

A Bang to the Head

..... just add students™

Part I: Jose's Story

Just before his 16th birthday, Jose collided with another player during a soccer game. In the video of the game, the collision looked harmless. Jose was slow to get up, but he did not lose consciousness. After a minute or two he stood up and was able to walk and talk. He told his coach that his head hurt but he felt he was fine to return to the game. Ten minutes later, however, he had a seizure and then lost consciousness.

The coach didn't know that one week earlier Jose had hit his head on the pavement when he fell off his skateboard. Following this accident, he had headaches and difficulty sleeping. He also found it difficult to concentrate. He did not report his symptoms to his parents or his coach. He never saw a doctor or even the school nurse for his symptoms.

A year after the soccer accident, Jose still has problems with his vision, coordination, memory, and concentration.

1. Do you think that Jose had a concussion? _____

Underline four parts of Jose's Story that support your answer.

2. List three things that you know about concussions.

- _____
- _____
- _____

3. List five kinds of activities that can cause a concussion.

- _____
- _____
- _____
- _____
- _____

Part 2: Concussion Quiz

Use the information in the **Concussion Fact Sheet** and **Concussion: What Happens to the Brain and Nerve Cells?** to answer the questions below. Mark each of the following statements as True (T) or False (F).

1. _____ A concussion is a brain injury.
2. _____ Concussions can be caused by a fall, a bump, or blow to the head or body.
3. _____ A blow to the head is not dangerous unless it results in a loss of consciousness.
4. _____ Concussions are less dangerous for children and teens.
5. _____ Concussions can occur in any sport or recreational activity.
6. _____ Some people may not feel or report their symptoms until hours or days after the injury.
7. _____ Following a coach's rules for safety and rules of the sport, practicing good sportsmanship at all times, and using proper protective equipment are all ways that athletes can reduce the risks for a concussion.
8. _____ Careful observation and testing of mental abilities is important for accurate diagnosis of a concussion.
9. _____ Nausea, headaches, sensitivity to light or noise, and difficulty concentrating are some symptoms of a concussion.
10. _____ Athletes who have a concussion should not return to play until they are symptom free and have received approval from a doctor or health care professional.
11. _____ A repeat concussion that occurs before the brain recovers from the first concussion can slow recovery or increase the likelihood of having long-term problems.
12. _____ X-rays or brain-imaging techniques such as CAT scans or MRI's are the best way to diagnose a concussion.
13. _____ Some symptoms of concussions may not appear until days or even weeks after the injury.
14. _____ Rest, avoiding physical activity, and avoiding activities that involve a lot of concentration help a person recover from a concussion.

Quiz Modified from: *A Quiz for Coaches, Athletes, and Parents* http://www.cdc.gov/concussion/pdf/quiz_Eng.pdf

Part 3: A Blood Test for Concussions?

Blood Tests Could Help Diagnose Concussions

Blood vessels that supply oxygen and nutrients to the brain also protect the neurons from outside molecules. This protection is due to the presence of a blood-brain barrier which acts as a “gatekeeper” allowing entry for the good molecules and keeping out the harmful molecules.

Researchers have identified a brain protein, named S100B, which is highly concentrated in the brain and cerebrospinal fluid. If the blood-brain barrier is damaged, S100B protein appears in the bloodstream within a minute.

Because symptoms of a concussion may not appear until hours or days after brain injury, they may not provide a timely and accurate diagnosis for a concussion. Researchers hope to develop a blood test that will enable doctors to quickly and accurately diagnose a concussion to determine if it is safe for a player to return to the game.

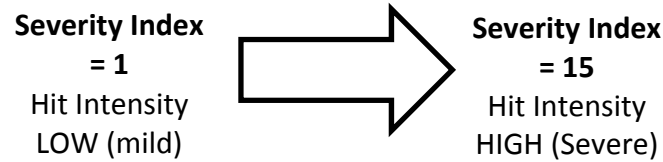
Scientists are conducting research to see if the level of S100B protein in the blood could be used to determine if a concussion has occurred. For this research, football players volunteered to wear helmets with sensors inside them to record the number and severity of hits to the players' heads. The players' blood levels of S100B protein were tested before and after a football game.

