Experiment HP-5: Heart Rate, Blood Pressure, and Vagal Tone

Heart Rate & Blood Pressure Section

This lab is part 1 of a series of 4 labs. All labs can be done individually, but it is best to do them in this order:

1) Heart Rate, Blood Pressure, and Vagal Tone
2) Personality and Vagal Tone
3) Vigilance and Reaction Time
4) Hot Reactor

Equipment Required

PC or Mac Computer

IXTA, USB cable, IXTA power supply

BP-220 or BP-220A Non-invasive blood pressure transducer – also used in the Hot Reactor lab

Black tygon tubing

PT-320 Pulse plethysmograph – also used in the Personaly & Vagal Tone, Vigilance-Reaction Time and Hot Reactor labs

RM-204 Respiration monitor – used in the Personality-Vagal Tone and Hot Reactor labs

RM-220 Nasal Cannula – used in the Personality-Vagal Tone and Hot Reactor labs

EM-220 Event Marker – used in the Vigilance-Reaction Time lab

Warning: *As explained above, this procedure involves stopping blood flow to the arm, which is potentially dangerous. Please take the following precautions.*

Precautions

1. Know what you are doing ahead of time.
2. Do not leave the cuff inflated for any prolonged period of time (>20 seconds).
3. The subject should flex and extend their fingers between experiments to maintain blood flow.
4. This experiment should be performed by healthy individuals who do not have a personal or family history of cardiovascular or respiratory problems. It is preferable to use more than one subject during the course of the lab session.

IWorx Sample Lab

Blood Pressure and Pulse Transducers Setup

1. Locate the BP-220 or BP-220A non-invasive blood pressure (NIBP) transducer and PT-320 pulse plethysmograph.
2. Plug the pulse sensor into the PT port.
3. While the subject is relaxing, place the blood pressure cuff around the upper portion of the left arm, just above the elbow. Place the pulse sensor on the volar surface (where the fingerprints are located) of the distal segment of the left middle finger or thumb. Wrap the Velcro strap around the end of the finger to attach the unit firmly in place until the subject can feel the pulse, but it is not too tight.
4. **Automated Blood Pressure and Pulse Transducer Setup -**Find the automatic blood pressure monitor and blood pressure cuff.
    - Slide the gray connector on the tubing of the BP cuff into the port on the left side of the BP monitor.
    - Turn on the BP monitor using the On/Off switch on the right side of the monitor. Cuff will automatically start.
    - Choose AutoBP from the View menu on the toolbar.

5. Manual BP cuff - Plug the tubing connector of the BP-220 into channel A2.
    - Choose IXTA View from the View menu on the toolbar.

Iworx Lab

Figure HP-5-S1: The BP-220 non-invasive blood pressure transducer and PPG-320 pulse sensor.

1.

Figure HP-5-S2: The PPG-320 pulse transducer and the BP-220 non-invasive blood pressure transducer connected to an IXTA.

Calibration of the Manual Non-Invasive BP Transducer

Procedure

1. Lay the cuff of the BP-220 on the lab table and click on the Record button.
2. Record data while the cuff is laying on the table for about 10 seconds.

iWorx Sample

3. Click on the AutoScale button at the upper margin of the Pulse and Blood Pressure channels. Your recording should look like Figure HP-5-S4.
4. Select Save As in the File menu, type a name for the file. Click on the Save button to save the data file.

