Experiment HM-12: EMG – Balance Board

Equipment Required

PC or Mac Computer

IX-TA-ROAM, USB cable, power supply

5 Disposable electrodes

Balance Board or Rocker Board

Alcohol swabs

Optional Equipment: Weights (5 lb), Hula-Hoop

Subject Attire:

It is important that the subject wear loose comfortable clothing/shorts that allows for the attachment of five (5) electrodes, two to either side of the lower leg (*Peroneus (fibularis) longus and Soleus*). Comfortable running shorts are a good choice. Standing, rocking, bending, stretching, and twisting could all be part of the exercise protocols that you can try.

EMG ROAM Setup

1. Locate the IX-TA-ROAM and disconnect the ROAM unit from the TA.
2. Attach the leads and the center of the ROAM to 5 electrodes.

Figure HM-12-S1: The IX-TA and ROAM Wireless.

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Choosing the Muscles for Recording EMG

1. Start with the subject's dominant leg. The way to figure this out is to have them start from a standing position and take a step forward. Whichever leg is their leading leg, use that.

2. Attach the red and black leads to the *Peroneus (fibularis) longus*. Attach the brown and white leads to the *Soleus*. The center of the ROAM can do either on the front or back of the leg.

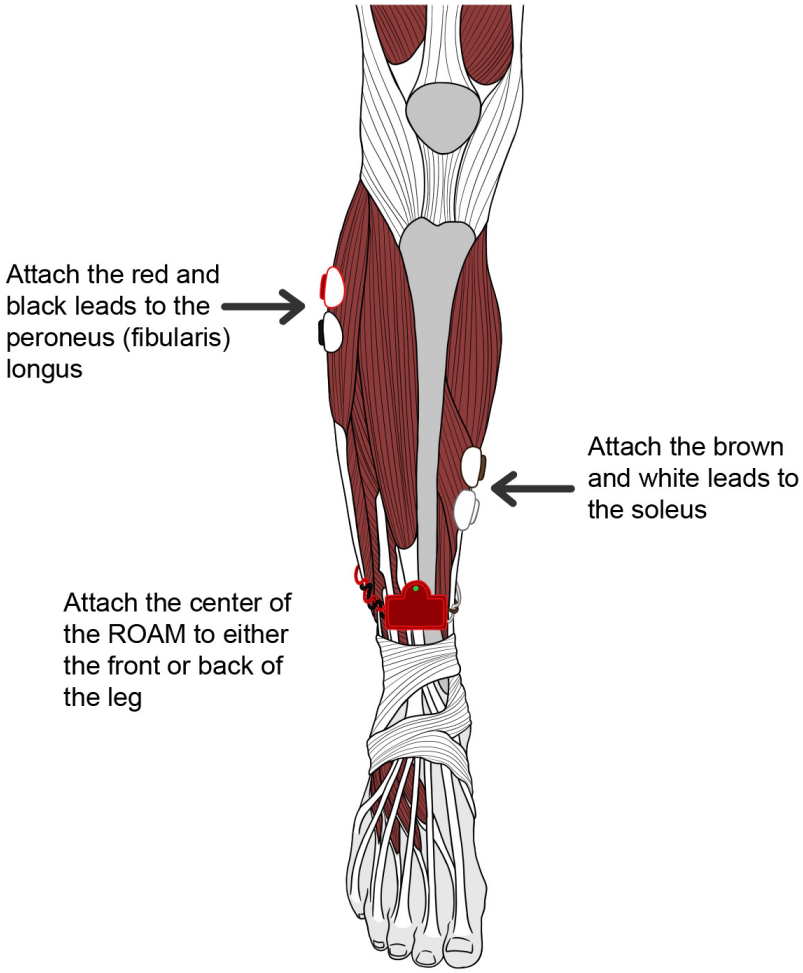

Figure HM-12-S2: The position of the ROAM electrodes on the leg. Either leg can be used, but the dominant one is suggested for better balance.

NOTE: Any leg muscles may be used in this lab. The two muscles listed are the ones used in the main lab activty. Try some of the optional activities in the lab.