1. Why is it important to have a blood test for concussions?

2. The last page of this lab is a **Player Information Sheet** with information on 9 football players who volunteered to participate in the research study. The information on this sheet describes data collected during and at the end of a football game.

Note: To make recording data on this sheet easier, you may tear this sheet off.

3. During the football game, the players wore special helmets that recorded the intensity of each hit to the head during the game. For each player, calculate the average hit intensity (also known as the Severity Index, or SI). Record the average hit intensity for each player on the Player Information sheet.



4. You will test the blood plasma collected at the end of the game to determine the S100B levels in Players 1–4. The S100B Levels at the end of the game for Players 5 through 9 have already been tested and recorded on the Player Information sheet.
- Dip a piece of S100B Test Paper into each of the blood plasma samples from Players 1–4 provided in your kit. Remove the test paper and immediately compare the color of the test paper with the colors on the S100B Levels color chart.
 - Record the S100B level information for players 1–4 on the Player Information sheet.
5. Use the information from the Player Information Sheet to complete the data table below.

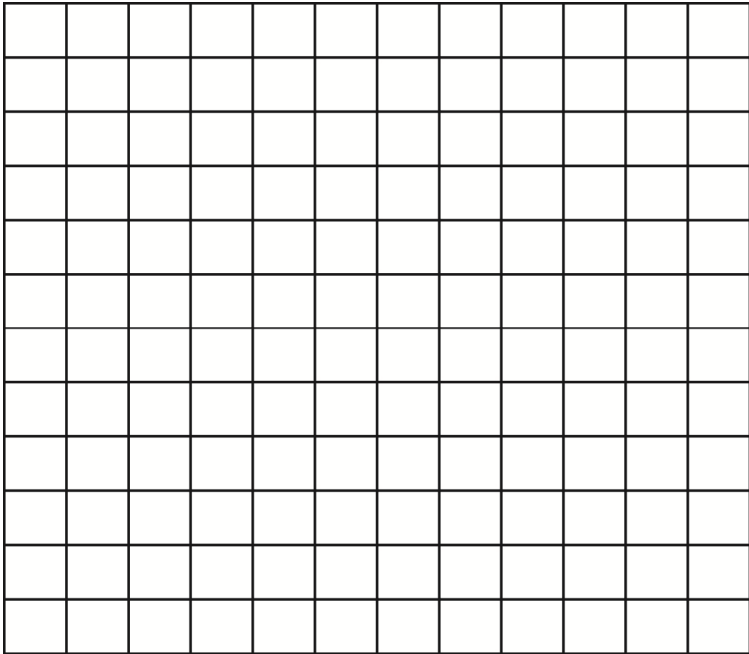
Player Number	<i>Average Hit Intensity (SI = Severity Index)</i>	<i>S100 B level in blood (mg/ml)</i>
1		
2		
3		
4		
5		
6		
7		
8		
9		

6. Researchers would like to know if testing blood for S100B protein levels could be used to accurately diagnose concussions. To answer this question, you will make a **scatter plot** graph of your data to determine if there is a correlation between high S100B levels and high hit intensity.

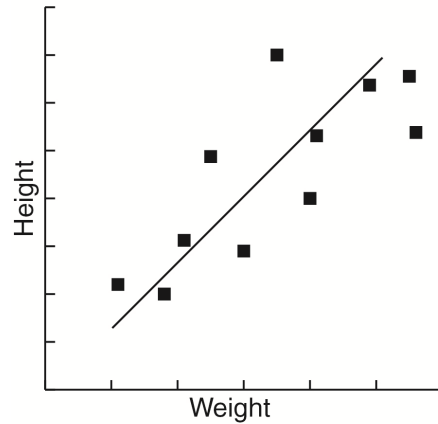
A **Scatter Plot** is a graph of plotted data points that show whether there is a correlation between two sets of data. For example, the scatter plot shown on the right shows the correlation between peoples' weight and height.

