AP Biology Calculations: Standard Deviation and Standard Error

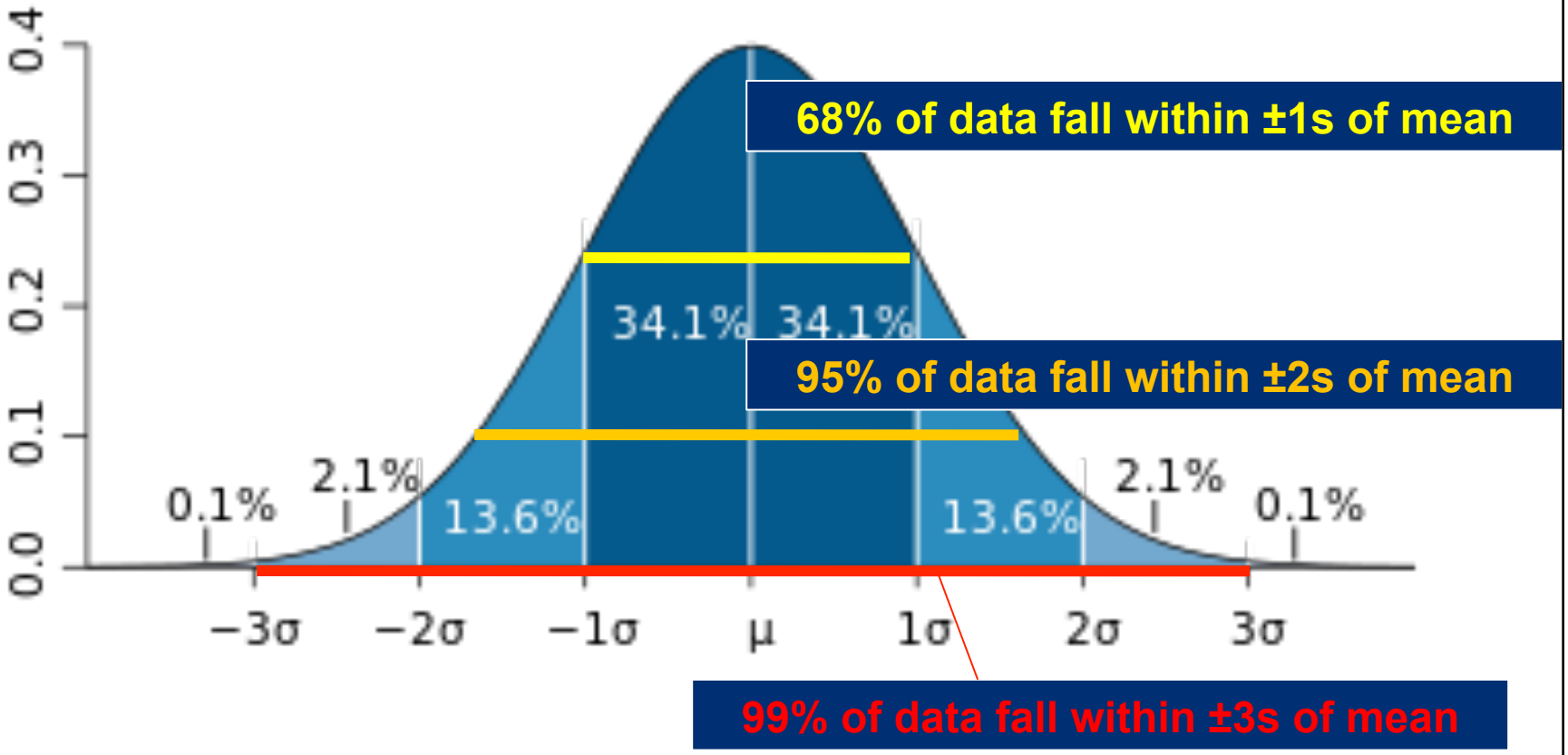
Standard Deviation:

- A measure of **how spread out** the data is from the mean

- **Lower standard deviation:**
  - Data is **closer to the mean**
  - Greater likelihood that the independent variable is causing the changes in the dependent variable

- **Higher standard deviation:**
  - Data is more **spread out from the mean**
  - More likely factors, other than the independent variable, are influencing the dependent variable