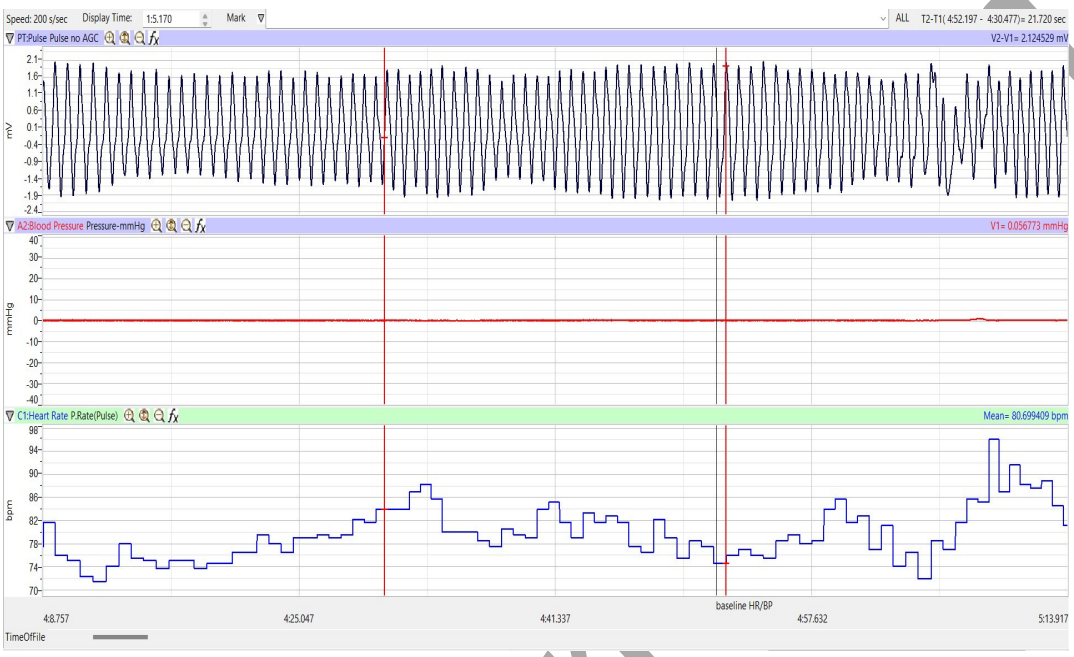

Figure HP-5-S4: The output of the BP-220 non-invasive blood pressure transducer displayed on the middle channel of the Main window. Pulse is shown on the top channel and heart rate on the bottom.

Units Conversion

1. Scroll to the beginning of the calibration data for the BP-220 non-invasive blood pressure transducer.
2. Use the Display Time icons to adjust the Display Time of the Main window to show the 10 second set of data on the Main window at the same time.
3. Click the 2-Cursor icon so that two cursors appear on the Main window. Place one cursor on the beginning of the flat section of data and the second cursor on the flat section of data collected approximately 10 seconds later/at the end.

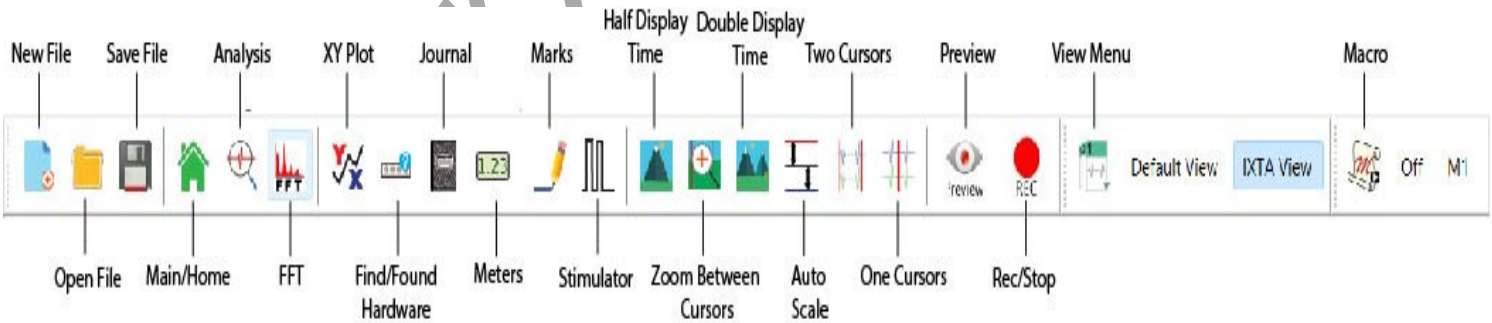

Figure HP-5-S5: The LabScribe toolbar.

4. Click V2-V1 to the right of the Blood Pressure channel. Select Set Offset.
5. Put a check mark in the box next to Apply units to all blocks. Enter “0” in the box at the top. Click OK

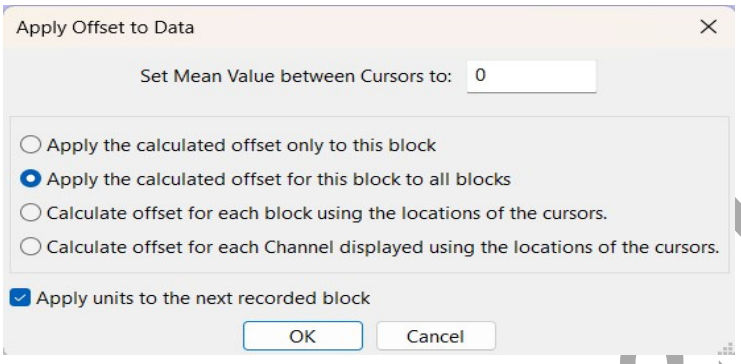

Figure HP-5-S6: The Units Offset dialogue window with the mean values set to “0”.

