

Experiment HS-5: Breathing Techniques and Heart Rate

Exercise 1: Breathing at Rest and Heart Rate

Aim: To determine the effect of breathing while resting on the subject's heart rate and the change in heart rate during respiratory sinus arrhythmia (RSA).

Procedure

1. The subject should sit quietly and breath normally before and during the recordings to prevent the creation of motion artifacts. Remind the subject to sit erect during the recording.
2. Type <Subject's Name> Breathing at Rest in the Mark box that is to the right of the Mark button.
3. Click on the Record button. Press the Enter key on the keyboard to mark the recording.
4. Click the AutoScale buttons for all four channels. Record for at least one minute.
5. Click Stop to halt recording. Your data may look like [Figure HS-5-L1](#).
6. Select Save As in the File menu, type a name for the file. Choose a destination on the computer in which to save the file, like your lab group folder). Designate the file type as *.iwxdata. Click on the Save button to save the data file.



Figure HS-5-L1: The pulse, respiration, heart rate, and breathing rate of a subject using abdominal breathing while at rest, displayed in the Main window.

Data Analysis

1. Scroll to the recording of the subject's breathing and heart rate while at rest. Display four adjacent breathing cycles that are free of artifacts in the Main window.
2. Use the Display Time icons to adjust the Display Time of the Main window to show the four complete breathing cycles on the Main window. The four adjacent breathing cycles can also be selected by:

- Placing the cursors on either side of a group of four complete breathing cycles; and
- Clicking the Zoom between Cursors button on the LabScribe toolbar ([Figure HS-5-L2](#)) to expand the four selected breathing cycles to the width of the Main window.

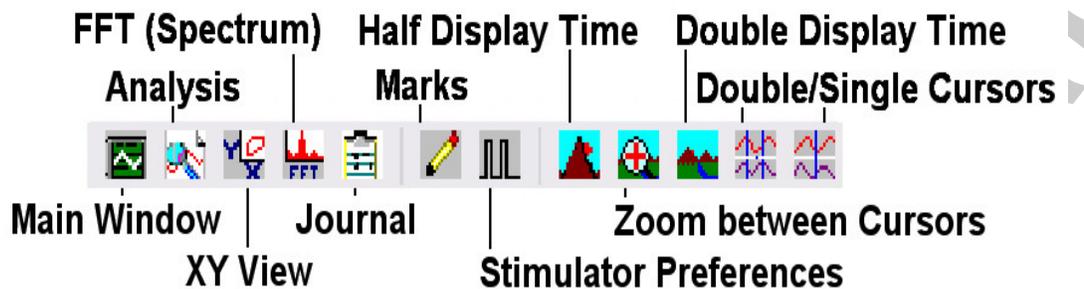


Figure HS-5-4: The LabScribe toolbar.

3. Click AutoScale on all four channels displayed on the Main window.
4. Sections of the data displayed on a rate channel may be calculated incorrectly if waves on the raw data channel have low amplitudes. For example, if a group of pulses have amplitudes that are low, they might not be identified by the rate function on the Heart Rate channel and used in the calculation of the subject's heart rate. Pulses or waves used in rate calculations can be properly identified by either adjusting the position of the raw data trace on the screen or adjusting the position of the threshold, a parameter in the rate function dialogue window which identifies the waves or pulses to be counted in the rate calculation.
 - To raise the level of the trace recorded on a raw data channel, use the mouse to click on and drag the trace higher on the screen. If the trace is moved up by the proper amount, the peaks of the missed pulses or waves will intersect the threshold level set in the rate function dialogue window. The pulses or waves that used to be missed in the rate calculation will now be included. On the rate channel, the revised plot of the rate calculation will be displayed automatically. If the rate is still not displayed properly, move the raw data trace up again.

Note: Setting the proper threshold level also prevents small artifacts in the data from being counted as pulse waves.

