

Cardiovascular and respiratory adjustments to exercise

Additional notes on breathing and use of respiratory belt and pulse transducers

Notes on breathing

The metabolic activities of tissues use up oxygen and produce carbon dioxide. The ultimate source of oxygen is atmospheric air. The ultimate destination of carbon dioxide is also the atmosphere. In the short term, however, these gases are exchanged between tissues and blood. Breathing movements pump air in and out of the lungs, where close contact between air and blood occurs, allowing interchange of oxygen and carbon dioxide between air and blood.

The internal structure of the lungs consists of a series of branching tubes that carry air to the alveoli. Alveoli, sometimes called air sacs, are tiny thin-walled, highly vascularized structures where respiratory gas exchange occurs.

The principal muscle activity in quiet breathing is rhythmic contraction of the diaphragm (a dome-shaped sheet of muscle that separates the thorax from the abdomen). Contraction of the diaphragm pulls the lower surface of the lungs down, and results in inspiration of air. In quiet breathing, expiration is mainly passive, and results from elastic recoil of the lungs. Rib movements also occur in quiet breathing because of the activity of the intercostal muscles, but are of small amplitude.

In forceful breathing, rib movements are obvious, and greatly expand and contract the volume enclosed by the ribcage. Other muscles are called on, too. The sternomastoid muscles of the neck assist in raising the sternum in forceful inspiration. Abdominal muscles raise the pressure in the abdomen and push the diaphragm up, providing a powerful expiratory force.

Breathing movements, unusually, have dual control from the central nervous system. Breathing movements can be made voluntarily in the same way as arm and leg movements. But if no conscious attention is focused on breathing, rhythmic muscle contractions occur spontaneously. Spontaneous breathing is under control of the respiratory centers in the medulla and pons of the brain. The respiratory centers ensure that gaseous exchanges at the lung matches the requirements of the body. In times of increased demand, the rate and depth of breathing are increased to bring more fresh air into the lungs. The respiratory centers are powerfully stimulated by a rise in the partial pressure of carbon dioxide in the blood, and more weakly stimulated by a fall in oxygen pressure.

Notes on use of respiratory belt transducers

1. Fasten the respiratory belt around the upper abdomen of a volunteer, as shown in Figure 1. The transducer should be at the front of the body, level with the navel, and the belt should be firm, but not uncomfortably tight. The belt is designed to be used over top of clothing, and it doesn't matter whether the volunteer is sitting or standing, as long as they are comfortable (remember that this is quite a long exercise!). Because everyone differs in their breathing patterns, you may need to change the position of the transducer to get the best signal from a subject. In some individuals a placement of the belt over the lower portion of the rib cage works best. In all cases ensure that the writing on the belt is facing away from the body (this ensures that the transducer is correctly oriented).
2. Connect the BNC plug on the respiratory belt transducer cable to the one of the Channel inputs on the PowerLab unit (Figure 1 – the type of PowerLab unit that your group is using may be different from the one shown below).