IWorX Sample Lab

Experiment HP-5: Heart Rate, Blood Pressure, and Vagal Tone

Heart Rate & Blood Pressure Section

This lab is part 1 of a series of 4 labs. All labs can be done individually, but it is best to do them in this order:

1) Heart Rate, Blood Pressure, and Vagal Tone
2) Personality and Vagal Tone
3) Vigilance and Reaction Time
4) Hot Reactor

Example Lab

Exercise 1: Baseline Heart Rate and Blood Pressure

Aim: To determine the resting heart rate and blood pressure of the subject.

Approximate Time: 15 minutes

Procedure

1. Select a subject. Instruct the subject to sit down and relax, with both hands in their lap.
2. Click on the Record button.
3. Click on the AutoScale All button. The pulse signals and heart rate histogram should expand to fill the channel windows.
4. Click Stop.

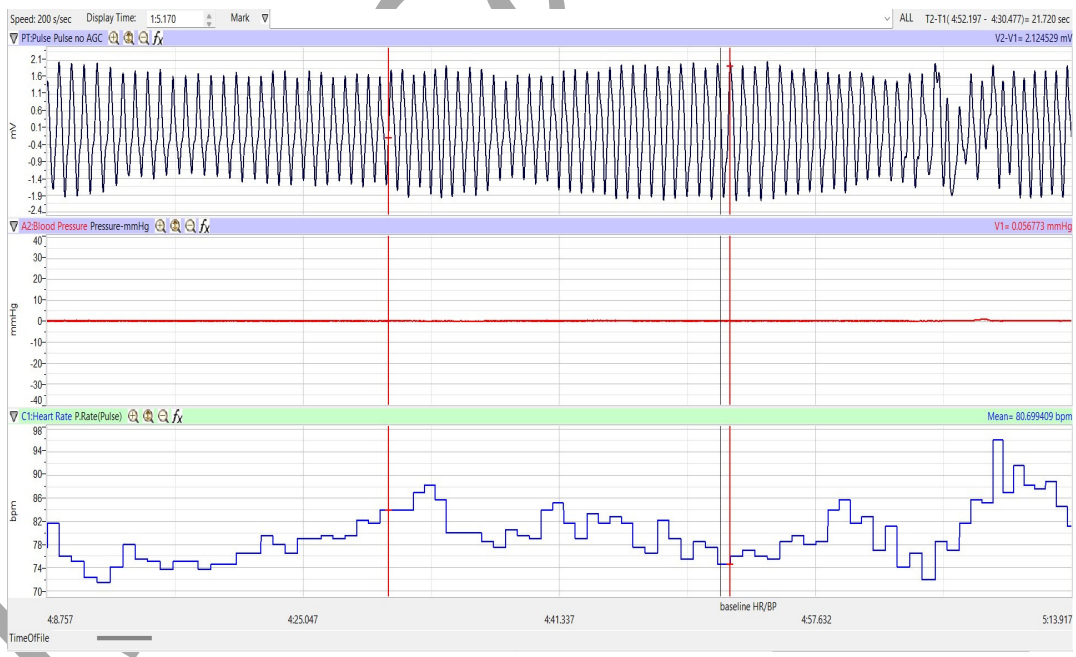

Figure HP-5-L1: Pulse and heart rate data from a relaxing subject.

5. Type **Baseline HR/BP** in the Mark box.
6. Click Record and click the mark button to mark the recording. Continue recording.
7. After recording for one minute, inflate the blood pressure cuff until the finger pulse wave on the Pulse channel disappears, approximately 180 mmHg.
8. Once the pulse wave disappears, release the cuff pressure at the rate of ~10 mmHg/second. Do not release the pressure too fast. Continue to release the pressure in the cuff until the data read 20 mmHg.
9. Click the Stop button. Make sure the blood pressure cuff is completely deflated and is not putting any unnecessary pressure on the subject's arm.
10. The subject should continue to relax between Exercises 1 and 2. To improve circulation in their arm, the subject should flex and extend their fingers to encourage blood circulation.
11. Select Save in the File menu.