- To adjust the level of the threshold parameter for a channel that uses a rate function, click on the Channel Function/Mode area to the right of the Channel Title on the rate channel. Select Setup from the menu to open the rate function dialogue window. Change the level of the threshold by: typing a new value in the box; or, clicking on the up or down arrows on the right side of the box; or, clicking on and sliding the threshold line, that is displayed on the graph of the raw data at the bottom of the dialogue window, up or down.
5. Click on the Analysis window icon in the toolbar ([Figure HS-5-L2](#)) or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window ([Figure HS-5-L3](#)).

- Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The mathematical functions, Max-Min, Max, Min, and Mean, should appear in this table. Values for these four parameters on each channel are seen in the table across the top margin of each channel.

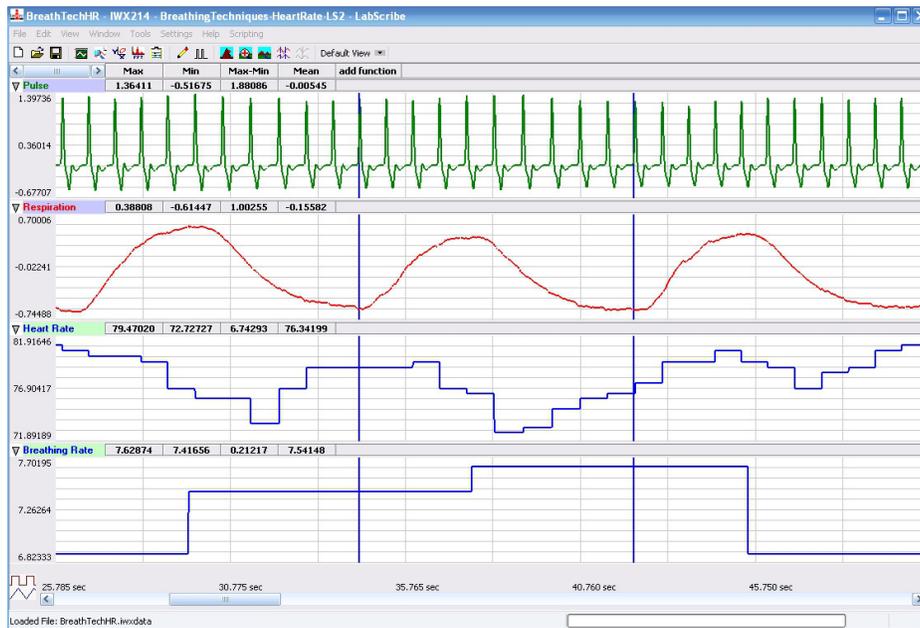


Figure HS-5-L3: The pulse, respiration, heart rate, and breathing rate of a subject using abdominal breathing while at rest, displayed on the Analysis window. The cursors are in positions to mark the beginning and end of a breath cycle.

- Once the cursors are placed in the correct positions for determining the breathing and heart rates, the values for these parameters can be recorded in the on-line notebook of LabScribe by typing their names and values directly into the Journal.
- The functions in the right-click menu of the Analysis window can also be used to enter the names and values of these parameters from the recording to the Journal. To use these functions:
 - Place the cursors at the locations used to measure the breathing and heart rates during the breath cycle.
 - Transfer the names of the mathematical functions used to determine the volumes and rates to the Journal using the Add Title to Journal function in the Volume menu.
 - Transfer the values for the volumes and rates to the Journal using the Add All Data to Journal function in the Volume menu.
- Use the mouse to click on and drag one cursor to the trough before the inhalation of the first breath cycle displayed on the Volume channel, and the other cursor to the trough before the inhalation of the second breath cycle (Figure HS-5-L3).
- The values for the following parameters on a breath cycle are determined when the cursors are placed at the two positions described in Step 9:
 - Maximum Heart Rate, which is the value for Max on the Heart Rate channel.

