

## Interpreting Graphs

As part of the scientific process, it is necessary to interpret data. Graphs can be a useful tool in identifying trends in data that may indicate a relationship between the variables you are studying. In this activity, you will investigate relationships among grip strength, hand temperature, gender, handedness, and perception of hand strength.

### Objectives

During this activity you will:

- Interpret information from InspireData™ plots of different types
- Investigate relationships among variables from data collected using Vernier sensors

### About the Data

An experiment was done using Vernier Surface Temperature Sensors and Hand Dynamometers. Hand Dynamometers measure the strength of your grip in newtons, a unit of force. The temperature probes were attached to the sides of the dynamometers so that the test subject's hand covered the probe when they held the dynamometer (see Figure 1). Participants were required to stand during data collection and had to squeeze both hand dynamometers, as hard as they could, for 10 seconds.



*Figure 1 – Vernier Hand Dynamometers and Surface Temperature Sensors used in this activity*

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The average grip force and temperature for each hand was measured by the sensors. The test subject's gender, handedness (which hand they write with), and perceived stronger hand were recorded (see Figure 2). Additional data columns were generated from the data to support the InspireData plots used in this activity.

Gender	Writing Hand	Perceived Stronger Hand?	Left Grip (N)	Left Temp (C)	Right Grip (N)	Right Temp (C)	Measured Stronger Hand	Strongest Grip (N)	
♂	Male	Right	Right	263.8	32.7	291.8	31.8	Right	291.8
♂	Male	Right	Right	236.2	31.3	290.7	30.0	Right	290.7
♂	Male	Right	Right	205.6	32.4	282.0	32.8	Right	282.0
♂	Male	Right	Right	398.8	34.0	415.3	34.3	Right	415.3
♂	Male	Left	Left	138.0	32.6	187.6	34.2	Right	187.6
♀	Female	Right	Right	80.3	30.8	60.6	30.0	Left	80.3
♀	Female	Right	Right	69.9	32.2	83.3	33.8	Right	83.3
♀	Female	Right	Right	147.7	32.7	158.2	33.1	Right	158.2
♀	Female	Right	Right	130.5	31.4	114.7	32.5	Left	130.5
♀	Female	Right	Right	91.9	32.0	163.1	32.5	Right	163.1
♀	Female	Right	Right	87.9	32.1	140.9	32.3	Right	140.9
♀	Female	Left	Left	142.7	31.1	117.2	30.6	Left	142.7
♀	Female	Right	Right	136.3	33.4	152.3	33.3	Right	152.3
♂	Male	Right	Right	165.7	30.3	210.1	28.0	Right	210.1
♂	Male	Right	Right	287.6	29.7	317.9	28.2	Right	317.9
♂	Male	Right	Right	200.8	32.3	221.9	31.2	Right	221.9
♂	Male	Right	Right	355.0	32.4	299.5	32.1	Left	355.0
♂	Male	Left	Left	234.3	32.0	199.2	32.0	Left	234.3
♀	Female	Right	Right	167.7	33.2	210.4	33.8	Right	210.4
♀	Female	Right	Right	71.9	31.5	74.9	31.3	Right	74.9
♀	Female	Left	Left	73.1	29.8	77.9	28.6	Right	77.9
♂	Male	Left	Left	216.2	31.2	178.6	31.2	Left	216.2
♂	Male	Right	Right	167.6	31.0	201.1	31.0	Right	201.1
♂	Male	Left	Right	154.7	31.9	186.4	31.7	Right	186.4
♂	Male	Right	Left	143.2	30.7	156.7	30.7	Right	156.7
♀	Female	Right	Right	150.8	30.4	179.5	30.4	Right	179.5
♀	Female	Right	Right	110.0	32.0	121.0	32.0	Right	121.0

Figure 2 – InspireData database

## Questions

Base your answers to questions 1-3 on the data table shown in Figure 2.

1. How many test subjects were male? How many were female? How many were left handed? How many were right handed?
2. The icon used for each participant is coded, based on the data, to give additional information when looking at the graphs. Generate a legend for the icons.
3. How was the data in the column "Strongest Grip" determined?

