Experiment HN-2: Stretch Receptors and Reflexes

Equipment Required

PC or Mac Computer

IXTA,USB cable, IXTA power supply

ROAM EMG

Disposable EMG electrodes

PRH-100/PRH-200 Patellar reflex hammer

EMG Cable and Reflex Hammer Setup

1. Locate Patellar Reflex Hammer and plug the BNC connector into Channel A3.
2. Disconnect the ROAM EMG from the dock and place the electrodes as shown.
3. Remove the plastic disk from a disposable electrode and apply it to one of the areas. Repeat for the other two areas.

Figure HN-2-S1: The PRH-200 Reflex Hammer.

4. Attach the electrodes from the ROAM as shown in Figure HN-2-S3.

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Figure HN-2-S2: The IX-TA-ROAM with the ROAM out of the dock.

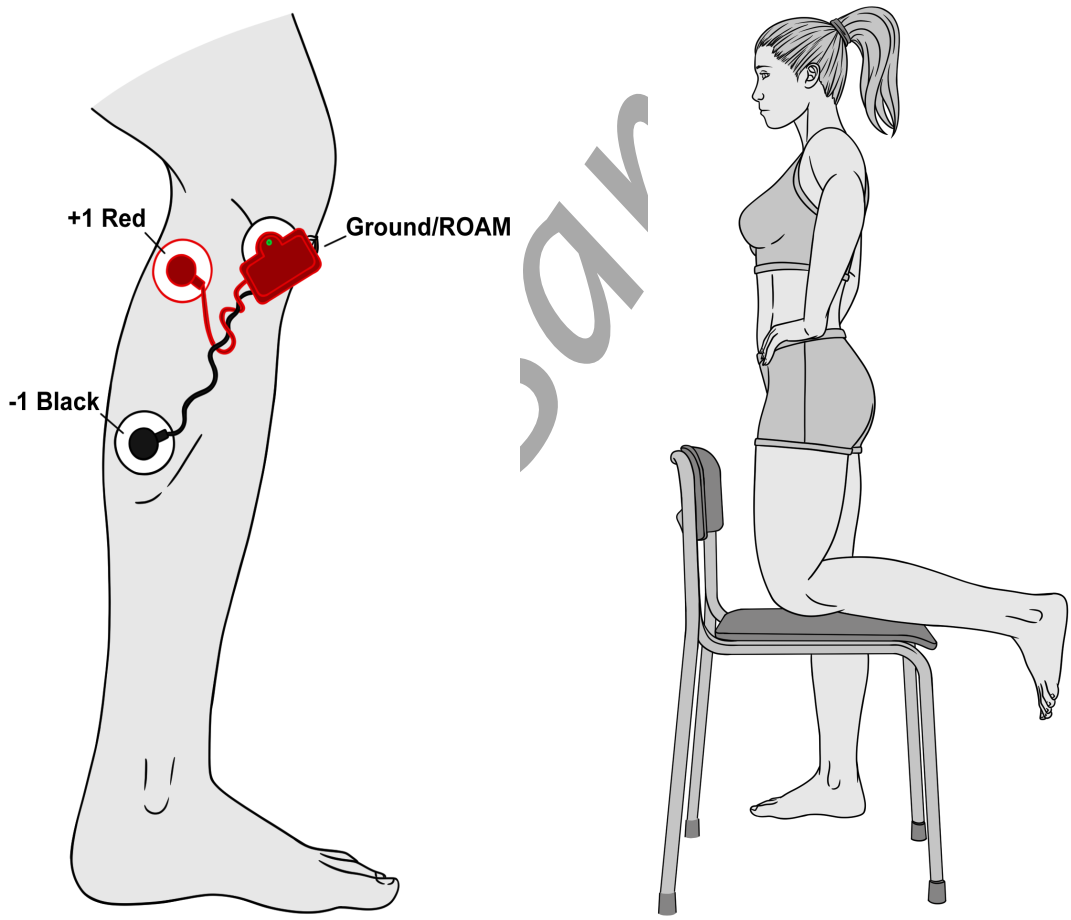

Figure HN-2-S3: The positioning of the electrodes on the leg and the best position for testing the Achilles reflex.

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NOTE: If doing the Patellar Reflex – continue right to Exercise 2.

Exercise 1: Achilles Tendon Reflex

Aim: To determine conduction time from tendon tap to response of the gastrocnemius muscle in the Achilles tendon reflex arc.