- Minimum Heart Rate, which is the value for Min on the Heart Rate channel.
- Respiratory Sinus Arrhythmia (RSA) Prominence or the difference between the minimum and maximum heart rates during a breath cycle, which is the value for Max-Min on the Heart Rate channel.
- Mean Heart Rate, which is the value for Mean on the Heart Rate channel.
- Mean Breath Rate, which is the value for Mean on the Breath Rate channel.

11. Record the values in the Journal using one of the techniques described in Steps 7 or 8, and on [Table HS-5-L1](#).

Table HS-5-L1: Heart Rate Variation during Breathing at Rest.

	Heart Rate (bpm)				Mean Breath Rate (bpm)
	Max	Min	Δ	Mean	
Breath 1					
Breath 2					
Breath 3					
Mean					
Normal Breathing Technique					
Aerobic Fitness					

12. Use the mouse to click on and drag the left cursor to the trough before the inhalation of the third breath cycle displayed on the Volume channel. Repeat Steps 10 and 11 for this breath cycle.
13. Use the mouse to click on and drag the left cursor to the trough before the inhalation of the fourth breath cycle displayed on the Volume channel. Repeat Steps 10 and 11 for this breath cycle.
14. Ask the subject to rate his or her aerobic fitness as high, moderate, or low. Note this rating in [Table HS-5-L1](#), along with the subject's normal breathing technique.
15. Enter the mean values for the subject's parameters while breathing at rest in [Table HS-5-L2](#).

Questions

1. The difference between the heart rates during a breath cycle is known as RSA prominence. What is the average RSA prominence of the subject?

2. What percentage of the pre-inhalation heart rate is the RSA prominence?
3. How does the RSA prominence of this subject compare to those of other subjects? Does the aerobic fitness of the subject correlate with his or her RSA prominence?

Table HS-5-L2: Heart Rates during Different Breathing Techniques.

Breathing Technique	Heart Rate (bpm)				Mean Breath Rate (bpm)
	Max	Min	Δ	Mean	
Rest					
Shallow Abdom.					
Bellows					
Deep Abdom.					

Exercise 2: Apnea and Heart Rate

Aim: To determine the effect of apnea on the subject's heart rate by having the subject hold his or her breath.

Procedure

1. The subject should sit quietly and breath normally before the recording begins. Also, remind the subject to sit erect and quietly during the recordings, and to breath normally at the beginning of the exercise.
2. In this exercise, the subject breaths normally until a regular breathing pattern is established. Then, the subject takes a deep inhalation through his or her mouth and holds that breath for about 7 seconds. Finally, the subject exhales slowly, through the mouth, over 7 seconds.
3. Type <Subject's Name> Normal Breathing in the Mark box that is to the right of the Mark button.
4. Click on the Record button. Press the Enter key on the keyboard to mark the recording.
5. Click the AutoScale buttons for all four channels. Record until the subject's breathing is regular and predictable.
6. Type During Apnea in the Mark box. Press the Enter key on the keyboard as you instruct the subject to take the deep breath and hold it.
7. Type Recovery from Apnea in the comment line. Press the Enter key on the key board as the

subject exhales and returns to breathing normally. Continue to record until the subject's breathing has returned to a normal pattern. Click Stop to halt the recording.

8. Click on Save in the File menu.

Data Analysis

1. Scroll to the recording of the subject's breathing before, during, and after holding his or her breath that is displayed in the Main window.
2. Use the Display Time icons to adjust the Display Time of the Main window to show the breathing from before to after apnea on the Main window. This segment of the data can also be selected by:
 - Placing the cursors on either side of the selected data; and
 - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the selected to the width of the Main window.
3. Click on the Analysis window icon in the toolbar ([Figure HS-5-L2](#)) or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window ([Figure HS-5-L4](#)).
4. The functions used to analysis this are the same as the ones used in Exercise 1 and programmed by the settings file.



Figure HS-5-L4: Pulse, respiration, heart rate, and breathing rate before, during, and after apnea for 7 seconds, displayed in the Analysis window.

