Your First BrainBLoX Activity: Balance and the Whole-Body Center of Mass

The purpose of this activity is to provide a gentle introduction to how to use BrainBLoX. In this simple exercise, you will determine the location of the whole-body center of mass (COM) and demonstrate the effect of sensory feedback on the ability to control the COM. The center of mass represents the point about which the mass is equally distributed. Thus, it is possible to perform a static analysis to determine the coordinates of the COM. The goal today is to find the COM location in two-dimensions. Using BrainBLoX and a Nintendo Wii balance board, you will measure changes in COM position over time.

Learning Goals

- Balance involves the control of the motion of the COM.
- Sensory feedback affects our ability to balance, (i.e. to control) the COM when standing.

Effect of Vision on Quiet Stance

To balance during upright stance we need to control our center of mass and maintain its position above our base of support which is usually represented by the outline of our feet. We are heavily reliant on sensory information in order to execute this control. In this activity we will use a Nintendo Wii Balance Board to observe, in real-time, the effect of sensory feedback or lack of sensory feedback on the ability to maintain the center of mass within our base of support. We will also examine how modifying the base of support affects the ability to maintain balance. The Wii Balance Board measures the location of the center of pressure (COP) which is the weighted average location of the forces acting on your feet. For small movements, the center of pressure provides a good approximation of the location of the center of mass (COM) in two dimensions in the transverse plane. Thus, for small movements, the balance board can provide us with an approximate measure of how the center of mass position changes over time.

Instructions

The balance board should already be connected and the BrainBLOX software loaded. Your screen should look like that of the screenshots on the back pages of the activity. These screen shots will help you identify which buttons are which and their associated functionality. You are encouraged to reference these pages as you work through this portion of the lab. There are also screenshots on each page to help you navigate the software as you move through the activity.

Part 1: Navigating the Software

1. First, let's spend a moment becoming acquainted with the software. Use the figure labeled Part 1 (on the last page or this handout) to help you navigate this part of the activity.

   On the computer in the BrainBLOX software, you should see a small green cursor in the middle of the white screen. Step on each the four corners of the board and watch the cursor on the screen move to each respective corner.

   The white screen that composes the left two thirds of the software interface is called the **Plot Region**. The **Plot Region** has four tabs on the right of the screen, each with a different presentation of the data. The two tabs that you will be using are the 'Recent Trace' tab which displays the real-time COM location, and the 'Full Plot' tab which displays the entire history of COM movement after a recording.

   The right-most third of the interface is called the **Control Panel**, this houses all of the toggles and controls that you will use to interact and manipulate data presentation. The collective stream of data coming from the Wii Balance Board is referred to as a channel of data; because we have one Balance Board we have one channel to record data.

2. Check the box labeled "Proportional" in the Recording Panel on the right of the screen. The cursor should increase in size as you push harder or bounce up and down on the Balance Board, The changing radius indicates relative change in magnitude of weight pushing down on the balance board.

3. Test the Wii Balance Board functionality. Have one person stand on the board.

   a. Move around and observe how cursor moves with weight shifts.

   b. Change the 'Fade Color' by clicking on the color block to the right of the 'Fade Color' text (default color is white). A color selection window will appear; select a color and click 'OK', this will close out the window and set the 'Fade Color' to the color of your choosing.

   c. Press the 'Record' button and have a person shift their weight around on the board. During recording you will notice the cursor now has a tail which will fade from the default green set for the 'Recent Plot' color to the 'Fade Color' you selected in the previous step. The presence of this tail will help you remember if you are or are not presently recording. When you are finished hit 'Record' again to stop.

   d. Click the 'Full Trace' tab on the right of the plot region to view the full trace of the COM movement during the recording.

   e. Hit the 'Clear All' button near the top of the control panel to remove all recordings.

   f. Click the 'Recent Trace' tab on the right of the plot region to return to real-time data observation.

Part 2: Recording and Collecting Data for COM Shift in Quiet Stance on Two-Legs

4. Recording Trial 1 (Eyes Open): use the figure labeled 'Part 2' (on the last page or this handout) to help you locate the toggles and controls for each of the steps in recording. All data should be recorded in the Data Table located at the end of the instructions.

    a. Set the 'Record Time' at the top of the panel to 0:00:10 (10 seconds).

    b. Subject should stand quietly on the balance board with their feet together and arms folded across their chest. When recording is finished the subject should not change position or move their feet on the balance board before the next trial.

    c. When ready, another person should press the 'Start All' button and let the subject know recording has begun and will continue for 10 seconds.

    d. Once the ten seconds has elapsed and the recording has concluded, use the information for maximum and minimum changes in distance of the COM in the X and Y directions as well as the mean to complete the corresponding column in the Data Table.