Approximate Time: 20 minutes

Procedure

1. Instruct the subject to sit on a lab bench so that the subject's thighs are supported by the top of the bench and their calves hang freely. Another position is to stand and place one leg on a chair so that the foot hangs over the edge (refer in the image in the set up).
2. The Achilles tendon is located above the heel and connects the gastrocnemius muscle to the tarsal bone of the foot. Tap the tendon with the wide end of the reflex hammer a few times to locate a point on the tendon which produces a consistent contraction of the gastrocnemius muscle and a downward movement of the foot (plantar flexion). The opposite, upward movement is known as dorsiflexion.
3. Click Record and then instruct the subject to move their foot up and down to demonstrate the type of EMG that occurs during plantar flexion and dorsiflexion. Click AutoScale All.
4. Type **Achilles** in the Mark box. Click the mark button to mark the recording. Continue recording.
5. Tap the subject's Achilles tendon to elicit the stretch reflex. Record a total of five trials using the same tapping force.
6. After the fifth trial, click Stop to halt recording.
7. Select Save As in the File menu, type a name for the file.
8. Repeat this exercise on the same subject using three different amounts of force, light, medium and a large amount of force.

Make sure to pause after each trial to allow the foot to relax.

Data Analysis

1. Scroll to the beginning of the data recorded for Exercise 1 to display the five trials on the Main window.
2. Use the Display Time icons to adjust the Display Time of the Main window to show both the signals made by tapping the tendon and the EMG response on the Main window.
3. Data can be collected from the Main window or the Analysis window. If you choose to use the Analysis window, click on the Analysis window icon in the toolbar.
4. The mathematical functions, T2-T1 should appear on screen. The value T2-T1 is shown in the upper right of the Main window and the upper left of the channel in the Analysis window.

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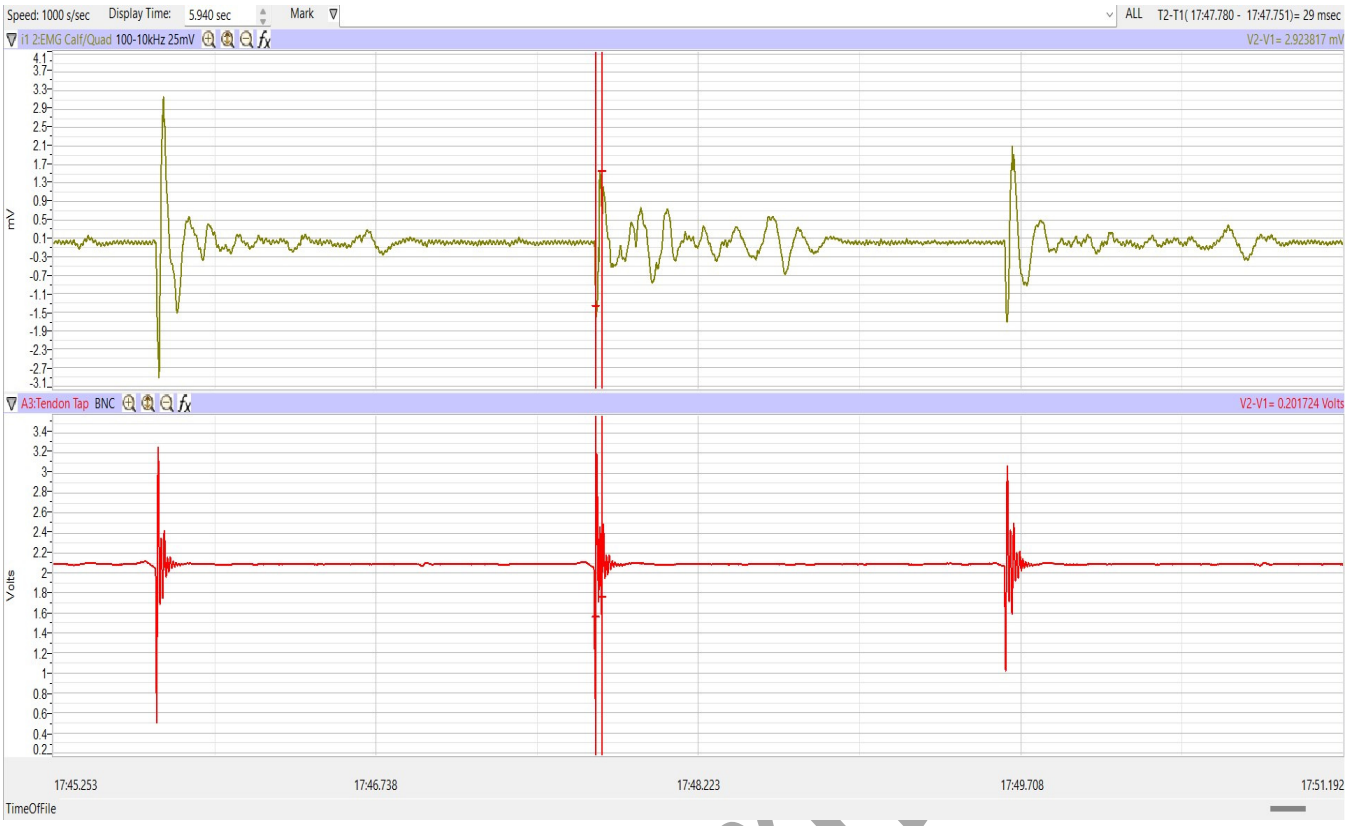