5. Use one of the techniques described in Exercise 1 to record the breathing and heart rates in the Journal.
6. Use the mouse to click on and drag one cursor to the trough on the Volume channel that precedes one of the subject's normal breath cycles, and the other cursor to the trough on the Volume channel that precedes the deep inhalation of apnea.

7. The values for the following parameters during normal breathing are determined when the cursors are placed at the two positions described in Step 6:
 - Maximum Heart Rate - Normal Breathing, which is the value for Max on the Heart Rate channel.
 - Minimum Heart Rate - Normal Breathing, which is the value for Min on the Heart Rate channel.
 - Difference (Maximum-Minimum) Heart Rate-Normal Breathing, which is the value for Max-Min on the Heart Rate channel.
 - Mean Heart Rate - Normal Breathing, which is the value for Mean on the Heart Rate channel
 - Mean Breathing Rate- Normal Breathing, which is the value for Mean on the Breath Rate channel
8. Record the values in the Journal using one of the techniques described in Exercise 1. Record the breath and heart rates in [Table HS-5-L3](#).
9. Use the mouse to click on and drag the left cursor to the trough on the Volume channel that follows the subject's exhalation at the end of apnea ().
10. The values for the following rates during apnea are determined by the positions of the cursors:
 - Maximum Heart Rate - Apnea, which is the value for Max on the Heart Rate channel.
 - Minimum Heart Rate - Apnea, which is the value for Min on the Heart Rate channel.
 - Difference (Maximum-Minimum) Heart Rate-Apnea, which is the value for Max-Min on the Heart Rate channel.
 - Mean Heart Rate - Apnea, which is the value for Mean on the Heart Rate channel.
11. Record the values in the Journal using one of the techniques described in Exercise 1. Record the heart rates in table.
12. Use the mouse to click on and drag the left cursor to a time point that is to the right of the subject's return to normal breathing displayed on the Volume channel ().
13. The values for the following rates during the recovery to normal breathing are determined by the positions of the cursors:
 - Minimum Heart Rate - Recovery to Normal Breathing, which is the value for Min on the Heart Rate channel.
 - Maximum Heart Rate - Recovery to Normal Breathing, which is the value for Max on the Heart Rate channel.
 - Difference (Maximum-Minimum) Heart Rate-Recovery to Normal Breathing, which is the value for Max-Min on the Heart Rate channel.
 - Mean Heart Rate - Recovery to Normal Breathing, which is the value for Mean on the Heart Rate channel.
 - Mean Breathing Rate- Recovery to Normal Breathing, which is the value for Mean on

the Breath Rate channel.

- Use the same techniques to record the values for these parameters in the Journal and on the table.

Table HS-5-L3: Heart Rates before, during, and after Apnea

Breathing Pattern	Heart Rate (bpm)				Mean Breath Rate (bpm)
	Max	Min	Δ	Mean	
Normal					
Apnea					
Recovery					

Questions

- How did the heart rate of the subject change during apnea and recovery from apnea?
- How did the RSA prominence of the subject change during apnea and recovery from apnea?
- How does the normal breathing before apnea compare to the first breaths in the recovery segment?
- How does the breathing rate in the recovery segment correlate to the heart rate in that same segment?

Exercise 3: Shallow Abdominal Breathing and Heart Rate

Aim: To determine the effect of shallow abdominal breaths on the subject’s heart rate.

Procedure

- The subject should sit quietly and breath normally before the recording begins. Also, remind the subject to sit erect and quietly during the recordings, and to breath normally at the beginning of the exercise.
- In this exercise, the subject breaths normally until a regular breathing pattern is established. Then, the subject takes shallow breaths at the rate of 40 to 50 breaths per minute, using the diaphragm as the primary force for moving air in and out of the lungs. A shallow breathing pattern that is about 30 seconds long should be recorded from the subject. Finally, the subject returns to breathing normally.
- Type <Subject’s Name> Normal Breathing in the Mark box that is to the right of the Mark button.
- Click on the Record button. Press the Enter key on the keyboard to mark the recording.