7. Use the graph grid below to make a **scatter plot** of the data in the data table.
- Label the horizontal axis (x-axis) with the independent variable: **Average Hit Intensity (SI = Severity Index)**. Include an appropriate scale.
 - Label the vertical axis (y-axis) with the dependent variable: **S100B Level (mg/mL)**. Include an appropriate scale.
 - Plot the data from the data table on the previous page. Draw a small circle around each of the plotted points.
 - Do not include the player numbers.
 - Do not connect the dots with a line.

The Effect of Hit Intensity on Blood S100B Levels



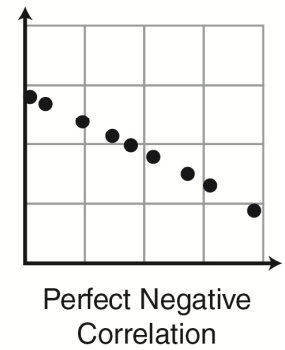
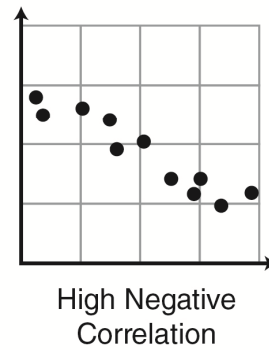
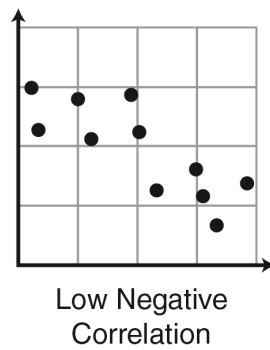
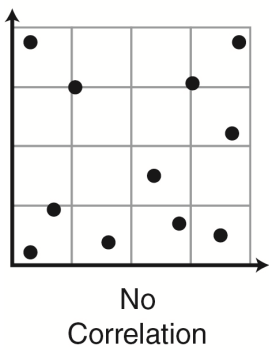
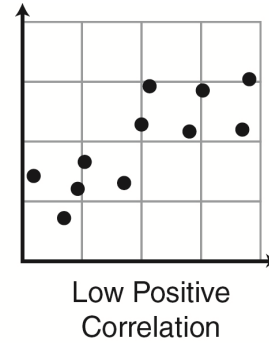
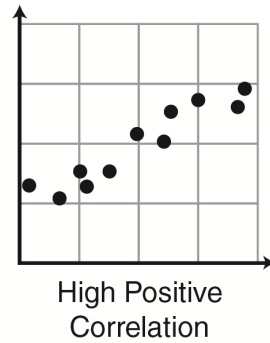
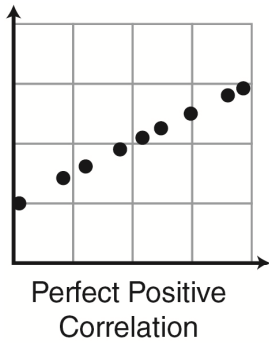
To summarize the relationship between the two variables, you can draw a **Line of Best Fit** (also called a "Trend Line") on a scatter plot. For example, see the line of best fit on the graph to the right.



8. Draw a line of best fit on your scatter plot to show the relationship between hit intensity and S100B levels. To do this you draw a straight line through the scatterplot so that an approximately equal number of points lie on either side of the line.

When two sets of data are strongly linked, they have a high correlation.

- Correlation is **Positive** when the values **increase** together
- Correlation is **Negative** when one value **decreases** as the other increases



9. What type of correlation is shown in your scatter plot?

10. What can you conclude based on the data in your graph?

11. Describe two ways that the experiment design might be improved to determine whether S100B levels could be used to determine if a concussion has occurred.

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- ---

Base your answers to question 13 on the information below, the results of your experiment, and the information in the box on page 4 (**Blood Tests Could Help Diagnose Concussions**).

