

# Balance

Maintaining physical balance is a complex task mediated by input from multiple sensory input sources. While the vestibular system is responsible for detecting the location and movement of the head in three dimensional space, input from proprioceptors regarding limb location and joint position, as well as input from the visual system, are also very important. When one of these input sources is distorted or removed, it becomes difficult to maintain balance, especially in challenging situations. The sensation of losing one's balance typically results in compensatory movements of the body as the subject tries to regain stability. These movements can be measured to determine how well a subject is able to maintain balance under different conditions. Less stability results in larger and more frequent movements.

In this experiment, you will explore your ability to balance with and without visual input using a Force and Acceleration Sensor to detect movement (measured here as acceleration). You will also compare your balance when standing on one foot at a time and determine whether there is any difference between balancing on your right and left feet.

## OBJECTIVES

- Measure your stability while attempting to balance with your eyes open and closed.
- Compare your ability to balance on your right and left feet with eyes open and closed.

## MATERIALS

Chromebook, computer, **or** mobile device  
Graphical Analysis 4 app  
Go Direct Force and Acceleration

## PROCEDURE

Select one person from your lab group to be the subject. **Important:** Do not attempt this experiment if you have a physiological condition that affects your balance.

### Part I Balance on two feet

1. Connect and set up the sensor.
  - a. Launch Graphical Analysis.
  - b. Connect Go Direct Force and Acceleration to your Chromebook, computer, or mobile device.
  - c. Click or tap Sensor Channels. Deselect the default Force channel and select the X-axis acceleration channel.
  - d. Click or tap Done.

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2. Set up the data-collection mode.
  - a. Click or tap Mode to open data-collection settings.
  - b. Change Rate to 100 samples/s and End Collection to 30 s.
  - c. Click or tap Done.
3. The subject should slip the sensor into the pocket of his or her pants with the hook pointing up. Alternately, the sensor can be taped or tied to the subject's thigh.
4. The subject should stand with both feet firmly on the floor and look at a fixed point on the wall. They should not look at the screen.
5. Click or tap Collect to start data collection. At 10s, instruct the subject to close their eyes. Continue data collection while they keep their eyes closed for the next 20 s.
6. Determine the change in movement for standing on both feet, eyes open.
  - a. Select the area of the graph where eyes were open (from 0 to 10 s). This will highlight the region of interest.
  - b. Click or tap Graph Tools, , and choose View Statistics.
  - c. Record the  $\Delta y$  for acceleration ( $\text{m/s}^2$ ) in Table 1.
  - d. Dismiss the Statistics box.
7. Determine the change in movement for standing on both feet, eyes closed.
  - a. Select the area of the graph where eyes were closed (from 10 to 30 s).
  - b. Click or tap Graph Tools, , and choose View Statistics.
  - c. Record the  $\Delta y$  for acceleration ( $\text{m/s}^2$ ) in Table 1.

### Part II Balance on one foot

8. The subject should slip the sensor into a pocket on the left side of his or her pants, with the hook pointing up. Alternately, the sensor can be taped or tied to the left leg.
9. The subject should stand on their left foot while raising their right foot off the floor and looking at a fixed point on the wall. He or she should not look at the screen.
10. Click or tap Collect to start data collection. At 10s, instruct the subject to close their eyes. Continue data collection while they keep their eyes closed for the next 20 s or until they put their right foot down or open their eyes.
11. Determine the change in movement for standing on the left foot, eyes open.
  - a. Select the area of the graph where eyes were open (from 0 to 10 s).
  - b. Click or tap Graph Tools, , and choose View Statistics.
  - c. Record the  $\Delta y$  for acceleration ( $\text{m/s}^2$ ) in Table 2.
  - d. Dismiss the Statistics box.
12. Determine the change in movement for standing on the left foot, eyes closed.
  - a. Select the area of the graph where eyes were closed (from 10 to 30 s).
  - b. Click or tap Graph Tools, , and choose View Statistics.
  - c. Record the  $\Delta y$  for acceleration ( $\text{m/s}^2$ ) in Table 2.

13. Repeat Steps 8–12, but standing on the right foot with the Force and Acceleration sensor on the right side.

## DATA

	Acceleration (m/s <sup>2</sup> )
Eyes open	
Eyes closed	

	Standing on left foot Acceleration (m/s <sup>2</sup> )	Standing on right foot Acceleration (m/s <sup>2</sup> )
Eyes open		
Eyes closed		

## DATA ANALYSIS

1. Balance is usually easiest to maintain while standing on both feet with eyes open. How did the amount of movement differ with and without visual input when standing on both feet?
2. When standing on one foot, how did the amount of movement differ with and without visual input?
3. Was balance easier to maintain standing on one foot than the other? Which was easier?
4. What types of activities might help improve balance?

## EXTENSIONS

1. Design an experiment that compares balance while holding a heavy object on one side of the body versus the other side.
2. Design an experiment that tests balance with arms held in different positions (e.g., held close to the body, extended out to the sides, raised over head).

Sample