The graph below was generated to show relationships among the survey questions asked.

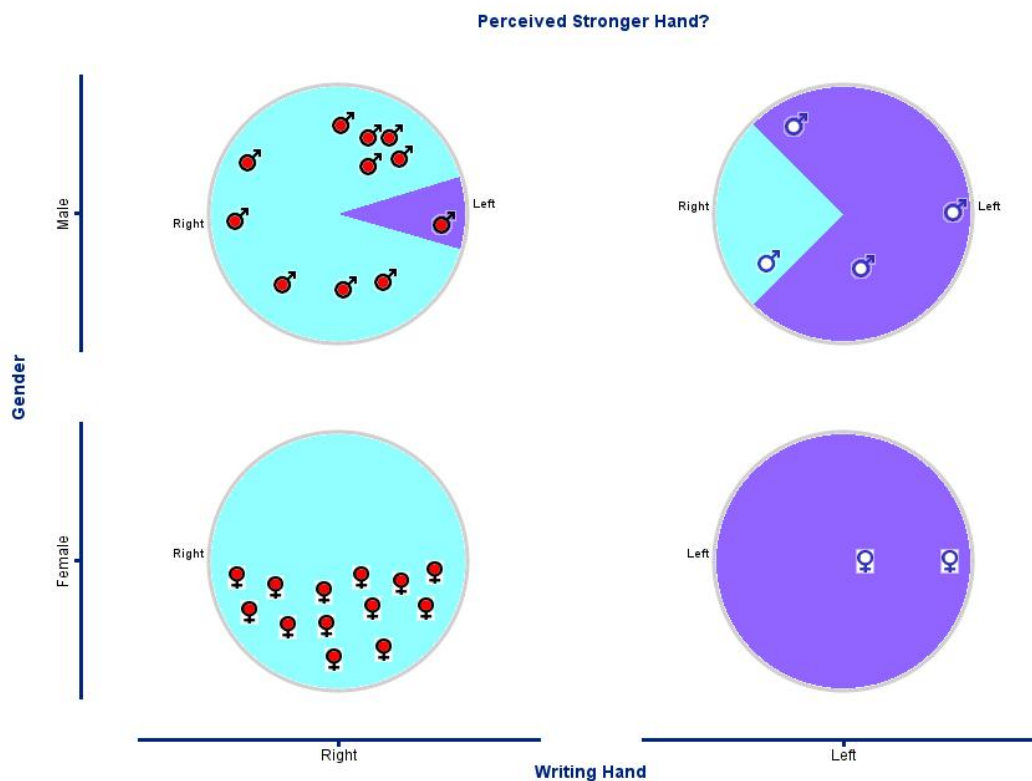


Figure 3 – InspireData Pie Plot

Base your answers to questions 4-8 on the graph in Figure 3.

4. Does the legend you created in question 2 match the data shown in this graph? Explain your reasoning.
5. What percent of the participants perceived their stronger hand to be the hand they write with? What percent of males? What percent of females? What percent of right-handers? What percent of left-handers?
6. Describe two ways the graph visually shows the percentages you determined in question 5.
7. What is wrong with the statement, "More males are left handed?" Modify the statement so that it is correct.
8. Write an accurate statement about the data that is supported by the graph.



The following graph shows information about the relationship between measured stronger grip and gender of the participant.

