Experiment HM-12: Wii Balance Board and EMG Activity

Background

**Balance:** The ability of the body to achieve a state of equilibrium, in this case ~ equal weight distribution. A good way to measure your balance is to stand on one leg with your arms across your chest and your eyes closed. Check the table below to see how good your balance is:

<table>
<thead>
<tr>
<th>Time (sec)</th>
<th>Balance Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15</td>
<td>Poor</td>
</tr>
<tr>
<td>15-29</td>
<td>Good</td>
</tr>
<tr>
<td>30+</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

Compare both legs. If you are able to balance for 30 sec on each leg, add arm movements to test your balance further or try standing on an uneven surface. Being able to maintain balance with minimal effort will help conserve energy. This energy can then be used for more explosive muscle contractions when performing sports related activities, or other activities in general. Balance can always be improved through practice and training.

**Proprioception:** An awareness of the position of one's body and limbs in space. If you can walk without watching your feet, kick a soccer ball without focusing on the ground, or shake someone's hand without looking your own hand, you're using proprioception. Proprioception is the capacity of the body to determine where all of its parts are positioned at any given time, and it plays an important role in your health and well-being.

Proprioception can be a difficult concept to grasp until you lose it, because so much proprioception occurs subconsciously, as a type of “sixth-sense” about the world around you. The most common symptom of reduced proprioception is poor balance. In this respect, most people can understand the concept that poor balance can be a result of poor proprioception. Even spinal posture has a proprioception component telling you whether or not you are sitting or standing upright. Good posture can be thought of as perfect spinal balance.

**Where does the Wii Balance Board fit into all this?**

Knowing what happens to your balance and center of gravity while doing certain body movements is a great way to train and improve core strength and posture. This lab will focus on standing on the Wii Board and trying to maintain that “perfect” balance while hula hooping, bending over, even holding weights (maybe even while standing on one leg). Use LabScribe to visualize the body action and make corrective adjustments if needed. Find your body's perfect balance.
Experiment HM-12: Wii Balance Board and EMG Activity

Equipment Required
PC or Mac Computer – with Bluetooth enabled
IXTA, USB cable, IXTA power supply
iWire-B3G ECG cable and electrode lead wires *(optional – 2\textsuperscript{nd} iWire-B3G)*
Disposable electrodes
Wii Balance Board
Alcohol swabs
Weights (5 lb)
Hula-Hoop

Start the Software
1. Click on LabScribe
2. Click Settings → Human Muscle → WiiBalance-EMG
3. Once the settings file has been loaded, click the Experiment button on the toolbar to open any of the following documents:
   - Appendix
   - Background
   - Labs
   - Setup (opens automatically)

Subject Attire:
It is important that the subject wear loose comfortable clothing/shorts that allows for the attachment of seven (7) electrodes to the hip area. Bending, stretching, standing and lying down could all be part of the exercise protocols that will be used. Comfortable, loose running shorts are a good choice.

Enabling Bluetooth
1. Open the Bluetooth Manager for your computer.
2. Add the Wii Balance Board as a device. Directions can be found online for your model of computer.
3. Once the Wii Board has been added as a Bluetooth device:
   - Open the Bluetooth Manager
   - Double-click on the Wii Board (Nintendo RVL-WBC-01)
     - Message should appear about syncing the Wii Board to the computer
Press and hold the sync button on the underside of the Wii Board. You may need to remove the battery cover

The Wii Board power light will flash

Click OK

- The bluetooth “connect” symbol will appear on your bluetooth menu (Figure HM-12-S1).

![Figure HM-12-S1: Bluetooth Manager showing the Wii Board connected ans synced to the computer.](image)

**EMG Cable Setup**

1. Locate the iWire-B3G EMG cable and electrode lead wires (Figure HM-12-S2) in the iWorx kit.

![Figure HM-12-S2: The iWire-B3G EMG cable with seven lead wires attached. Five leads or seven may be used for this lab.](image)
**Note - Make sure to connect the iWire-B3G to the IXTA prior to turning it on.**

2. Insert the connector on the end of the iWire box into the iWire 1 input on the front of the IXTA (Figure HM-12-S2).

![iWire-B3G connected to IXTA](image)

*Figure HM-12-S2: A five lead EMG cable connected to an IXTA.*

**Enable the Wii Balance Board**

1. Click “External Devices” menu on the LabScribe toolbar (Figure HM-12-S3)

![External Devices Menu](image)

*Figure HM-12-S3: External Devices Menu*

2. Click Wii Balance Board.
   - When first connecting the Wii Board – go to Setup. Enter the hexadecimal serial number you received from iWorx. You will only need to do this once.
   - Click Enable – you must do this each time you use the Wii Board.


4. After a short time, LabScribe will appear on the computer screen as configured by the WiiBalance-EMG settings (Figure HM-12-S4).

![LabScribe with WiiBalance-EMG settings](image)
Choosing the Muscles for Recording EMG

1. Choose one or two muscle groups on each leg to record EMG activity while doing a variety of activities on the Wii Board. A suggestion is to use opposing pairs of muscles on one leg or the same muscle on each leg, but this is not necessary, and any muscles of choice can be used.

