

# Heart Rate as a Vital Sign

Since the earliest days of medicine, heart rate has been recognized as a *vital sign* (an indicator of health, disease, excitement, and stress). Medical personnel use heart rate to provide clues as to the presence of many medical conditions. Reflex changes in heart rate are one of the body's most basic mechanisms for maintaining proper perfusion to the brain and other tissues. Low blood volume caused by bleeding or dehydration results in the heart beating faster as it attempts to maintain adequate blood pressure. Excitement, stress, and anxiety activate the autonomic nervous system, which may also speed the heart rate and raise blood pressure.

The autonomic nervous system consists of sympathetic and parasympathetic branches, which have opposing effects on the circulatory and other organ systems. Sympathetic activation raises blood pressure in addition to pulse. After an initial activation of the sympathetic nervous system, the increase in blood pressure stretches nerve fibers in the baroreceptors (see Figure 1). This results in a reflex activation of the parasympathetic nervous system, which, through actions opposite to those of the sympathetic nervous system, helps to restore homeostasis.

In this experiment, you will observe how the heart responds to cold stimulus applied peripherally. In this case, cold will act as a noxious stimulus, activating the “fight or flight” response through the sympathetic nervous system.

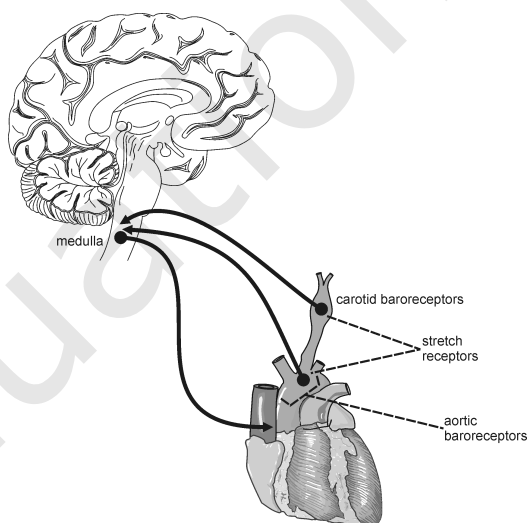


Figure 1

## OBJECTIVES

In this experiment, you will

- Obtain graphical representation of heart rate.
- Compare heart rate before and after exposure to cold stimulus.
- Observe an example of sympathetic nervous system activation (“fight or flight response”).

## MATERIALS

computer	ice water bath
Vernier computer interface	towel
Logger Pro	saline solution in dropper bottle (only for use with Exercise HR Monitor)
Vernier Hand-Grip Heart Rate Monitor <b>or</b>	
Vernier Exercise Heart Rate 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.
2. Open the file “03 Heart Rate Vital Sign” from the *Human Physiology with Vernier* folder.
3. Prepare to collect data.
  - a. Sit in a chair, facing away from the computer.
  - b. Prepare to submerge your foot in the ice water bath by removing your shoe and sock.
  - c. Position your foot adjacent to the ice water bath, but do not put it in the bath yet.
4. 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 2. 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 3. 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 2. **Note:** The receiver must stay within 60 cm of the handles during data collection.



Figure 2

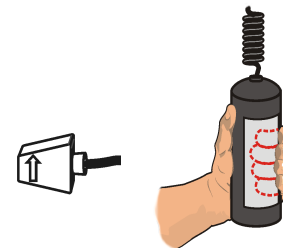


Figure 3

### 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 4). 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. **Note:** The receiver must stay within 60 cm of the handles during data collection.