σ = standard deviation

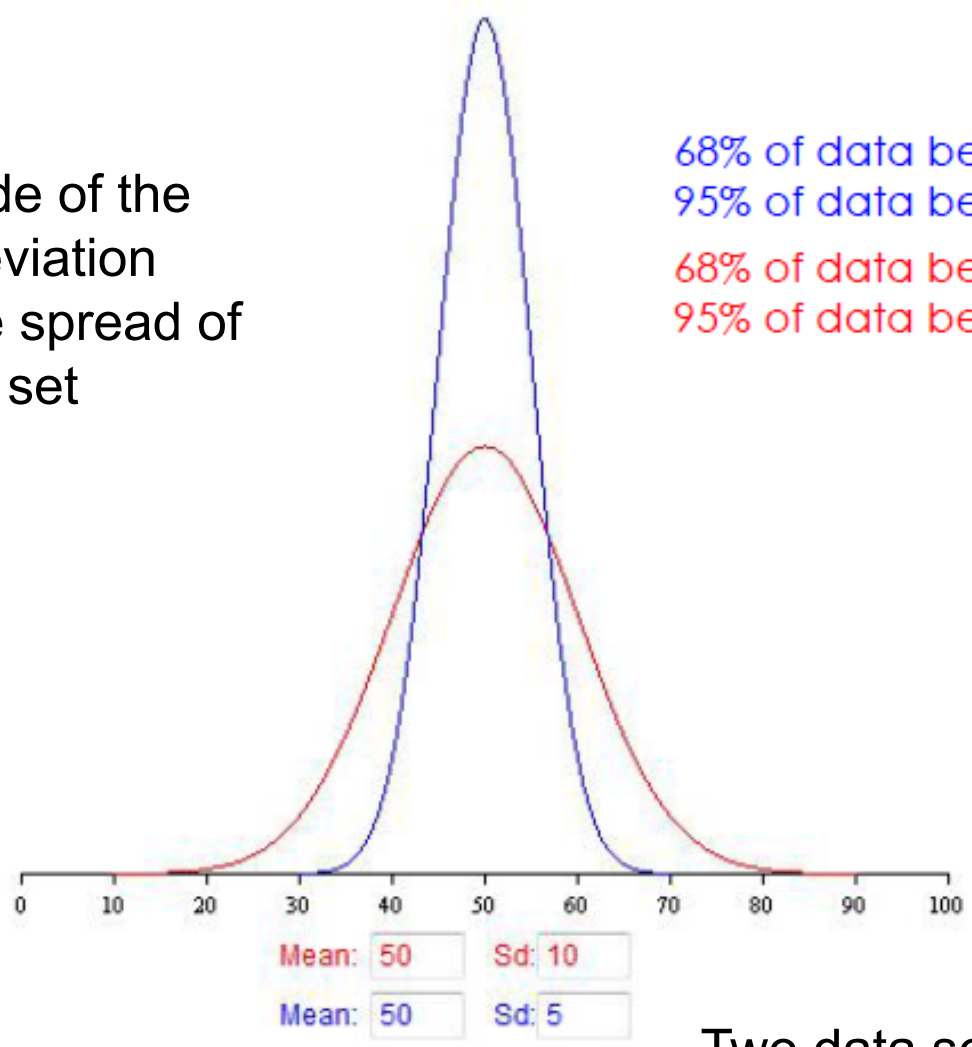


68% of data fall within ±1s of mean

95% of data fall within ±2s of mean

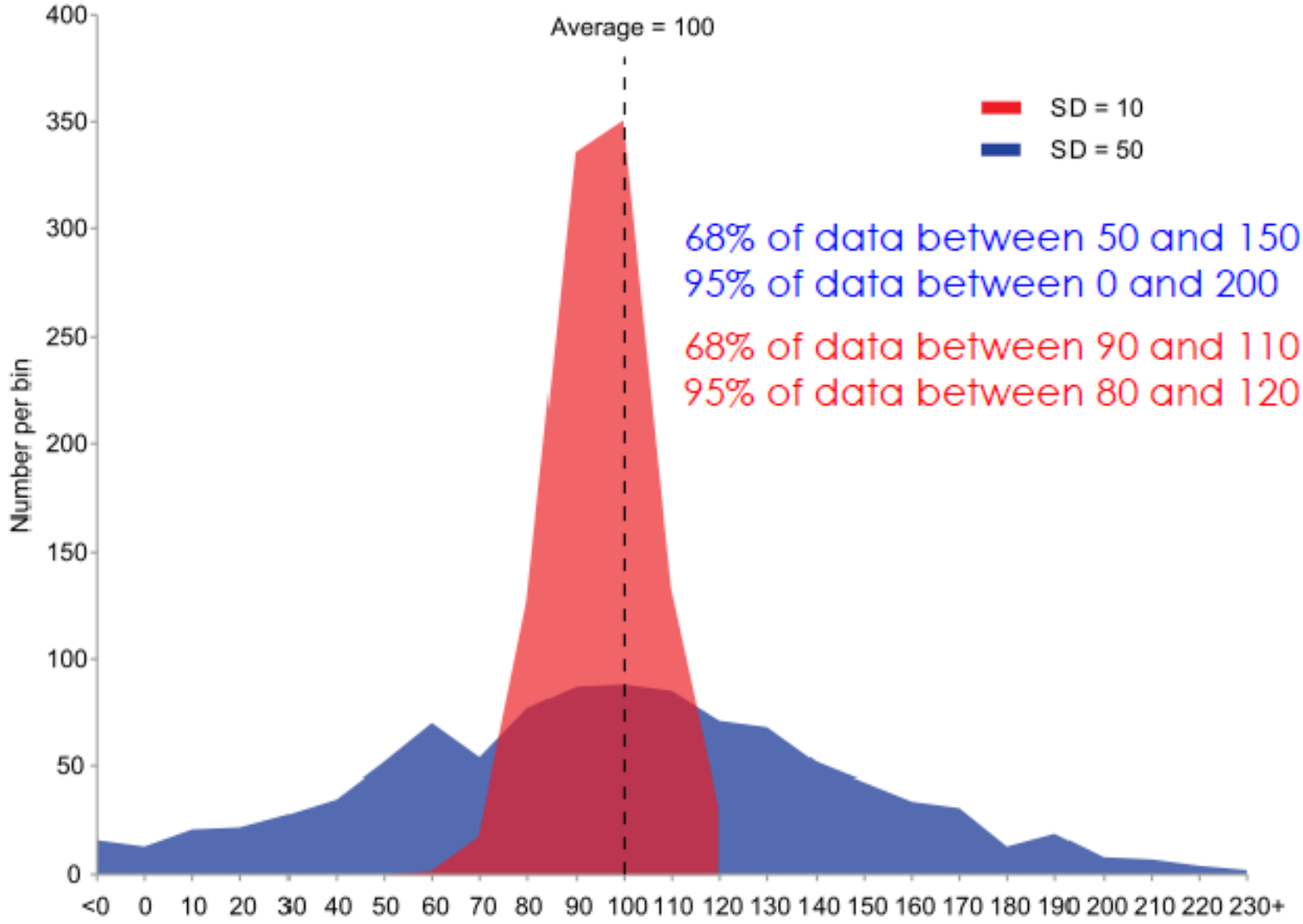
99% of data fall within ±3s of mean

The magnitude of the standard deviation depends on the spread of the data set



Two data sets: same mean; different standard deviation

Actual data sets aren't always so pretty...



Calculating standard deviation, s

$$s = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

1. Calculate the mean ($\bar{x}$)
2. Determine the difference between each data point, and the mean
3. Square the differenes
4. Sum the squares
5. Divide by sample size (n) minus 1
6. Take the square root

Standard Error:

- Indication of **how well the mean of a sample ($\bar{x}$) estimates the true mean of a population** (μ)

- Measure of accuracy, if the true mean is known
- Measure of precision, if true mean is not known

- **Accuracy** – How close a measured value is to the **actual (true) value**

- **Precision** – How close the measured values are **to each other**.