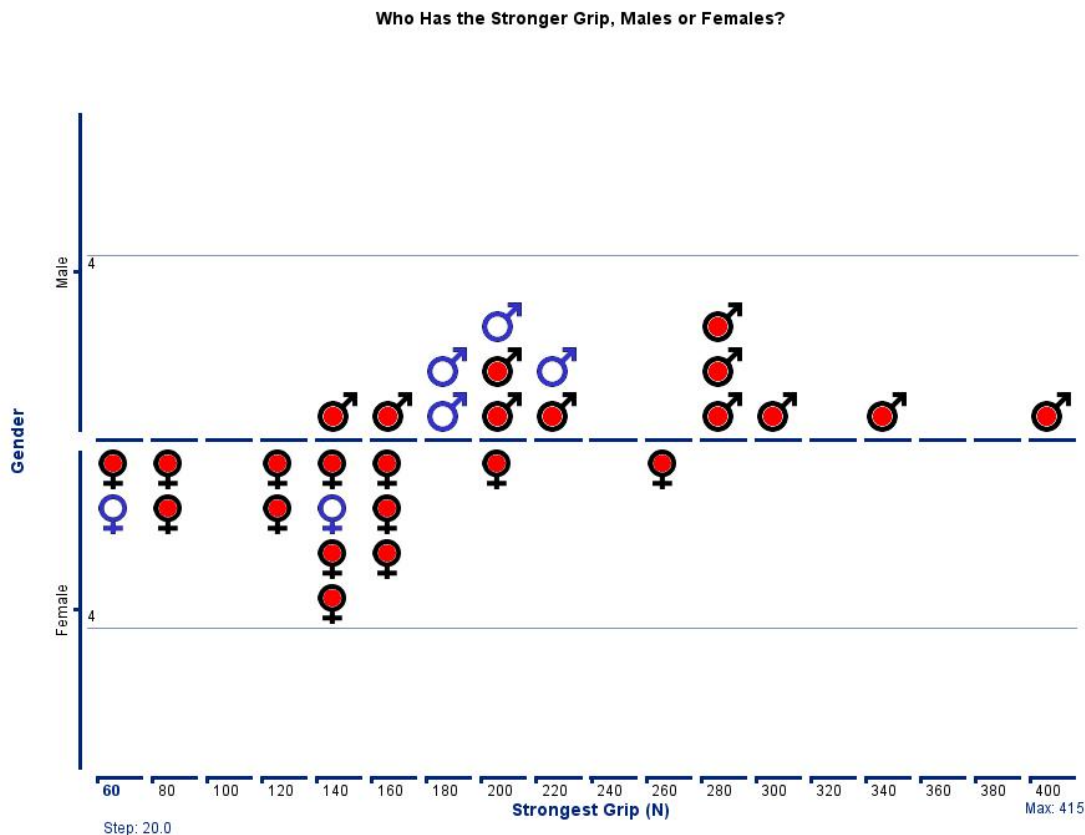


Figure 5 – InspireData Free Plot

Base your answers to questions 14-17 on the graph in Figure 5.

14. Write two conclusions you can draw from the graph?
15. Besides gender, identify two other factors that could influence grip strength?
16. Describe how you might modify this experiment to determine if the factors you listed in question 15 influence grip strength.
17. This experiment used the average grip force measured over a 10-second period as a measure of grip strength. Is this a fair way to measure someone's strength? Are there other factors that should be considered?



22. Locate the points (30, 30) and (33, 33) on the graph and use a ruler to draw a line that connects these points. What does it mean if a point is on this line? What does it mean if a point is above this line? What does it mean if a point is below this line?
23. How many points are on, above, and below the line you drew in question 22. Verify this using the data table (see Figure 2). What conclusions can you draw from this? Explain your reasoning.

*For questions 24–29, create at least one graph that can be used to support your answer. Identify any new columns of data you created in order to build your graphs.*

24. Do females have colder hands than males?
25. Which group, males or females, have the greatest difference in hand strength between their left hand and their right hand?
26. How likely is it to have your writing hand, your strongest hand, and your warmest hand all be your right hand?
27. Is there a relationship between your warmest hand and your strongest hand?
28. Do the people with the greatest difference in hand temperature (comparing left to right) have the greatest difference in hand strength?
29. Is hand temperature a good predictor of hand strength?

## Extension

Collect your own data to investigate some related topics. Here are a few ideas to get you started:

- Does your hand strength depend on the sport(s) you play?
- Does your hand strength depend on your occupation?
- Does greater hand strength in males compared to females depend on age?
- Is there a relationship between grip strength and how long you can hold a grip (fatigue)?
- Are older left-handed people less, equal, or more likely to show differences in hand strength (comparing left to right) than younger left-handed people?
- Is there a relationship between hand strength, hand temperature, handedness, and ethnicity?