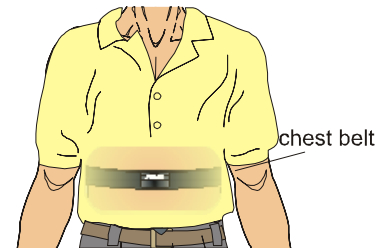
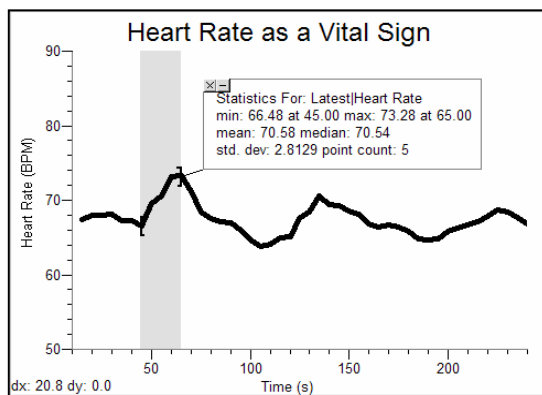
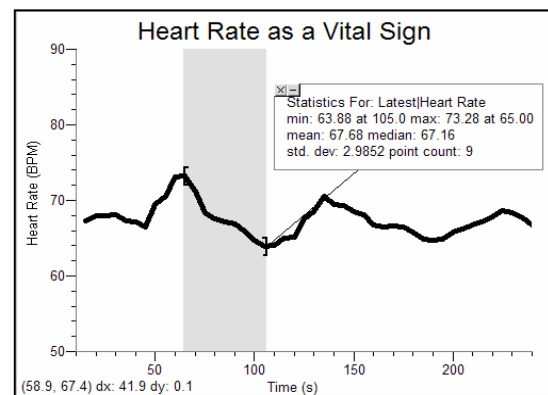


Figure 4

5. To determine that everything is set up correctly, click ▶Collect to begin monitoring heart rate. Note that there may be up to a 30 second delay before data are seen. The readings should be within the normal range of the individual, usually between 55 and 80 beats per minute. Click ■ Stop when you have determined that the equipment is operating properly, and proceed to the next step.
6. Collect data to observe the effect of submerging your foot in an ice water bath. **Note:** Read over this step prior to beginning data collection to familiarize yourself with the process.
  - a. Click ▶Collect.
  - b. If the baseline is not stable, repeat Steps 5. If the baseline is stable, plunge your foot into the ice water bath at 40 s.
  - c. Remove your foot from the ice water bath 30 s after immersion (when data have been collected for 70 s) and rest it on the towel.
  - d. Remain seated and allow data collection to continue for the full 240 s data-collection period.
7. Click and drag over the area of the graph where the resting (“baseline”) heart rate is displayed. Click the Statistics button, Σ/2. The Statistics box will appear with the statistics calculated for the selected region. Record the mean resting heart rate, to the nearest whole number, in Table 1.
8. Move the Statistics brackets to highlight the total time of data collection. The values in the statistics box will be recalculated to reflect this change. Record the maximum and minimum heart rates, to the nearest whole numbers, and the corresponding times at which these rates are graphed, in Table 1.
9. Move the statistics brackets to highlight the region of the graph beginning at 40 s (when the foot was immersed in the ice water bath) and ending at the first peak (see Figure 5). Record the maximum heart rate value in Table 1. In the corresponding Time column record (to the nearest whole number) the  $\Delta x$  value displayed at the lower left corner of the graph.



*Figure 5*



*Figure 6*

10. Move the Statistics brackets to enclose the region of the graph beginning at the first peak and ending at the lowest point in the valley that follows (see Figure 6). Record the minimum heart rate value as the Rebound heart rate in Table 1. Record the  $\Delta x$  value in the corresponding Time column.

## DATA

Table 1		
Condition	Heart rate (beats/minute)	Time (s)
Resting heart rate		
Maximum heart rate		
Rebound heart rate		

## DATA ANALYSIS

1. How long after immersion did your heart rate reach its maximum value? Explain the physiologic mechanism that led to this change in heart rate.
2. Describe the changes in heart rate that occurred after the maximum value. How can you explain the minimum heart rate value? How would you explain the heart rate variations seen in the remainder of the experiment?
3. How long after the maximum heart rate did it take to arrive at your rebound heart rate? What can you say about the relative speed of physiologic response to a stimulus *vs.* the speed of mechanisms that are designed to maintain homeostasis?
4. If the heart rate is too slow there is inadequate blood pressure to maintain perfusion to the brain. This can lead to loss of consciousness (fainting). Keeping in mind the autonomic nervous system responses that you observed in this experiment, explain the sequence of events that results in a severely frightened person fainting.

# Vernier Lab Safety Instructions Disclaimer

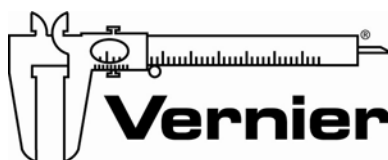
**THIS IS AN EVALUATION COPY OF THE VERNIER STUDENT LAB.**

This copy does not include:

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

The complete *Human Physiology with Vernier* lab manual includes 24 labs and essential teacher information. The full lab book is available for purchase at:

<http://www.vernier.com/cmat/hpa.html>



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