5. Cloning the channel is another way of saying "copying' the channel. The following steps will allow you to make a copy of the channel in order to compare the second set of data you will record to the first data you just recorded.
    a. The numbered tabs on the control panel are called channels. The default channel is labeled '1'. You can only record data in channel '1', but we can make a copy of the data you just recorded so that you can collect more data without losing any previously recorded data.
    b. Hit the 'Clone' button to make a copy of the channel. You will now see a second tab labeled '-1' to the right of the channel '1' tab. This is the copy.
    c. In order to record new data without viewing the data you already collected you need to un-check the checkboxes labeled 'Show History' and 'Recent Plot' in the copy channel, which again is labeled '-1'. You can ensure you are looking at the original data and not the copy because in the copy channel the 'Zero Sensors' and 'Record' buttons are toggled off so you cannot click on them.
    d. Click the channel '1' tab to take data for a second trial.
    e. MAKE SURE YOU ARE IN THE CHANNEL '1' TAB!
    Click the 'Clear' button. This clears the channel so that you are ready to collect another trial.

6. Recording Trial 2 (Eyes Closed):

    a. Change the color of the Full Trace for this trial to something different than the previous trial so that we can easily distinguish between the two trials when overlaying them on the same plot (the default is blue for the full plot). Change the Full Trace color by clicking the color box across from the 'Full Plot' check box. Again, a new color selection window will open; select a new color and click 'OK' to set the color choice and close the window.

    b. Change the 'Record Time' to 10 seconds as done in step 4a.

c. Subject should stand quietly on the balance board with their feet together and arms folded across their chest and their **eyes closed**. The subject can move around and step off the board once the second trial is completed.

d. When ready, initiate the timed recording as done in step 4c, another person should press the 'Start All' button and let the subject know the recording has begun and will continue for 10 seconds.

e. Once the ten seconds has elapsed and the recording has concluded, use the information for maximum and minimum changes in distance of the COM in the X and Y directions as well as the mean to complete the corresponding column in the data table on the Data Collection Sheet as done in step 4d.

7. Compare the two traces

   a. Click on the 'Full Trace' tab in the plot region. This will show you the entire path of COM movement during each trial, the second trial corresponding to the 'Full Plot' color you chose in step 6a.

   b. Use the overlay of the two traces from each trial to help you answer the questions on the Data Collection Sheet.

8. OPTIONAL: If you want to save your data, click the 'Save" button (below the 'Zero Sensors' panel) to save the data from this trial to the desktop. This will bring up a 'Save filename' window, click on the 'Desktop' icon on the left side to select the desktop as your saving location, type the filename in the white box near the bottom of the window with the name 'Trial01' (No file extension is needed). Click 'Save' in the lower right-hand corner to save the data and close the window. You can do this for each channel separately by clicking on its respective tab.

9. Click the 'Clear All' button near the top of the panel to remove all recordings.

10. Click the 'Recent Trace' tab to the right of the plot region to return to real-time data collection.

Data Table: Part 2: Two-Legs Data

Parameters	Trial 1 (Eyes Open)	Trial 2 (Eyes Closed)
X Max (cm)		
X Min (cm)		
X Range (cm) = X Max – X Min		
X mean (cm)		
Y Max (cm)		
Y Min (cm)		
Y Range (cm) = Y Max – Y Min		
Y mean (cm)		

1. Is this what you expected?

2. If you were standing only on one leg, what would you expect to see? How would the range and mean change? Would they change at all?