Low Accuracy
High Precision

High Accuracy
Low Precision

High Accuracy
High Precision

Calculating Standard Error, SE

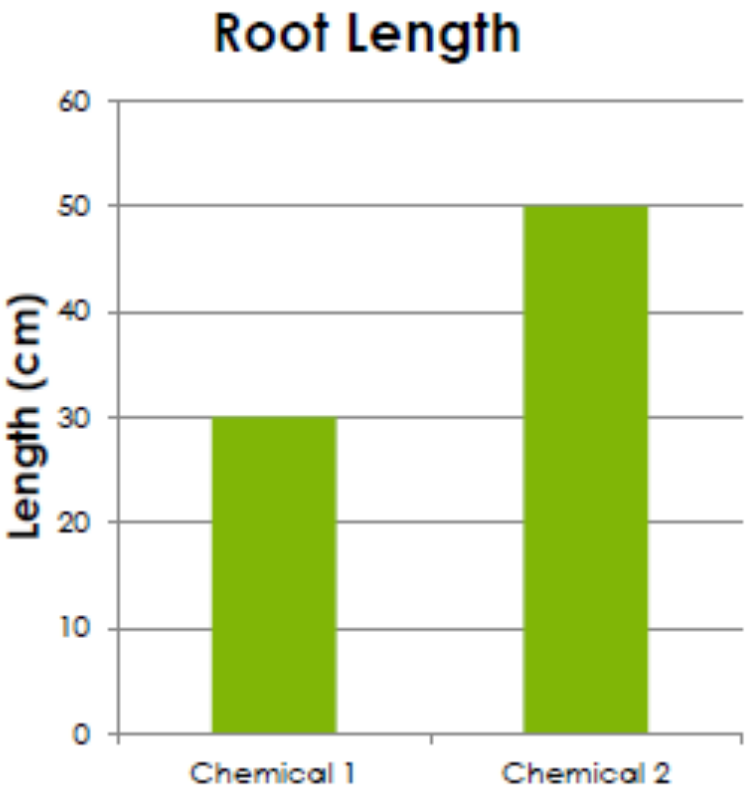
$$SE_{\bar{x}} = \frac{s}{\sqrt{n}}$$

1. Calculate standard deviation
2. Divide standard deviation by square root of sample size

How do we use Standard Error?