Figure HN-2-L1: An Achilles tendon reflex response and patellar hammer signal displayed on the Main window. The cursors are in position to measure the reflex conduction time.

Note: If the response is upside-down, use the Invert button under the down arrow to the left of the EMG channel.

If using the TA-ROAM, you will be measuring from the Accelerometer channel (represents the tendon tap) to the EMG channel.

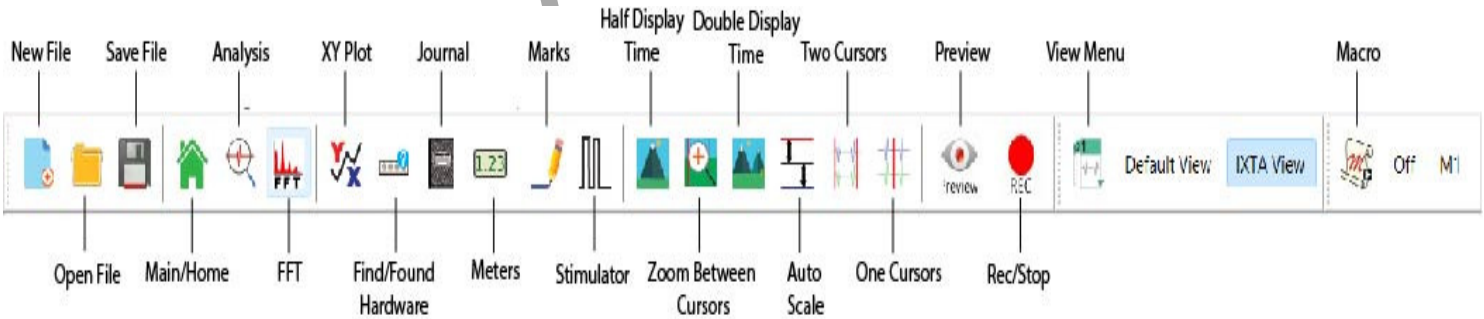

Figure HN-2-L2: The LabScribe toolbar.

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5. Use the mouse to click on and drag a cursor to the onset of the signal recorded from the reflex hammer which is displayed on the Tendon Tap channel. Drag the other cursor to the beginning of the EMG wave which is recorded on the EMG Calf channel.
6. Once the cursors are placed in the correct positions for determining the reflex conduction time, record the value for T2-T1 in the Journal. The value can be recorded in the on-line notebook of LabScribe by typing its name and value directly into the Journal. Values can also be recorded in separate data table.

Figure HN-2-L3: An Achilles tendon reflex response and patellar hammer signal displayed on the Analysis window. The cursors are in position to measure the reflex conduction time.

7. Once the reflex conduction time in the first trial is measured and recorded, use the scroll bar at the bottom of the Analysis window to move the data from the second trial onto the window. If needed, use the Display Time icons to adjust the width of the Analysis window to show both the signal from the tendon tap and the subject's EMG response on the same window.
8. Repeat Steps 5 through 7 on the data from the other four trials.
9. Once the reaction times in all ten trials have been measured and recorded, determine the mean reflex conduction time of the subject. Record the mean reflex conduction time for the Achilles reflex at this relative strength of tap in Table 1.
10. Measure the distance between the belly of the subject's calf muscle and the site of the sensory-motor synapse in the spinal cord. For the purpose of this exercise, assume that the sensory-motor synapse is at spinal segments L5 and S1, which are just above the top of the hip bone. Multiply this measurement by 2 to determine the total length of the nerve path.