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Work

Optional placement of electrodes:

1. Use the thigh or hip muscles instead. Locate the muscles of the hip region over which the recording electrodes will be placed. Muscles can be located by flexing, extending, abducting and adducting the leg and noting the areas of the hip where the muscles are tense:

    - One pair of recording electrodes can be placed over the ***Rectus femoris*** muscle. The electrodes are placed at 50% of the distance from the anterior superior iliac spine to the superior aspect of the patella, with the distance between the electrodes being 4.5 cm. Make sure to stay along the midline of the Rectus muscle. Place a pair of electrodes on each leg if you decide to look at both legs simultaneously.
    - Another pair of electrodes can be placed over the ***Vastus lateralis*** muscle. The electrodes are placed at 66% of the distance from the anterior superior iliac spine to the lateral border of the patella, with the distance between the electrodes of 3.5 cm. Make sure to stay on the belly of the Vastus.
    - The center of the ROAM can be placed as the center of the square of electrodes when using the Vastus and Rectus muscles.

NOTE: If using only one leg, the all the electrodes will be placed on one leg.

3.

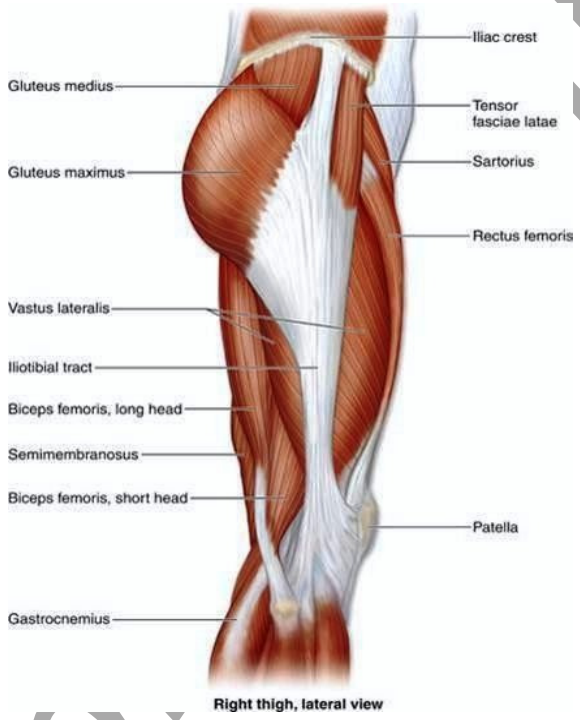

Figure HM-12-S3: Muscles in the hip for doing optional exercises.

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Experiment HM-12: Balance Board and EMG

This lab is written so that students can experiment with different activities demonstrating how to maintain balance and see how the body performs during those activities.

Exercise 1: Standing Balance and Center of Gravity

Aim: To study the EMG and Balance activity in leg muscles while the subject stands on the Balance Board with both feet.

Approximate Time: 30 minutes

Procedure

1. Instruct the subject that he or she will be doing the following during all the exercises:
    - Make sure the subject has no known hip, lower back or knee injuries, issues or balance problems.
    - All exercises will be performed in the same manner.
        - Start on the Balance Board, standing with both feet, arms at their sides;
        - Try to maintain balance, without wobbling, for at least 15 seconds;
        - Step off the board and repeat;
        - Each exercise will be performed for 5 reps.
2. The subject will step on the Balance Board and stand still for at least 15 seconds.
3. Click AutoScale All to show the recordings on all the channels.
4. Look at the graph and the data recorded:
    - The center of gravity on the graph should show almost in the center of the graph.
    - X, Y and Z on the Accelerometer window show how the subject is balancing.
    - EMG activity of leg muscles should show low level activity as the subject retains muscle tone to stand upright.

Exercise A – Leg Up

1. Before starting the recording, type the name of the first exercise, **Leg Up**, in the Mark box. Instruct the subject to get into position to perform this exercise. The leg with the electrodes should be the one on the board. Lift the leg that does not have the electrodes attached.
2.