- Click the AutoScale buttons for all four channels. Record until the subject's breathing is regular and predictable.
- Type Shallow Abdominal in the Mark box. Press the Enter key on the keyboard as you instruct the subject to start shallow abdominal breathing for 30 seconds.
- Type Recovery from Shallow in the Mark box. Press the Enter key on the keyboard as the subject returns to breathing normally. Continue to record until the subject's breathing has returned to a normal pattern. Click Stop to halt the recording. Your data should look like [Figure HS-5-L5](#).
- Click on Save in the File menu.

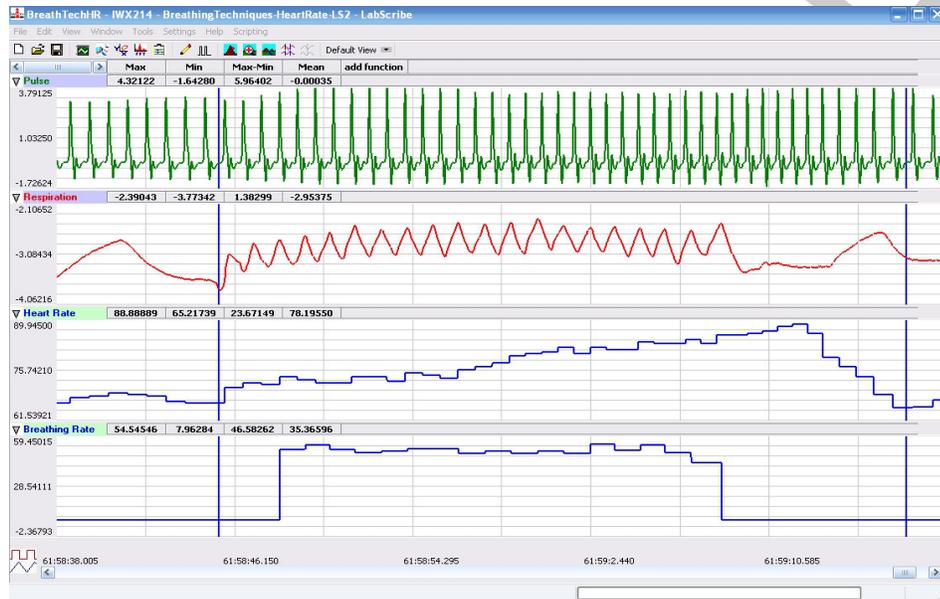


Figure HS-5-L5: Pulse, respiration, heart rate, and breathing rate before, during, and after shallow abdominal breathing, displayed in the Analysis window. The average breath rate during shallow abdominal breathing was 50.84 breaths per minute.

Data Analysis

- Use the same techniques used in Exercise 2 to determine the breathing and heart rates before, during, and after shallow abdominal breathing ([Figure HS-5-L5](#)).
- Use the same techniques to record the values for these parameters in the Journal and on [Table HS-5-L4](#).

Table HS-5-L4: Heart Rates before, during, and after Shallow Abdominal Breathing.

Breathing Pattern	Heart Rate (bpm)				Mean Breath Rate (bpm)
	Max	Min	Δ	Mean	
Normal					
Shallow					
Recovery					

Questions

1. How did the heart rate of the subject change during shallow abdominal breathing and recovery from shallow abdominal breathing?
2. How did the RSA prominence of the subject change during shallow abdominal breathing and recovery from shallow abdominal breathing?
3. How does the normal breathing before shallow abdominal breathing compare to the first breaths in the recovery segment?
4. How does the breathing rate in the recovery segment correlate to the heart rate in that same segment?

Exercise 4: Bellows Breathing and Heart Rate

Aim: To determine the effect of very rapid breathing, often referred as the Bellows Breathing Technique on the subject’s heart rate.