The above directions are for the manual BP cuff.

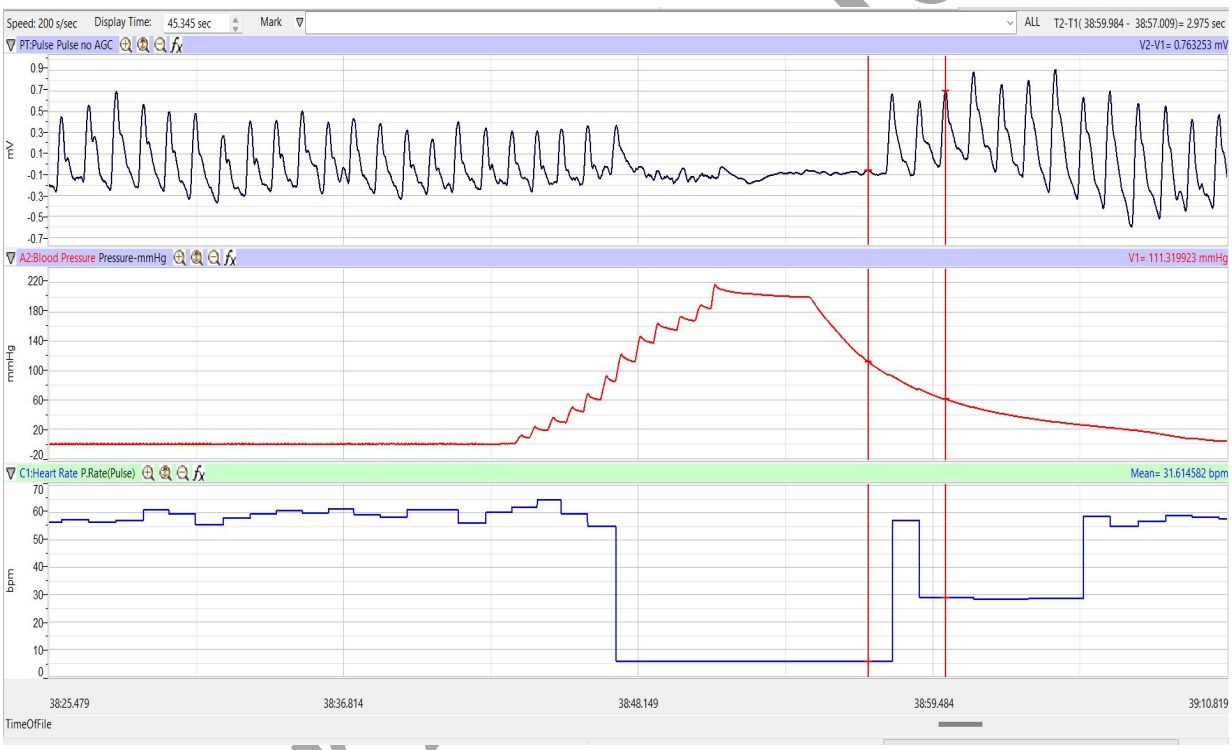

Figure HP-5-L2: The pulse waves and the pressure in the BP-600 recorded during the occlusion of the brachial artery as displayed in the Main window. Pulses disappear when the pressure in the cuff exceeds the pressure in the artery. The pulse wave reappears when the pressure in the cuff is released, The subject's heart rate is recorded on the bottom channel.

For the automated BP cuff, once the cuff is activated, it will inflate and deflate automatically. The systolic and diastolic blood pressures will be displayed on the LCD screen of the blood pressure system.

Work in Lab

Data Analysis - Baseline Heart Rate

1. Scroll through the recording and find the section of data recorded before the pressure in the cuff was blocking the pulse.
2. Use the Display Time icons to adjust the Display Time of the Main window to show this section of data. This section of data can also be selected by:
    - Placing the cursors on either side of the section of data needed.
    - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the segment of data to the width of the Main window.
3. Click on the Analysis window icon.