Click the Record button. Click on the Mark button to label the recording.
3. Click AutoScale on all channels to show the recordings on all the channels.
4. As soon as the record button is clicked, have the subject complete 5 reps of the “Leg Up” exercise.
    - Make sure to engage core muscles;

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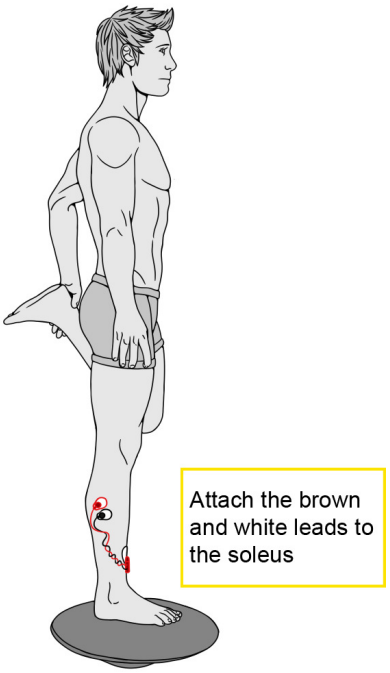
- Left the leg off the Balance Board and hold for 15 seconds;
    - Try to stay as steady as possible;
- Place the leg down for 15 seconds;
- Repeat 4 times.



5. After the 5th rep, place both feet on the board and regain your center of gravity. Click Stop to halt the recording. Step off the board.
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.
7. The recording should look similar to what is shown in the figure below.