Procedure

1. The subject should sit quietly and breath normally before the recording begins. Also, remind the subject to sit erect and quietly during the recordings, and to breath normally at the beginning of the exercise.
2. In this exercise, the subject breaths normally until a regular breathing pattern is established. Then, the subject breaths as rapidly as possible for 10 to 15 seconds, moving air in and out through the nose while the mouth is gently closed. Bellows breathing can be as rapid as 2 to 3 breaths per second and can lead to dizziness. Finally, the subject returns to breathing normally.
3. Type <Subject’s Name> Normal Breathing in the Mark box that is to the right of the Mark button.
4. Click on the Record button. Press the Enter key on the keyboard to mark the recording.
5. Click the AutoScale buttons for all four channels. Record until the subject’s breathing is regular and predictable.
6. Type Bellows Breathing in the Mark box. Press the Enter key on the keyboard as you instruct the subject to start bellows breathing for 15 seconds.

7. Type Recovery from Bellows in the Mark box. Press the Enter key on the keyboard as the subject returns to breathing normally. Continue to record until the subject's breathing has returned to a normal pattern. Click Stop to halt the recording. Your data should look like [Figure HS-5-L6](#).
8. Click on Save in the File menu.

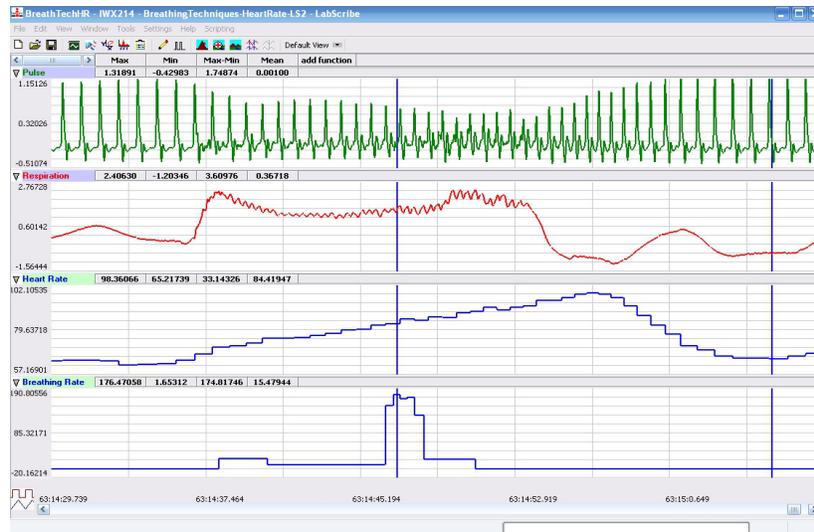


Figure HS-5-L6: Pulse, respiration, heart rate, and breathing rate before, during, and after bellows breathing, displayed in the Analysis window. During a section of bellows breathing, the maximum breath rate was 203.4 breaths per minute.

Data Analysis

1. Use the same techniques used in Exercise 2 to determine the subject's breathing and heart rates before, during, and after bellows breathing ([Figure HS-5-L6](#)).
2. Use the same techniques to record the values for these parameters in the Journal and on [Table HS-5-L5](#).

Table HS-5-L5: Heart Rates before, during, and after Bellows Breathing.

Breathing Pattern	Heart Rate (bpm)				Mean Breath Rate (bpm)
	Max	Min	Δ	Mean	
Normal					
Bellows					
Recovery					

Questions

1. How did the heart rate of the subject change during bellows breathing and recovery from bellows breathing?
2. How did the RSA prominence of the subject change during bellows breathing and recovery from bellows breathing?
3. How does the normal breathing before bellows breathing compare to the first breaths in the recovery segment?
4. How does the breathing rate in the recovery segment correlate to the heart rate in that same segment?

Exercise 5: Deep Abdominal Breathing and Heart Rate

Aim: To determine the effect of deep abdominal breathing on the subject's heart rate.