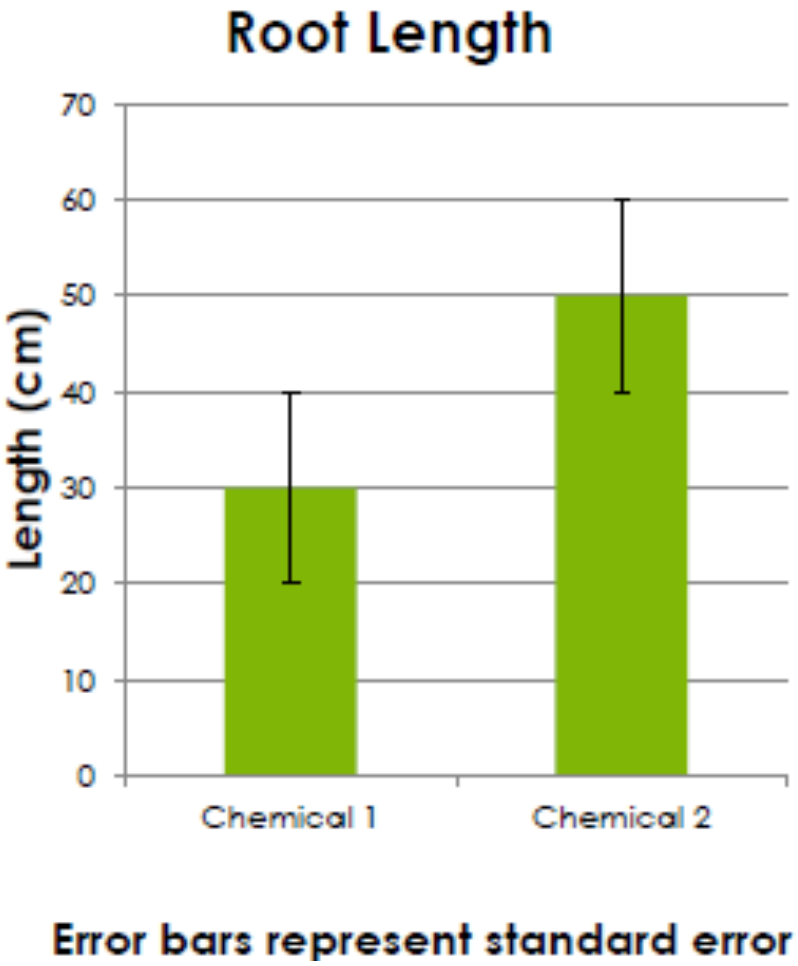
Create bar graph

- mean on Y-axis
- sample(s) on the X-axis
- chemical 1 mean = 30 cm
- chemical 2 mean = 50 cm



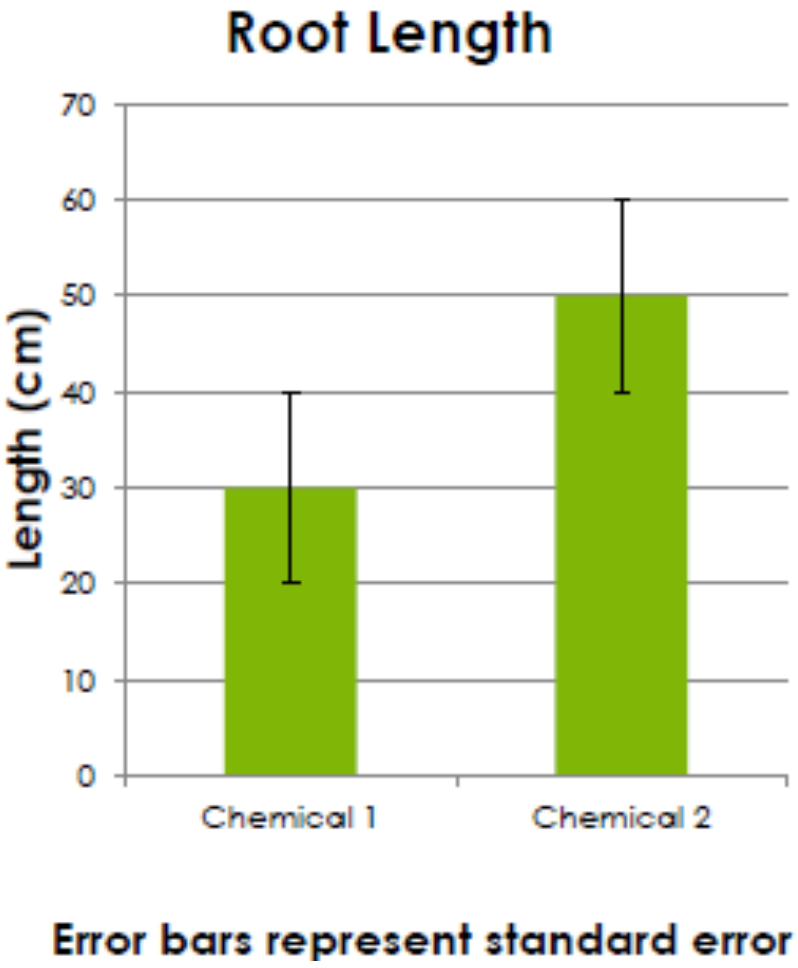
Add error bars!