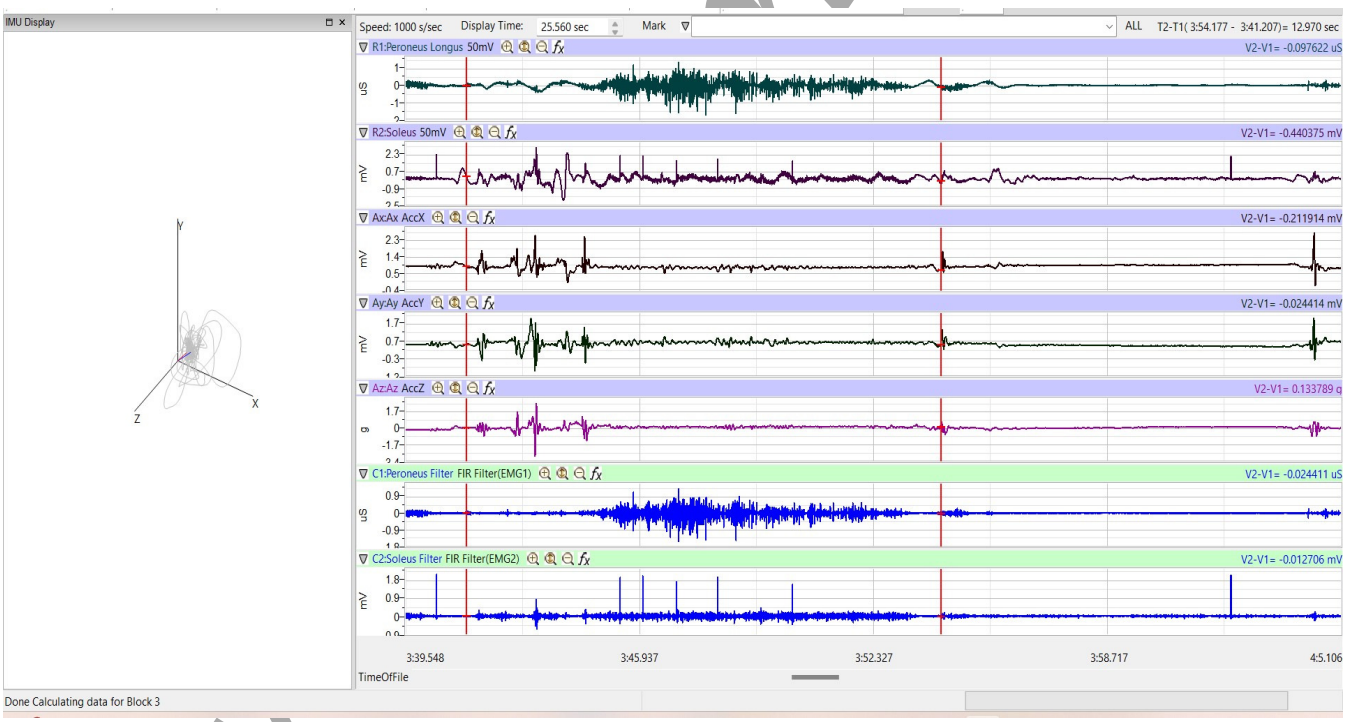


Figure HM-12-L1: Muscle EMG activity and accelerometer data as the subject balances on one leg.

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Exercise B. Rocking Back and Forth

1. Repeat Exercise A, this time rocking the board front and back so that the board touches the floor in each direction. Try to have a slow and steady movement and maintain your balance while doing so. Make sure to mark your recording appropriately.
    - Step on the board.
    - Lift the leg without the electrodes on it.
    - Rock backwards until the board touches the floor, rock forwards until the board touches the floor.
    - Repeat 5 times, front to back.

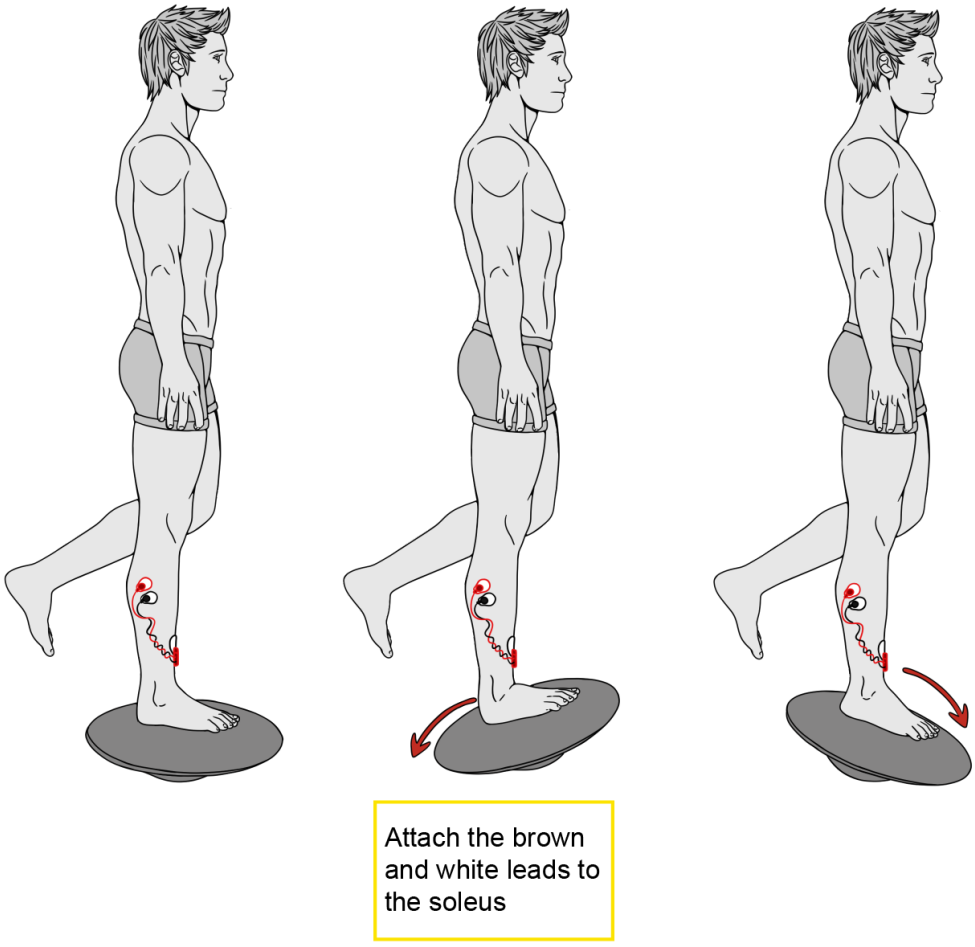

Figure HM-12-L2: Procedure for balancing on one leg and rocking back and forth.