Work Sample

11. Even though this stretch reflex is known as a monosynaptic reflex, the pathway includes the neuromuscular synapse (NMJ) as well. Assume that synaptic transmission takes about 0.5 msec, calculate the conduction velocity in the nerves composing this reflex pathway by the equation:

$$\text{Conduction Velocity (m/sec)} = \frac{\text{Total path length (mm)}}{\text{(Mean reflex time (msec) - 0.5msec)}}$$

12. Record the conduction velocities for the Achilles reflex recorded from the three different tapping strengths in Table 1.

Questions

1. Which muscle groups are involved in plantar flexion and in dorsiflexion of the ankle?
2. Does the subject's reflex time change with different stimulus strengths? Why does it or doesn't it change?
3. Design an experiment to measure the reflex time more precisely.

Exercise 2: Patellar Tendon (Knee Jerk) Reflex

Aim: To determine conduction time from tendon tap to response of the quadriceps muscle in the patellar tendon reflex arc.

Approximate Time: 40 minutes

Procedure

1. Instruct the subject to sit on a lab bench so that the subject's thighs are supported by the top of the bench and their calves hang freely.
2. Remove the lead wires of the EMG recording cable from the electrodes over the subject's calf muscle. Keep these electrodes on the subject's calf muscle.
3. Place a new set of recording electrodes on the quadriceps muscle of the subject on the medial side of the thigh, so that:
    - the black (-1) lead wire is attached to an electrode which is about 12 cm from the knee.
    - the red (+1) lead wire is attached to an electrode which is about 10 cm above the negative electrode.
    - the green (C) lead wire is attached to the electrode on the knee that functions as the ground.

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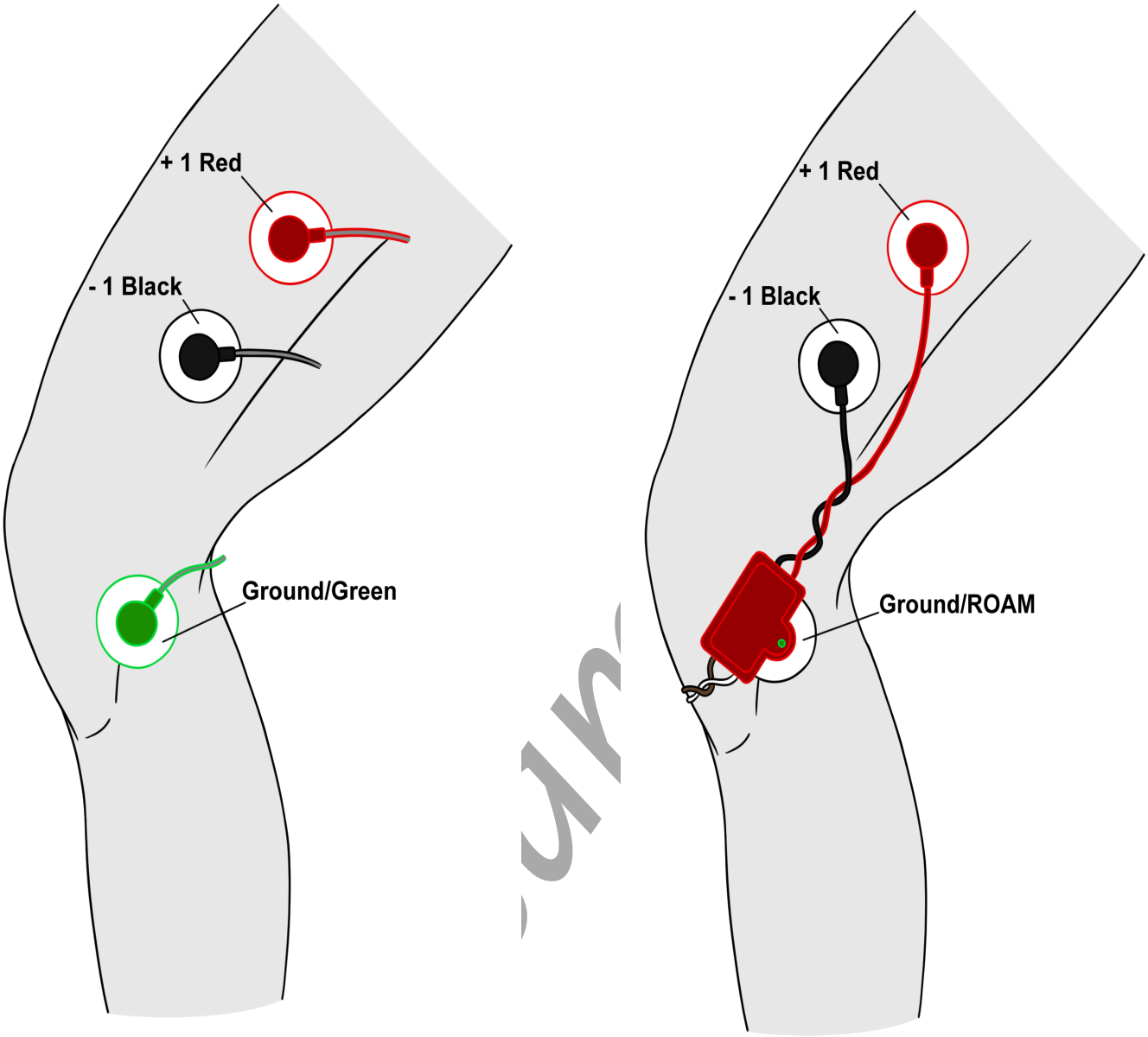