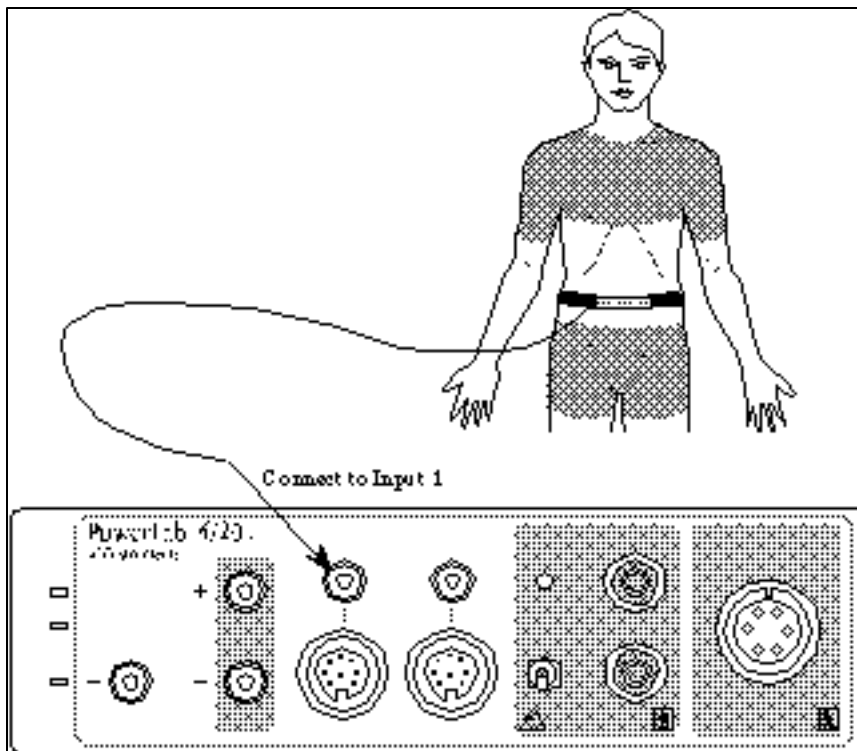


Figure 1: Setting up the experiment: connecting the respiratory belt.

3. Choose the Input Amplifier command from the appropriate Channel Function pop-up menu.
4. Ask the volunteer to take deep, strong breaths. Observe the signal (Figure 2).

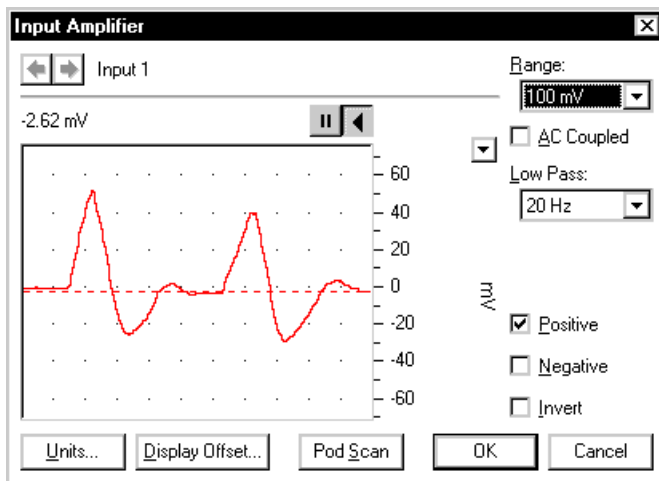


Figure 2: The Input Amplifier dialog box showing the breathing signal; the range has been adjusted so that the signal is the correct size.

5. Adjust the value in the Range pop-up menu of the Input Amplifier dialog box so that the breathing signal occupies about a half to two-thirds of full scale. Click the OK button to close the dialog box.

It is important when recording normal respiration that the volunteer is facing away from the computer screen, and is not consciously controlling breathing. The volunteer should relax to avoid conscious control of respiration.

6. Click the Start button to start Chart recording in a preview mode (with rex X on Chart icon on lower right of screen) to make sure that you are getting an adequate record. Ask the volunteer to breathe normally for 2 – 3 minutes.

Notes on use of pulse transducers

1. Connect the BNC plug on one end of the finger pulse transducer's cable to the BNC socket for a second channel on the PowerLab unit. Rotate the connecting ring of the transducer plug clockwise until it locks (Figure 3 -- the type of PowerLab unit that your group is using may be different from the one shown below).
2. Place the pressure pad of the finger pulse transducer against the distal segment (the tip) of the middle finger of either hand of the volunteer. Use the Velcro strap to attach it firmly — neither loose nor tight (Figure 3).