2. Click AutoScale on all channels to amplify signals.
3. Click on the Save button to save the data file.

Lab Manual

Data Analysis

1. Scroll through the recording and find the first complete section of data recorded while the subject was standing with the left leg up.
2. Use the Display Time icons to adjust the Display Time of the Main window so all 5 reps appear on the Main window. The five reps can also be selected by clicking the Double Display time icon on the LabScribe toolbar.
3. Open the Accelerometer window by clicking View → Accelerometer Window

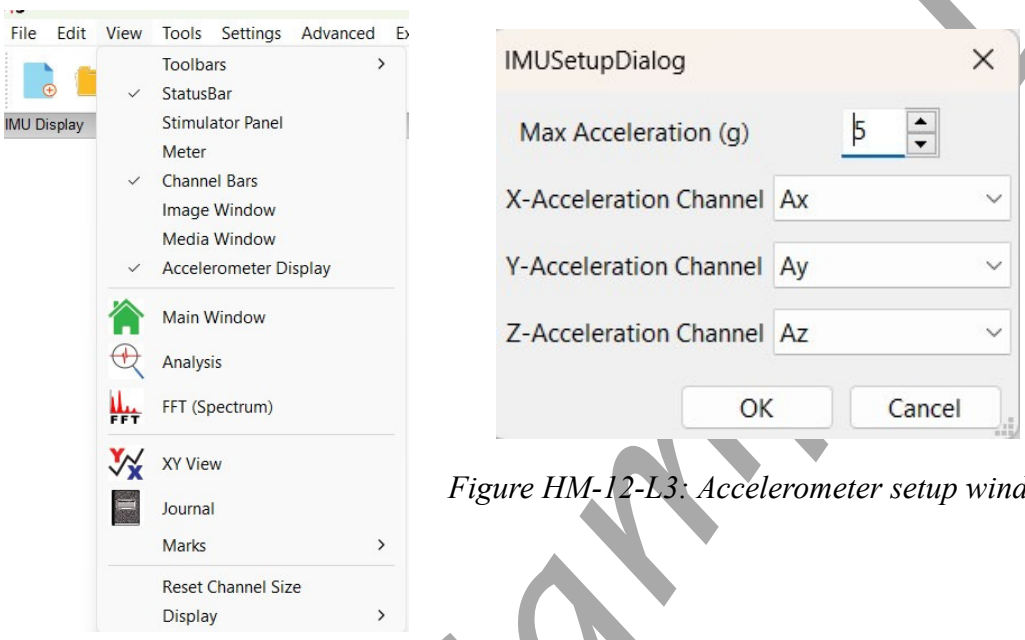

Figure HM-12-L3: Accelerometer setup windows.

4. This will open the IMU Setup Dialog. Set the Max Acceleration to the maximum value of the X, Y and Z channels on LabScribe. Set the Ax, Ay and Az channels as shown. Click OK.
5. Click on the Analysis window icon in the LabScribe toolbar to transfer the data displayed in the Main window to the Analysis window.