Figure HN-2-L3: Circuit diagram for recording EMGs from the thigh muscles. Using the iWireB3G on the left and the wireless ROAM on the right.

4. Feel the position of the patellar tendon just below the kneecap. Place one hand on the patella (kneecap), and use the other hand to tap the patellar tendon with the reflex hammer. Find the point on the patellar tendon that causes the greatest response from the quadriceps muscle.
5. Click Record and then instruct the subject to raise and lower their lower leg to demonstrate the type of EMG that occurs during quadriceps contraction and relaxation. Click AutoScale All. Click Stop to halt the recording.

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6. Type **Patellar** in the Mark box.
7. Click Record and then click the mark button to mark the recording.
8. Instruct the subject to relax their quadriceps muscle and that the exercise has begun.
9. Tap the subject's patellar tendon to elicit the stretch reflex. Record a total of five trials using the same tapping force.
10. After the fifth trial, click Stop to halt recording.
11. Select Save in the File menu.
12. Repeat this exercise on the same subject while the subject is voluntarily contracting their quadriceps.
13. Repeat this exercise on the same subject while the subject is performing the Jendrassik Maneuver. Make sure the leg is fully relaxed at all times. To perform this muscle activity:

Make sure to pause after each trial to allow the foot to relax.

Figure HN-2-L4: Jendrassik Maneuver

Data Analysis

1. Use the same technique explained in Exercise 1 to measure and record the conduction times of the subject's patellar reflex, the patellar reflex with quadriceps muscle tension, and the patellar reflex with the Jendrassik Maneuver.
2. Enter the mean reflex conduction times and velocities for this exercise in Table 1.

Questions

1. Compare the average reflex times of the Achilles and patellar tendon reflexes. What factors contribute to the difference between the two reflex times?
2. Is the patellar reflex inhibited or enhanced by voluntary muscle activity in the quadriceps? Speculate on the mechanism of inhibition or enhancement.

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3. Is the patellar reflex retarded or facilitated during the Jendrassik's Maneuver (voluntary muscle activity an another part of the body)? Speculate on the mechanism of retardation or facilitation.
4. Besides excitatory inputs from stretch receptors, what synaptic inputs might influence the activity of spinal motorneurons?

Table HN-2-L1: Reflex Conduction Times and Velocities for Achilles and Patellar Tendon Reflexes.

Reflex	Mean Reflex Conduction Time (ms)	Reflex Conduction Velocity (m/s)
Achilles Tendon - Light Tap		
Achilles Tendon - Medium Tap		
Achilles Tendon - Heavy Tap		
Patellar Tendon - Quadriceps Relaxed		
Patellar Tendon - Quadriceps Tensed		
Patellar Tendon - Jendrassik's Maneuver		

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