Procedure

1. The subject should sit quietly and breath normally before the recording begins. Also, remind the subject to sit erect and quietly during the recordings, and to breath normally at the beginning of the exercise.
2. In this exercise, the subject breaths normally until a regular breathing pattern is established. Then, the subject breaths slowly and deeply, inhaling through the nose and exhaling through the mouth for 1 minute. Finally, the subject returns to breathing normally.
3. Type <Subject's Name> Normal Breathing in the Mark box that is to the right of the Mark button.
4. Click on the Record button. Press the Enter key on the keyboard to mark the recording.
5. Click the AutoScale buttons for all four channels. Record until the subject's breathing is regular and predictable.
6. Type Deep Abdominal Breathing in the Mark box. Press the Enter key on the keyboard as you instruct the subject to start deep abdominal breathing for a minute.
7. Type Recovery from Deep Abdominal in the Mark box. Press the Enter key on the keyboard as the subject returns to breathing normally. Continue to record until the subject's breathing has returned to a normal pattern. Click Stop to halt the recording.
8. Click on Save in the File menu.

Data Analysis

1. Use the same techniques used in Exercise 2 to determine the subject's breathing and heart rates before, during, and after deep abdominal breathing ([Figure HS-5-L7](#)).
2. Use the same techniques to record the values for these parameters in the Journal and on [Table HS-5-L6](#).

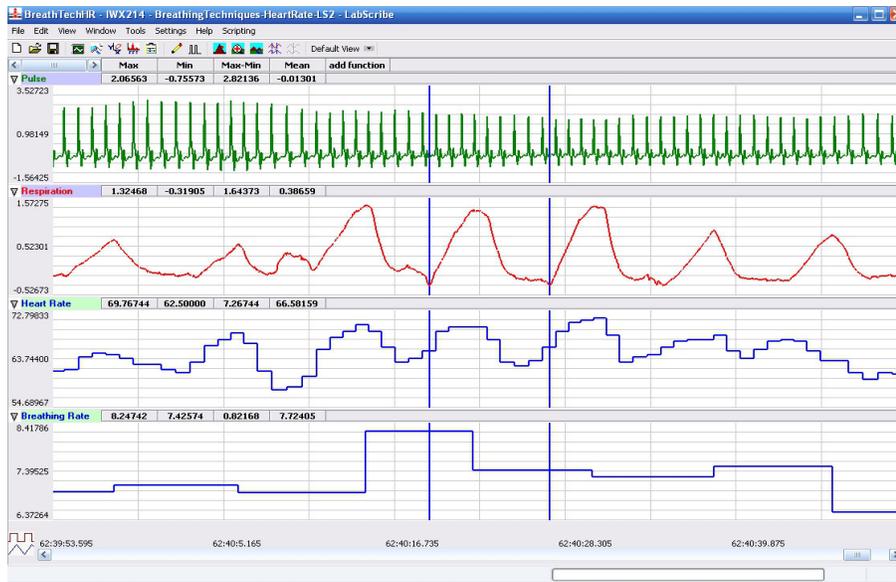


Figure HS-5-L7: Pulse, respiration, heart rate, and breathing rate before, during, and after deep abdominal breathing, displayed in the Analysis window.

Table HS-5-L6: Heart Rates before, during, and after Deep Abdominal Breathing.

Breathing Pattern	Heart Rate (bpm)				Mean Breath Rate (bpm)
	Max	Min	Δ	Mean	
Normal					
Deep Ab					
Recovery					

Questions

1. How did the heart rate of the subject change during deep abdominal breathing and recovery from deep abdominal breathing?
2. How did the RSA prominence of the subject change during deep abdominal breathing and recovery from deep abdominal breathing?
3. How does the normal breathing before deep abdominal breathing compare to the first breaths in the recovery segment?
4. How does the breathing rate in the recovery segment correlate to the heart rate in that same segment?
5. How do the heart rates of the four breathing techniques listed in [Table HS-5-L1](#) compare? How do the RSA prominences of the four breathing techniques listed in the table compare?