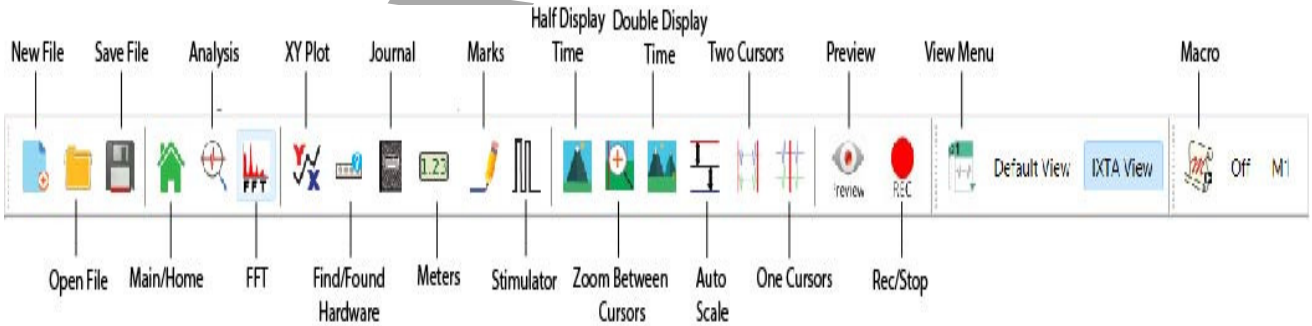

Figure HM-12-L4: The LabScribe toolbar.

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6. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The mathematical functions, Abs. Int. and T2-T1 should appear in this table. The values for Abs. Int. and T2-T1 for each muscle are seen in the table across the top margin of each EMG channel.
4. Click and drag the cursors to be on either side of one EMG contraction on the muscle that shows the highest EMG activity. Place them so they are **exactly** 5 seconds apart during the EMG burst. If the subject did not hold the pose for 5 seconds, place the cursors to either side of the EMG burst and note the time.
    - Use the right and left arrow keys to get the cursors exactly "x" seconds apart, after you have moved them to the location during the EMG activity.
    - Click Tools
    - Choose "Lock Cursor Separation" to lock the cursors to that time interval.
5. Once the cursors are placed and locked for measuring the first EMG burst, the values for the parameters can be recorded in the on-line notebook of LabScribe by typing the names and values directly into the Journal, or on a data table.
6. The values for Abs. Int. and T2-T1 on the channels are the relative amounts of the EMG activity during which the EMG burst occurred.
7. Record the values from each muscle group during the first EMG burst in the Journal, or on a data table.
8. Look at the Accelerometer graph. The X, Y and Z axis show the relative activity in that direction. Look at how the subject is balancing but looking at where the activity is on the XYZ plot.
9. Use the mouse to move the cursors to the next EMG burst when the subject lifted their leg again, and measure and record the values for Abs. Int. and T2-T1 from the muscles.
10. Measure the Abs.Int and T2-T1 for the EMG bursts for the remaining three repetitions.
11. Average the values for the Abs. Int. taken from the muscles during the exercise. Enter the averages for each muscle during the first exercise on your own data table.
12. Select Save from the File menu.

Note – You may need to "unlock" cursor separation to continue the lab and "relock" when performing the next data analysis.

Data Analysis for Rocking Back and Forth

1. Repeat the above the analysis for the time in which in the subject rocked back and forth.
2. Measure the Abs.Int and T2-T1 for the EMG bursts for each rocking motion.