2. 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.
• If using, the third pair of electrodes can be placed on the *Gluteus maximus* muscle. These two electrodes can be placed high on the Gluteus maximus, but below the iliac crest, so as not to interfere with clothing. Make sure the electrodes are at least 2-3 centimeters apart, on the 'meaty' portion of the upper Gluteus maximus. Avoid getting these electrodes on the medius.

• A green electrode, used as the ground, can be placed either on the lower abdomen on the side of whichever leg has been chosen for the electrode placement; or in the center of the square of electrodes when using the Vastus and Rectus muscles.

*NOTE: Any leg muscles may be used in this lab. The muscles listed are just a suggestion. Try the Semitendinosus and the Gastrocnemius as well.*

**Figure HM-12-S5:** Position of electrodes used to record EMG from muscles in the hip during various exercises.
NOTE: If using only one leg, the all the electrodes will be placed on one leg. If using both legs, the ground electrode can be placed on the abdomen or on one of the legs.

3. Use an alcohol swab to clean and scrub the areas where the electrodes will be placed (Figure HM-12-S3). Let the areas dry before attaching the electrodes.

4. Remove the plastic disk from a disposable electrode and apply it to one of the scrubbed areas. Attach an electrode to each of the other areas.

5. Snap the recording lead wires onto the electrodes, so that:
   - the red “+1” and black “-1” leads are attached to the electrodes on the Rectus femoris.
   - the white “+2” and brown “-2” leads are attached to the electrodes on the Vastus lateralis (or the Rectus of the other leg)
   - the blue “+3” and yellow “-3” leads are attached to the electrodes on the Gluteus maximus.
   - the green “C” lead (the ground) is attached to an electrode on the lower abdomen on the side of whichever leg has been chosen for the electrode placement; or in the center of the square of electrodes when using the Vastus and Rectus muscles.

NOTE: An optional 2nd iWire may be used to examine EMG activity from the other leg as well. If using, all the electrodes from one iWire will be on one leg, and the electrodes from the 2nd iWire will be on the other leg.
Experiment HM-12: Wii Balance Board and EMG Activity
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 Wii Board with both feet.
Approximate Time: 60 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 Wii Board, standing with both feet, arms at their sides;
      • Try to maintain balance, without wobbling, for at least 15 seconds;
      • Step off the Wii Board and repeat;
      • Each exercise will be performed for 5 reps.
2. The subject will step on the Wii 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.
   • Front left (FL), back left (BL), front right (FR) and back right (BR) foot placement should be straight lines on the recording.
   • EMG activity of leg muscles should show low level activity as the subject retains muscle tone to stand upright.

A. Left Leg Up
1. Before starting the recording, type the name of the first exercise, <Left Leg Up>, in the Mark box to the right of the Mark button. Instruct the subject to get into position to perform this exercise.
2. Click the Record button in the upper right corner of the LabScribe Main window. 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 “Left Leg Up” exercise.
   - Make sure to engage core muscles;
   - Left the left leg off the Wii Board and hold for 15 seconds;
     - Try to stay as steady as possible;
   - Place the left leg down for 15 seconds;
   - Repeat 4 times.
5. After the 5th rep, place both feet on the Wii Board and regain your center of gravity. Click Stop to halt the recording.
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 Figure HM-12-L1.

![Figure HM-12-L1: Muscle EMG activity and Wii motion as the subject lifts their leg off the Wii Board.](image)

B. Right Leg Up
1. Repeat Exercise A, this time lifting the right leg. Make sure to mark your recording appropriately.
2. Click AutoScale on all channels to amplify signals.
3. Click on the Save button to save the data file.
C. 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.

D. 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.

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 (Figure HM-12-L2).
3. Look at the data on the TL, BL, TR and BR channels.
   • Which leg shows higher activity?
   • Is the subject leaning more to the left or the right?
   • Is the subject balancing more to the front or back of the board?
3. 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-L3).

Figure HM-12-L2: The LabScribe toolbar.
4. 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.

5. 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.
   - Use the right and left arrow keys to get the cursors exactly 5 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 a 5 second interval.

6. 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.

7. The values for Abs. Int. and T2-T1 on the channels are the relative amounts of the EMG activity during a 5 second period in which the EMG burst occurred.

8. Record the values from each muscle group during the first EMG burst in the Journal, or on a data table.

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 data analysis.
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? (Figure HM-12-L4)

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 lateralis, Vastus medialis and Rectus femoris
   - Hamstrings: use the Semimembranosus, Semitendinosus and Biceps femoris
   - Gastrocnemius, Gluteus medius, Tensor fascia latae
   - Rectus abdominus (to look at core)
3. Choose a different activity:
   - Try using a hula hoop
   - Bend at the waist

Figure HM-12-L3: EMG activity while the subject is raising the right leg. The cursors are placed to measure the Abs.Int of the muscle activity. The muscle with the highest activity is the muscle firing the strongest.
• 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
• Pretend to ski or ski jump (like in the Wii games)
• Other ideas???

**Figure HM-12-L4:** EMG activity and Wii Board motion during one of the optional activities. Can you guess which one this is??

**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 Wii board and look at the data for TL, BL, TR and BR.

**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 Exercises
Using the 2nd iWire-B3G

- Test the subject bilaterally
- Choose an additional 3 muscles to test at the same time
  - an example: test both the quads and hamstrings simultaneously