in response to the coughing. When the heart rate levels off for at least 15 s (or reverses direction), stop coughing. Data will be collected for 400 s.
5. Click and drag to highlight the baseline heart rate data points on the graph. Click the Statistics button, and record the mean value to the nearest whole number as the Baseline heart rate in Table 1.

6. Drag both of the Statistics brackets to enclose the region where the heart rate levels off. Record the mean heart rate to the nearest whole number as the Maximum heart rate in Table 1. Close the Statistics box by clicking the × in the corner of the box.

7. Determine the difference between the Maximum heart rate and the Baseline heart rate and record this value in Table 1.

8. Determine the time between the onset of coughing and the beginning of the plateau. To do this, click and drag between approximately 60 s (time at onset of coughing) and the beginning of the plateau. Record the $\Delta x$ value that is displayed at the lower left corner of the graph to the nearest whole number in Table 1.

9. Determine the recovery time. To do this, click and drag between the last point on the plateau and the point at which the heart rate returns to baseline. If the baseline heart rate is not achieved before the end of the experiment, drag to include the last data point recorded. Record the $\Delta x$ value that is displayed at the lower left corner of the graph to the nearest whole number in Table 1.

**DATA**

<table>
<thead>
<tr>
<th></th>
<th>Table 1</th>
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<tbody>
<tr>
<td>Baseline heart rate (bpm)</td>
<td>Maximum heart rate (bpm)</td>
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</table>

**DATA ANALYSIS**

1. In what direction did your heart rate change in this experiment? According to the table in the Introduction, what are the possible explanations for this change?

2. There are medications that can selectively block the action of either sympathetic or parasympathetic influences on the heart. How could such medications be used to determine which of these systems is responsible for a change in heart rate such as was seen in this experiment?
3. Compare the response and recovery times recorded in Table 1. List possible survival advantages of the differences you see.

4. The parasympathetic and sympathetic nerve supplies are severed during heart transplantation and are not surgically repaired. Would a heart transplant recipient’s heart rate change with coughing (or with a severe fright)?

5. You are in a remote location and a member of your party complains of chest pain and dizziness. You find that his pulse is 35 bpm. You immediately call 911 and are told that it will take 15 minutes for the helicopter to arrive. You know that CPR should not be performed on conscious individuals. Drawing from the knowledge you have gained from this experiment, what might be done to improve your patient’s pulse and blood pressure?

EXTENSION

Perform the experiment with different coughing frequencies and intensities.
THIS IS AN EVALUATION COPY OF THE VERNIER STUDENT LAB.

This copy does not include:

- Safety information
- Essential instructor background information
- Directions for preparing solutions
- Important tips for successfully doing these labs