

# Balance



**Figure 1** Balancing on one foot on a balance beam

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 plate to detect movement. 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 or left foot.

## Objectives


- Use digital tools to measure forces that are applied by the foot while balancing.
- Analyze and interpret a graph to identify patterns of motion.
- Analyze and interpret data to make claims about how visual system inputs affect balance.

## Materials

- ☐ Chromebook™, computer, or mobile device
- ☐ Vernier Graphical Analysis app
- ☐ Go Direct Force Plate

# Investigation

## Set up for data collection

1. To ease set up, visit [www.vernier.com/til/19319](http://www.vernier.com/til/19319) and download the file called **Balance-Template**, found at the bottom of the page.
2. Set up Graphical Analysis and your sensor:
  - a. Launch Graphical Analysis and click **Choose File**.
  - b. Open the **Balance-Template** file.
  - c. Click Sensor Setup, .
  - d. Find your force plate in the list of available devices and click **Connect**.


### Tips

- The ID is located on the label of your force plate.
  - Make sure the force plate is powered on (red blinking LED) and that Bluetooth is enabled on your device.
- e. Click **Done**.
3. Select one person from your group to be the subject. **Important:** Do not volunteer if you have a physiological condition that affects your balance.
  4. **Safety check:** During data collection, the subject will be balancing with their eyes closed. Make sure the testing area is free of furniture or objects that could harm the person if they lose their balance.
  5. Calibrate the sensor to normalize the readings to the subject's mass:
    - a. Have the subject stand with both feet firmly on the force plate and look at a fixed point on the wall. They should not look at the screen.
    - b. Click one of the meters (X-axis Balance or Y-axis Balance) and choose **Calibrate**.
    - c. With the subject standing still, click **Calibrate Now**. The app will take readings for several seconds and set the value to 0 for both channels. You do not need to calibrate the other channel.


## Investigation Part 1: Balance on two feet

In this part, you will collect data for balancing on two feet, first with eyes open and then with eyes closed.

6. Collect data for eyes open:
  - a. Have the subject stand with both feet firmly on the force plate, looking at a fixed point on the wall. They should not look at the screen.
  - b. Start data collection. Data will be collected for 30 seconds and will stop automatically.
7. Collect data for eyes closed:
  - a. Have the subject stand with both feet firmly on the force plate, but this time, they should close their eyes.
  - b. When they are ready, start data collection. **Note:** The previous data set will be stored automatically.

8. Analyze and record data.
  - a. To display both data sets, click the y-axis label. Make sure both data sets are turned on.
  - b. Click Graph Options, , and choose **View Statistics**.
  - c. Record the standard deviation for both data sets in Table 1.

## Investigation Part 2: Balance on one foot

9. In this part, you will collect data for balancing on one foot, first with eyes open and then with eyes closed. It is not unusual for the subject to lose their balance. Assign someone to be a spotter to help the subject if they lose their balance.
10. Calibrate the sensor:
  - a. Have the subject stand on their left foot in the middle of the force plate.
  - b. Click **Calibrate**. The app will take readings for several seconds and set the value to 0 for both meters.
11. Collect data for eyes open:
  - a. Have the subject stand on the left foot, looking at a fixed point on the wall. They should not look at the screen.
  - b. When the subject is ready, start data collection. Data collection will stop automatically after 30 seconds, but if the person loses balance and touches the floor, stop data collection early.
12. Collect data for eyes closed:
  - a. Have the subject stand on their left foot again, with their eyes closed.
  - b. When they are ready, start data collection. Data collection will stop automatically after 30 seconds, but if the person loses balance and touches the floor, stop data collection early.
13. Analyze and record data for eyes open and eyes closed:
  - a. To display both data sets, click the y-axis label. Turn on the data sets for balancing on one foot, eyes open and eyes closed.
  - b. Click Graph Options, , and choose **View Statistics**.
  - c. Record the standard deviation for both data sets in Table 2.
14. Repeat part 2 (including the calibration step) with the subject standing on the right foot.

# Data

Table 1: Balance on Both Feet	
	Standard deviation
Eyes open	
Eyes closed	

Table 2: Balance on One Foot	
	Standard deviation
Left foot, eyes open	
Left foot, eyes closed	
Right foot, eyes open	
Right foot, eyes closed	

## 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. It is often more difficult to maintain balance when standing on one foot. Describe how the movement differed when balancing on one foot with and without visual input. You may choose to include a graph of your data as evidence.
3. Was balance easier to maintain standing on one foot than the other? Which was easier? Why do you think so?
4. What types of activities might help improve balance? Why?

## 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 overhead).