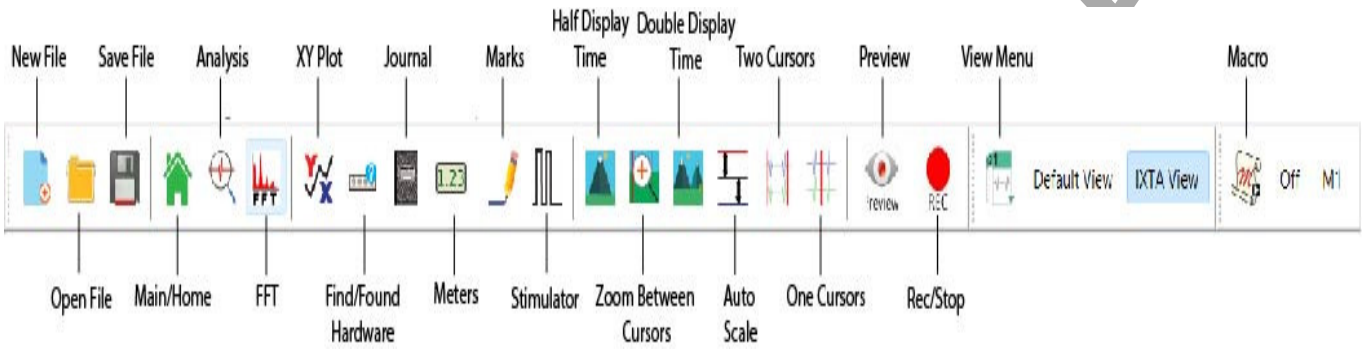

Figure HP-5-L3: LabScribe toolbar

4. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The mathematical functions that are listed should include Value1, Value2, V2-V1, T2-T1, Max, Min, and Mean. The values for these parameters from each channel are seen in the table across the top margin of each channel.
5. On the Heart Rate channel, click and drag one cursor to the left margin of the data displayed in the Analysis window. Drag the other cursor to the right margin of the same data and measure the following:
    - Maximum Heart Rate, Minimum Heart Rate and Mean Heart Rate
6. Once the cursors are placed in the correct positions for determining the maximum, minimum, and mean heart rates, these rates can be recorded in the on-line notebook of LabScribe by typing the names and values directly into the Journal.
7. The functions in the channel menus of the Analysis window can also be used to enter the names and values of the parameters from the recording to the Journal. To use these functions:
    - Place the cursors at the locations used to measure the cuff pressures from the Heart Rate channel.
    - Transfer the names of the mathematical functions used to determine the heart rates to the Journal using the Add Title to Journal function in the Heart Rate channel menu.
    - Transfer the value for the blood pressure to the Journal using the Add Ch. Data to Journal function in the Heart Rate channel menu.

iworx Sam... Lab

8. Record the values for these rates in the Journal using one of the techniques described in Steps 5 or 6, and in Table 1.

Data Analysis - Baseline Blood Pressure

1. Scroll through the recording and find the section of data recorded before, during, and after the pressure in the cuff was blocking the pulse.
2. Use the same procedures used in previous section to position the blood pressure data in the Main window, display the selected data in the Analysis window, position the cursors to make measurements.
3. On the Pulse channel, use the mouse to click on and drag the cursors to specific points on the recording in the Analysis window to measure the following:
    - **Systolic blood pressure**. To determine the subject's systolic blood pressure, place a cursor on the peak of the first pulse wave that reappears after the pressure from the cuff is released. The value for Value1 on the Blood Pressure channel is the subject's systolic blood pressure.
    - **Diastolic blood pressure.** To determine the subject's diastolic blood pressure, place the other cursor on the peak of the first of the largest pulse waves that reappears as the pressure from the cuff is released. The value for Value1 on the Blood Pressure channel is the subject's diastolic blood pressure.
    - **Pulse pressure,** or difference between the systolic and diastolic pressures. To measure the pulse pressure, leave the cursors used to measure the systolic and diastolic pressures. The value for V2-V1 on the Blood Pressure channel is the subject's pulse pressure.
4. Record the values for these pressures in the Journal using one of the techniques described in Steps 5 or 6 of the previous section, and in Table 1.