Cause and Correlation

Cause and correlation are terms that are often confused or used incorrectly. A correlation means a relationship between two or more variables. A cause is something that results in an effect.

Just because one variable is correlated with another, it does not mean that it is the cause of another. To claim a factor causes an outcome, there has to be a mechanism or process that explains how the factor causes the outcome.

12. Do you think that hits to the head cause increased S100B levels? Explain why or why not.
Hint: Refer to the information in the box on page 4.

13. Do you think that S100B levels should be used to determine whether a person has a concussion? Explain why or why not.



Player Information Sheet

<p>Player # 1</p> <p>Symptoms: Mild confusion for a few minutes after third hit. Mild headache at end of game.</p> <p>Hit Intensity (SI = Severity Index)</p> <ul style="list-style-type: none"> • Hit 1 intensity SI = 5 • Hit 2 intensity SI = 1 • Hit 3 intensity SI = 6 <p>Average Hit Intensity SI = _____</p> <p>S100B level at end of game _____</p>	<p>Player # 2</p> <p>Symptoms: Mild confusion after second hit, blurred vision at end of game.</p> <p>Hit Intensity (SI = Severity Index)</p> <ul style="list-style-type: none"> • Hit 1 intensity SI = 5 • Hit 2 intensity SI = 7 • Hit 3 intensity SI = 12 <p>Average Hit Intensity SI = _____</p> <p>S100B level at end of game _____</p>	<p>Player # 3</p> <p>Symptoms: Headache at end of game.</p> <p>Hit Intensity (SI = Severity Index)</p> <ul style="list-style-type: none"> • Hit 1 intensity SI = 1 • Hit 2 intensity SI = 1 • Hit 3 intensity SI = 1 <p>Average Hit Intensity SI = _____</p> <p>S100B level at end of game _____</p>
<p>Player # 4</p> <p>Symptoms: Mild headache at end of game.</p> <p>Hit Intensity (SI = Severity Index)</p> <ul style="list-style-type: none"> • Hit 1 intensity SI = 2 • Hit 2 intensity SI = 14 <p>Average Hit Intensity SI = _____</p> <p>S100B level at end of game _____</p>	<p>Player # 5</p> <p>Symptoms: “Saw stars” and confused after one hit</p> <p>Hit Intensity (SI = Severity Index)</p> <ul style="list-style-type: none"> • Hit 1 intensity SI = 10 • Hit 2 intensity SI = 2 <p>Average Hit Intensity SI = _____</p> <p>S100B level at end of game <u> 8 </u></p>	<p>Player # 6</p> <p>Symptoms: Brief period of unconsciousness after second hit. Benched for remainder of game.</p> <p>Hit Intensity (SI = Severity Index)</p> <ul style="list-style-type: none"> • Hit 1 intensity SI = 11 • Hit 2 intensity SI = 7 <p>Average Hit Intensity SI = _____</p> <p>S100B level at end of game <u> 10 </u></p>
<p>Player # 7</p> <p>Symptoms: Mild headache at end of game</p> <p>Hit Intensity (SI = Severity Index)</p> <ul style="list-style-type: none"> • No hits <p>Average Hit Intensity SI = _____</p> <p>S100B level at end of game <u> 0 </u></p>	<p>Player # 8</p> <p>Symptoms: None</p> <p>Hit Intensity (SI = Severity Index)</p> <ul style="list-style-type: none"> • Hit 1 intensity SI = 2 • Hit 2 intensity SI = 4 <p>Average Hit Intensity SI = _____</p> <p>S100B level at end of game <u> 4 </u></p>	<p>Player # 9</p> <p>Symptoms: None</p> <p>Hit Intensity (SI = Severity Index)</p> <ul style="list-style-type: none"> • Hit 1 intensity SI = 3 • Hit 2 intensity SI = 1 • Hit 3 intensity SI = 2 <p>Average Hit Intensity SI = _____</p> <p>S100B level at end of game <u> 0 </u></p>