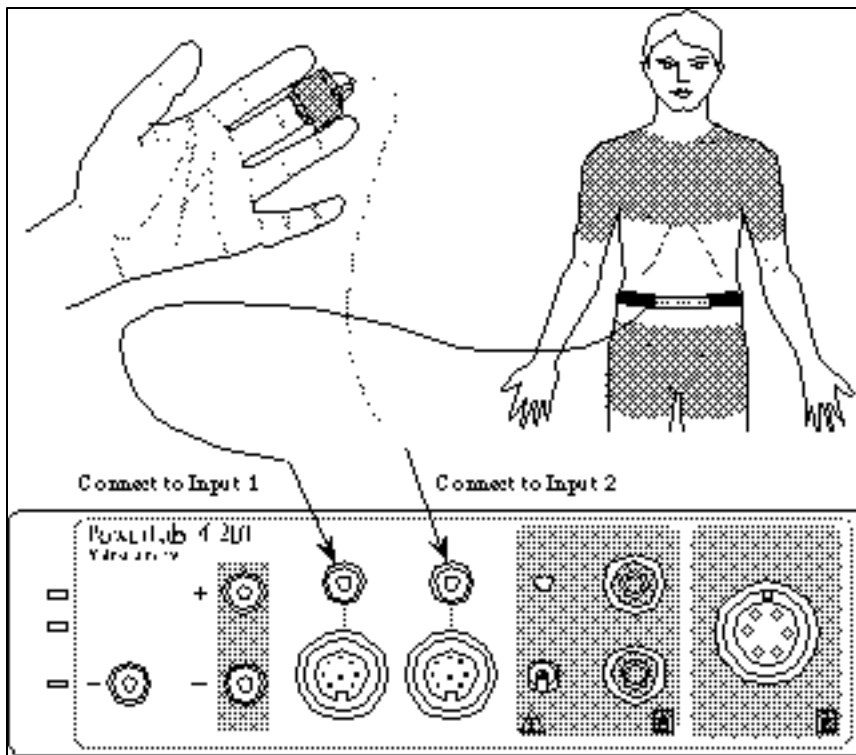


Figure 3: The connections for the experiment: the finger pulse transducer and the respiratory belt.

3. Choose the Input Amplifier command from appropriate Channel Function pop-up menu. Adjust the value in the Range pop-up menu of the dialog box that appears so that the signal occupies about a half to two thirds of full scale when the volunteer has both hands in his or her lap. Click the OK button to close the Input Amplifier dialog box.

Getting a baseline recording of respiration and pulse

1. Click the Start button to start Chart recording – you can do this in a full recording mode (without red X on Chart icon on lower right of screen). Ask the volunteer to breathe normally and record a baseline pulse rate and breathing pattern for 3–5 minutes. Type 'baseline 1' and press the Return key to enter the comment. Figure 4 shows a typical recording of breathing and heart rate.
2. Click the Stop button to stop Chart recording. The is now ready to start his/her first exercise regime. Keep all transducers connected to your subject during this period and try not to displace them during exercise
3. Note that you should also obtain a baseline blood pressure for your subject – keep the blood pressure cuff around the subject's arm (uninflated) during exercise.
4. Following the exercise regime you will immediately start recording of respiration and pulse and obtain blood pressure at specific recovery times – see your lab procedures for details.
5. To save your files at the end of each subject's recording, choose Save from the File menu to save the recording. Save the files to the hard drive folder named Biol236.S02 – use a filename that you can remember.

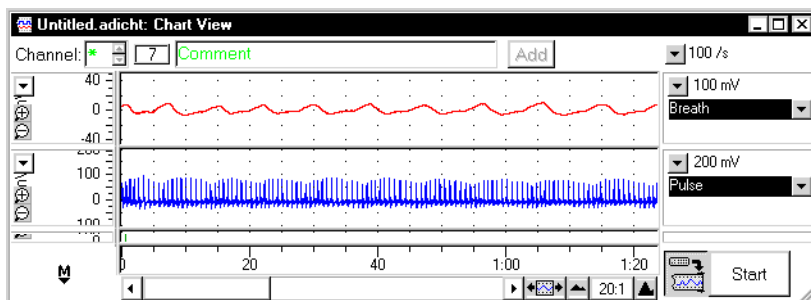


Figure 4: Typical recording of breathing and heart rate.

Acknowledgements

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