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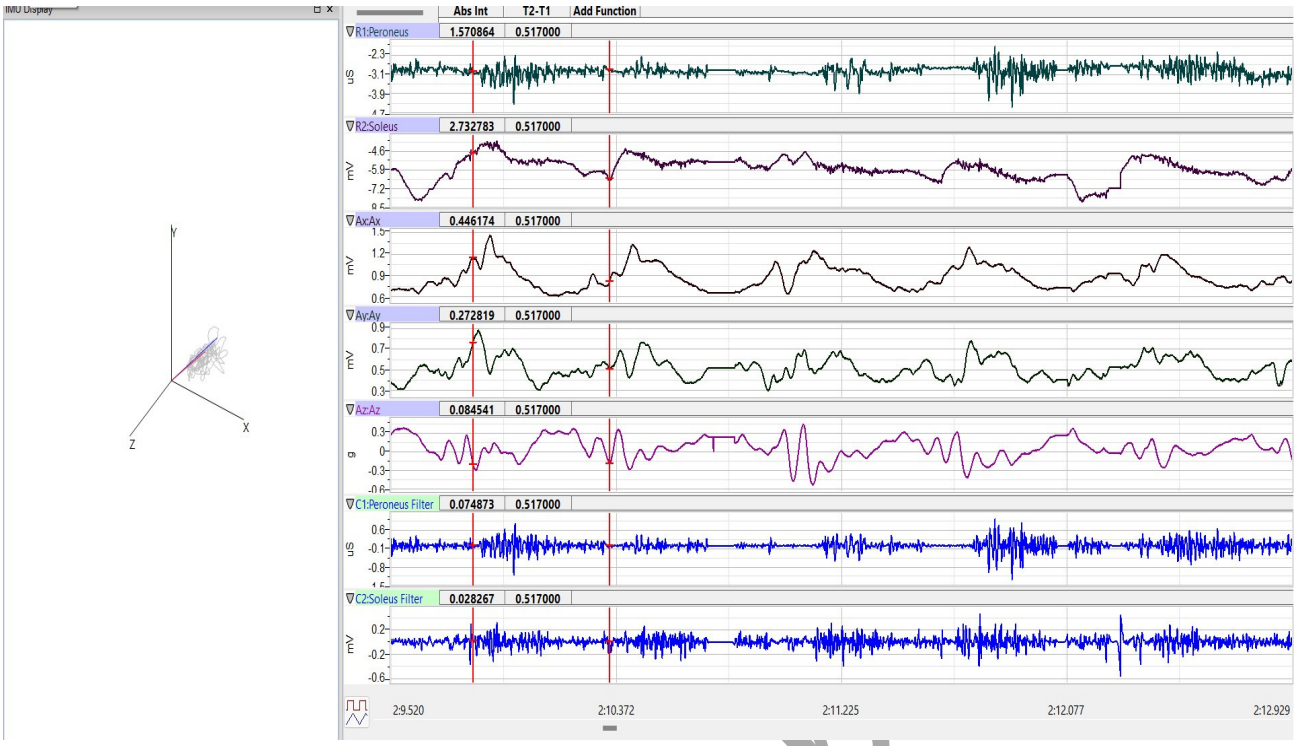

Figure HM-12-L5: EMG activity while the subject is rocking back and forth. The cursors are placed to measure the Abs.Int of the muscle activity in one direction. The muscle with the highest activity is the muscle firing the strongest.

Questions

1. Can the subject maintain his or her center of gravity easily? For how long?
2. What happens if the subject closes their eyes? Is it easier or harder to maintain balance? Why?
3. How does proprioception play a role when the subject closes their eyes?
4. How easily is the subject thrown "off-balance"? Is it easier to balance using one side or the other? If so, which side works better? Why?
5. What muscles are activated during each of the exercises?

Optional Standing Exercises

1. Left Arm Out

1. Repeat Exercise A, this time lifting the left arm straight out to the side.
2. Click AutoScale on all channels to amplify signals.
3. Repeat steps 1 and 2 with the left arm holding a 5 lb weight..
4. Repeat steps 1 and 2 with the left arm straight out in front.
5. Repeat step 4 holding a 5 lb weight.
6. Click on the Save button to save the data file.

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2. Right Arm Out

1. Repeat Exercise C, this time using the right arm.
2. Click AutoScale on all channels to amplify signals.
3. Click on the Save button to save the data file.

Exercise 2: Other Activities

Aim: To study the EMG activity and balance while performing other activities. Create your own hypotheses about these activities. What do you think will happen to the subject's balance? To the subject's EMG activity?

Approximate Time: 15 minutes per activity

Procedure

1. Use the same experimental setup used in Exercise 1.
2. Choose different muscles to use:
    - Quadriceps: use the Vastus medialis and Rectus femoris
    - Hamstrings: use the Semimembranosus or Semitendinosus and Biceps femoris
    - Gastrocnemius, Gluteus medius or Tensor fascia latae
    - Rectus abdominus (to look at core)
3. Choose a different activity:
    - Try using a hula hoop
    - Lift the leg out to the side
    - Pass a small medicine ball back and forth to a partner
    - Play Pat-a-cake or other fast hand game
    - Other ideas???

Data Analysis

1. Use the same procedures used in Exercise 1 to measure and record the Abs. Int. and T2-T1 from each muscle when using a different targeted muscle groups.
2. Always look at the graph for what is occurring on the balance board and look at the data for center of gravity and how well you are maintaining your balance.

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