Part 3: Recording and Collecting Data for COM Shift in Quiet Stance on One-Leg

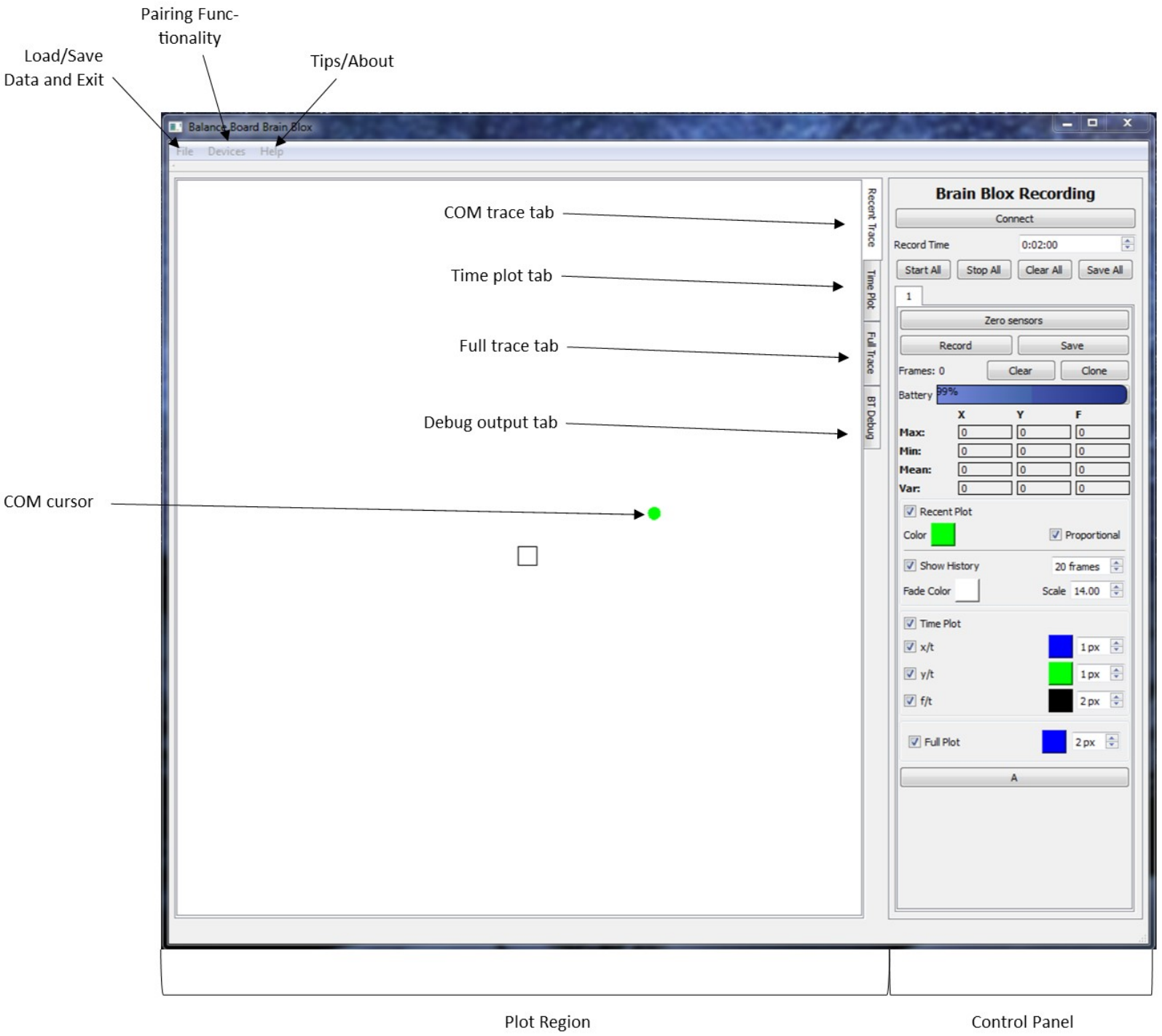
Repeat steps 4-10, but this time have the subject stand on one leg with their arms across their chest. Use the data to fill out the appropriate tables on the data collection sheet and answer the corresponding questions.

Data Table: Part 3: One-Leg Data

Parameters	Trial 1 (Eyes Open)	Trial 2 (Eyes Closed)
X Max (cm)		
X Min (cm)		
X Range (cm) = X Max – X Min		
X mean (cm)		
Y Max (cm)		
Y Min (cm)		
Y Range (cm) = Y Max – Y Min		
Y mean (cm)		

3. Is this what you expected?

4. Compare your results for standing on one-leg and standing on two-legs. What does the change in X and Y range mean? What about change in X and Y mean?


Load/Save
Data and Exit
Pairing Func-
tionality
Tips/About
Balance Board Brain Blox
File
Devices
Help
COM trace tab
Time plot tab
Full trace tab
Debug output tab
COM cursor
Recent Trace
Time Plot
Full Trace
BT Debug
Brain Blox Recording
Connect
Record Time
0:02:00
Start All
Stop All
Clear All
Save All
1
Zero sensors
Record
Save
Frames: 0
Clear
Clone
Battery
99%
X
Y
F
Max:
Min:
Mean:
Var:
Recent Plot
Color
Proportional
Show History
20 frames
Fade Color
Scale
14.00
Time Plot
x/t
1 px
y/t
1 px
f/t
2 px
Full Plot
2 px
A
Plot Region
Control Panel

Overview of Control Panel Functionality