Table HP-5-L1: Baseline Heart Rate and Blood Pressures

Subject_____	Baseline-Relaxation
Maximum Heart Rate (BPM)	
Minimum Heart Rate (BPM)	
Mean Heart Rate (BPM)	
Systolic Pressure (mmHg)	
Diastolic Pressure (mmHg)	
Pulse Pressure (mmHg)	

Worx Sample Lab

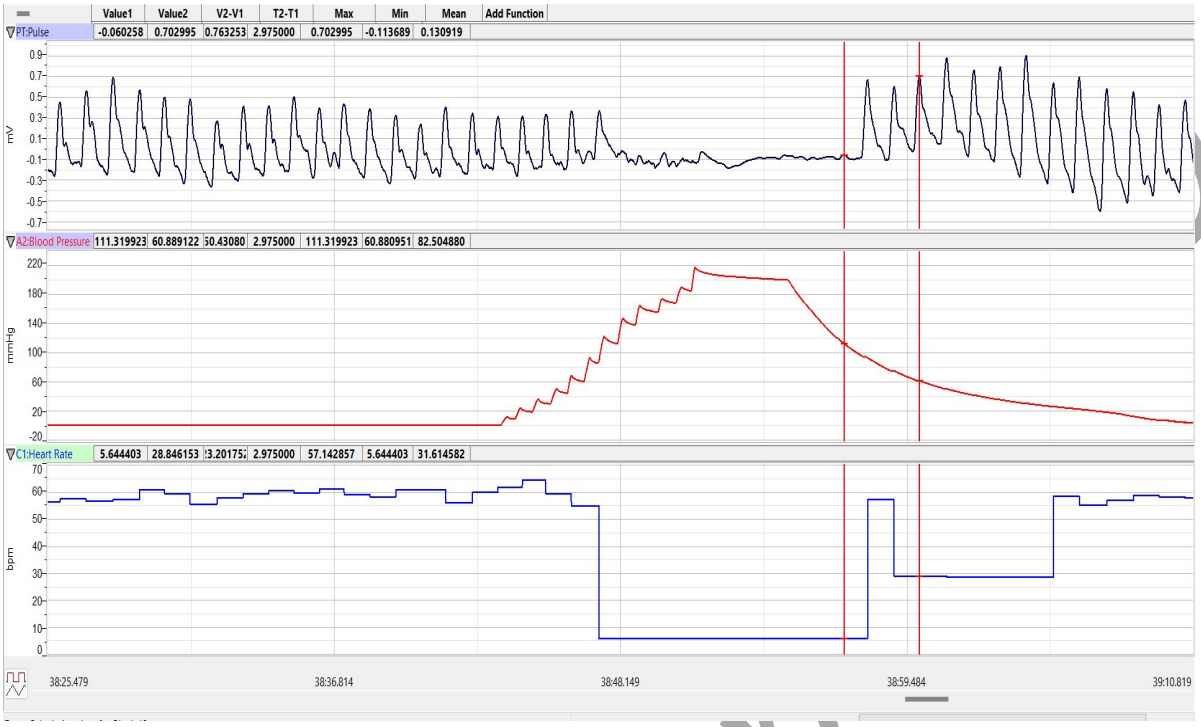

Figure HP-5-L4: The pulse waves and the pressure in the BP-220 recorded during the occlusion of the brachial artery as displayed in the Analysis window. The names and values of the parameters measured appear in the tables above the channels.

Exercise 2: Mild Cognitive Stressor

Aim: To determine if a mild cognitive stressor (spelling backwards) has an effect on heart rate and blood pressure. The hypothesis is that mild cognitive stressors will cause the subject's heart rate and blood pressure to increase when compared to the rates and pressures while relaxing or performing less distressing tasks.

Approximate Time: 20 minutes

For the automated blood pressure cuff, record the values from the cuff before starting Task B and again before saving the data.

Procedure

1. In this exercise, use the same subject used in Exercise 1. Instruct the subject to sit quietly as the rest of the lab group prepares for this exercise.
2. The pulse plethysmograph should be positioned on the subject's finger in the same manner that was used in Exercise 1. The blood pressure cuff should also be positioned around the subject's arm in the same manner that was used in Exercise 1.
3. The mild cognitive stressor that will be used in this exercise is spelling backwards. Lists of five-letter words to be used in the spelling tasks are located in Table 2.

Worx Sample

4. Select twelve words at random from the list for Task A before the exercise begins. Words from this list are mated with similar words from the list for Task B. For example, if above is selected from A list, then abide from B list must be used. Note the twelve words from each list.
5. Designate a member of the lab group to speak the words to the subject during the tasks, and another member of the group to record the words misspelled by the subject in each task.
6. Before beginning the exercise, inform the subject of the experimental conditions:
    - Task A is performed first. In Task A, the subject will spell the twelve words selected from the A list forwards, as printed.
    - Task B is performed second. In Task B, the subject will spell the twelve words from the B list backwards.
    - The words from the B list are paired with the words selected from the A list. The words from the B list should be spoken in the same order as the words to which they are mated from the A list.
    - The words in each task will be spoken by a member of the lab group at five-second intervals, whether the subject has finished the spelling of the previous word or not. Since each task contains twelve words, each task will last one minute.
    - Another member of the lab group will keep track of the number of words spelled in error in each task, whether forward or backward. Spelling of a word that is not completed before the next word is spoken is considered to be misspelled.
7. Type **Begin Task A** in the Mark box.
8. Click Record to begin recording the finger pulse of the subject. Click AutoScale All. Click the mark button as the first word in Task A is spoken. Continue to record as the subject attempts to spell each word forwards as a new word is spoken every five seconds.
9. Type **End Task A** in the Mark box. At the end of Task A, click the mark button to mark the recording. Continue to record.
10. As soon as the task has ended, take the subject's blood pressure. inflate the blood pressure cuff until the finger pulse wave on the Pulse channel disappears.
11. Once the pulse wave disappears, release the cuff pressure at the rate of ~10 mmHg/second. Continue to release the pressure in the cuff until the data read 20 mmHg.
12. Click Stop to halt the recording. Make sure the blood pressure cuff is completely deflated and is not putting any unnecessary pressure on the subject's arm.
13. Instruct the subject to sit quietly as the rest of the lab group prepares for Task B. Begin Task B as soon as possible.
14. Type **Begin Task B** in the Mark box.
15. Click Record. Click AutoScale All. Click the mark button as the first word in Task B is spoken. Continue to record as the subject attempts to spell each word backwards as a new word is spoken every five seconds.
16. Type **End Task B** in the Mark box. At the end of Task B, click the mark button to mark the recording. Continue to record.

WorX Sample Lab

17. As soon as the task has ended, take the subject's blood pressure. inflate the blood pressure cuff until the finger pulse wave on the Pulse channel disappears.
18. Once the pulse wave disappears, release the cuff pressure at the rate of ~10 mmHg/second. Continue to release the pressure in the cuff until the data read 20 mmHg.
19. Click Stop to halt the recording. Make sure the blood pressure cuff is completely deflated and is not putting any unnecessary pressure on the subject's arm.
20. Open the Journal and note the number of words misspelled in each task
21. Select Save in the File menu.

Table HP-5-L2: Five Letter Word Lists for Tasks A and B

Task A Spell Forward	Task B Spell Backward	Task A Spell Forward	Task B Spell Backward
above	abide	maple	mouse
adopt	adult	niche	nickel
ahead	alarm	nectar	novel
barge	batch	prowl	pearl
bread	brain	pride	prune
cable	candy	rusty	rowdy
champ	chief	realm	rafter
clean	clear	rapid	ruler
derby	deuce	sound	sober
dough	dozen	smock	smart
dream	drive	start	stomp
earth	empty	shawl	shock
event	exert	tramp	tackle
frame	frost	treat	truck
flour	flack	table	truth
growl	grant	wrath	whack
house	heart	water	worth
joust	juror	weary	woman
leach	lucky	young	yours
learn	laugh	zeros	zebra

Data Analysis - Heart Rates during Task A

1. Scroll through the recording and find the section of data recorded during Task A.
2. Use the same procedures used in Exercise 1 to position the heart rate data taken during Task A in the Main window and display the selected data in the Analysis window.

IWorX Sample Lab

3. On the Heart Rate channel, click and drag one cursor to the left margin of the data displayed in the Analysis window. Drag the other cursor to the right margin of the same data and measure the following:
    - Maximum, Minimum and Mean Heart Rates during Task A.
4. Record the values for these rates in the Journal using one of the techniques described in Exercise 1, and in Table 3.

Data Analysis - Blood Pressures after Task A

1. Scroll to the recording of the subject's blood pressure taken after the completion of Task A.
2. Use the same procedures used in Exercise 1 to position the blood pressure data taken after Task A in the Main window and display the selected data in the Analysis window.
3. Use the same procedures used in previous section to position the cursors to make measurements and record the values of the parameters in the Journal and in Table 3.
4. On the Pulse channel, use the mouse to click on and drag the cursors to specific points on the recording displayed in the Analysis window to measure the following:
    - **Systolic blood pressure**. To determine the subject's systolic blood pressure, place a cursor on the peak of the first pulse wave that reappears after the pressure from the cuff is released. The value for Value1 on the Blood Pressure channel is the subject's systolic blood pressure.
    - **Diastolic blood pressure.** To determine the subject's diastolic blood pressure, place the other cursor on the peak of the first of the largest pulse waves that reappears as the pressure from the cuff is released. The value for Value1 on the Blood Pressure channel is the subject's diastolic blood pressure.
    - **Pulse pressure,** or difference between the systolic and diastolic pressures. To measure the pulse pressure, leave the cursors used to measure the systolic and diastolic pressures. The value for V2-V1 on the Blood Pressure channel is the subject's pulse pressure.
5. Record the values for these pressures in the Journal using one of the techniques described in Exercise 1, and in Table 3.

Data Analysis - Heart Rates and Blood Pressure during Task B

1. Scroll through the recording and find the section of data recorded during Task B.
2. Use the same procedures used to measure the heart rates and blood pressure during Task A to measure the heart rates during Task B.
3. Record the values for these rates in the Journal using one of the techniques described in Exercise 1, and in Table 3.

iWorx Sample Lab

Questions

1. Is the subject's mean heart rate and blood pressure higher during Task A (spelling forward) than during the baseline measurements taken in Exercise 1?
2. Is the subject's mean heart rate and blood pressure higher during Task B (spelling backward) than in the baseline period?
3. Is the subject's mean heart rate and blood pressure higher in Task B (spelling backward) than in Task A (spelling forward)?
4. Does your data support the hypothesis that heart rate and blood pressure increases when tasks that are more distressing are performed?

Table HP-5-L3: Heart Rates and Blood Pressures of a Subject Tested for the Effects of a Mild Stressor and for Reaction Times

Subject_____						
Experimental Condition	Maximum Heart Rate (BPM)	Minimum Heart Rate (BPM)	Mean Heart Rate (BPM)	Systolic Pressure (mmHg)	Diastolic Pressure (mmHg)	Pulse Pressure (mmHg)
Baseline 1						
Spelling Forward						
Spelling Backward						
Baseline 2						
Reaction Time						

References

Cole, P. M., Zahn-Waxler, C., Fox, N. A., Usher, B. A., & Welsh, J. D. (1996). Individual Differences in Emotion Regulation and Behavior Problems in Preschool children. Journal of Abnormal Psychology, 105(4), 518-529.

Eisenberg, N., Fabes, R. A., Karbon, M., Murphy, B. C., Carlo, G., & Wosinski, M. (1996). Relations of School Children's Comforting Behavior to Empathy-related Reactions and Shyness. Social Development, 5(3), 330-351.

Harris, R. M., Porges, S. W., Carpenter, M. E., & Vincenz, L. M. (1993). Hypnotic Susceptibility, Mood State, and Cardiovascular Reactivity. American Journal of Clinical Hypnosis, 36(1), 15-25.

iWorx Sample Lab

Jemerin, J. M. & Boyce, W. T. (1990). Psychobiological Differences in Childhood Stress Response. II. Cardiovascular Markers of Vulnerability. Journal of Developmental Behavioral Pediatrics, 11(3), 140-150.

Kagan, J., Reznick, J. S., & Snidman, N. (1987). The Physiology and Psychology of Behavioral Inhibition in Children. Child Development, 58, 1459-1473.

Lane, J. D., Adcock, R. A., & Burnett, R. E. (1992). Respiratory Sinus Arrhythmia and Cardiovascular Responses to Stress. Psychophysiology, 29(4), 461-470.

Porges, S. W. (1992). Vagal tone: A Physiological Marker of Stress Vulnerability. Pediatrics, 90(3), 498-504.

Thayer, J. F., Friedman, B. H. & Borkovec, T. D. (1996). Autonomic Characteristics of Generalized Anxiety Disorder and Worry. Biological Psychiatry, 39(4), 255-266.

IworX Sample Lab