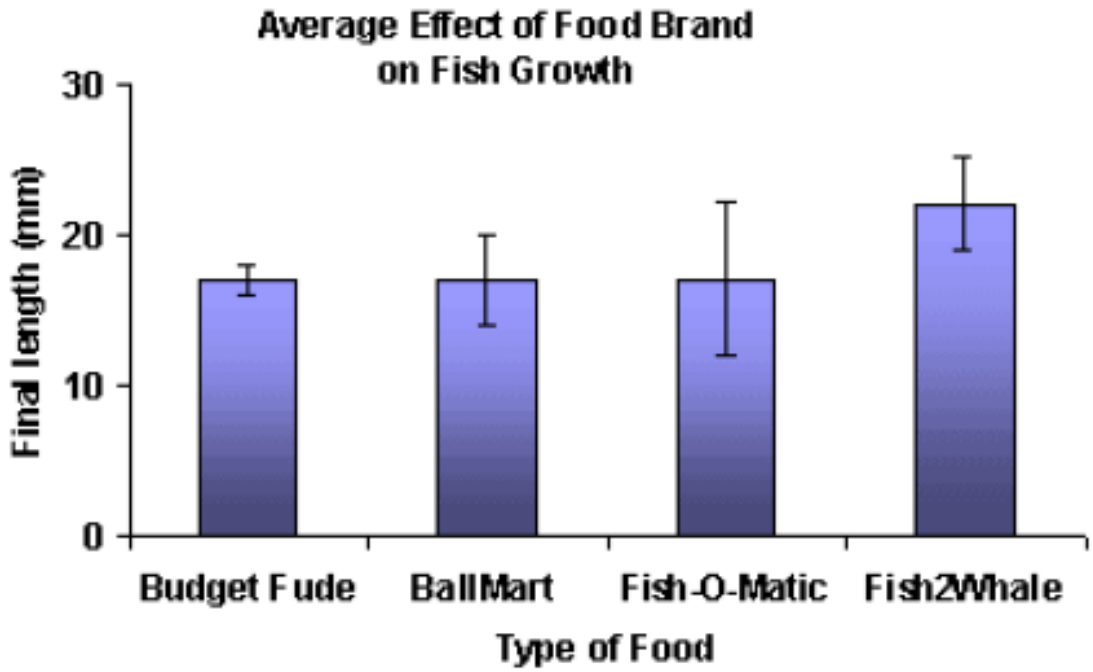
- ± SE
- Indicate in figure caption that error bars represent standard error (SE)



Analyze!

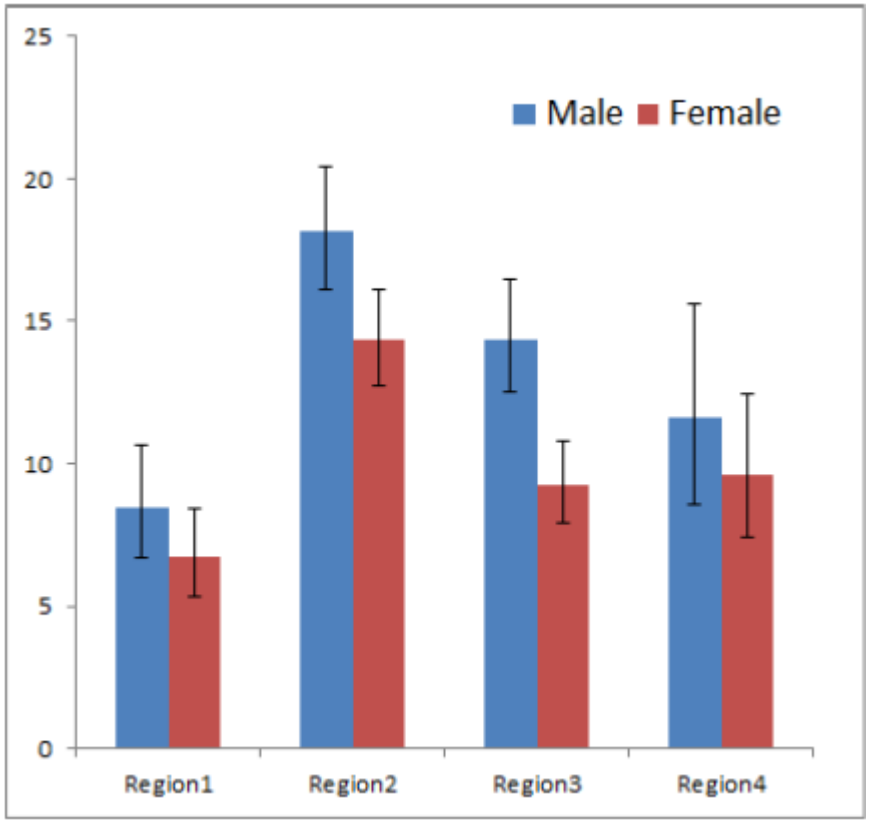
- Look for overlap of error lines:
  - **If they overlap**: The difference is not significant
  - **If they don't overlap**: The difference may be significant





Which is a valid statement?

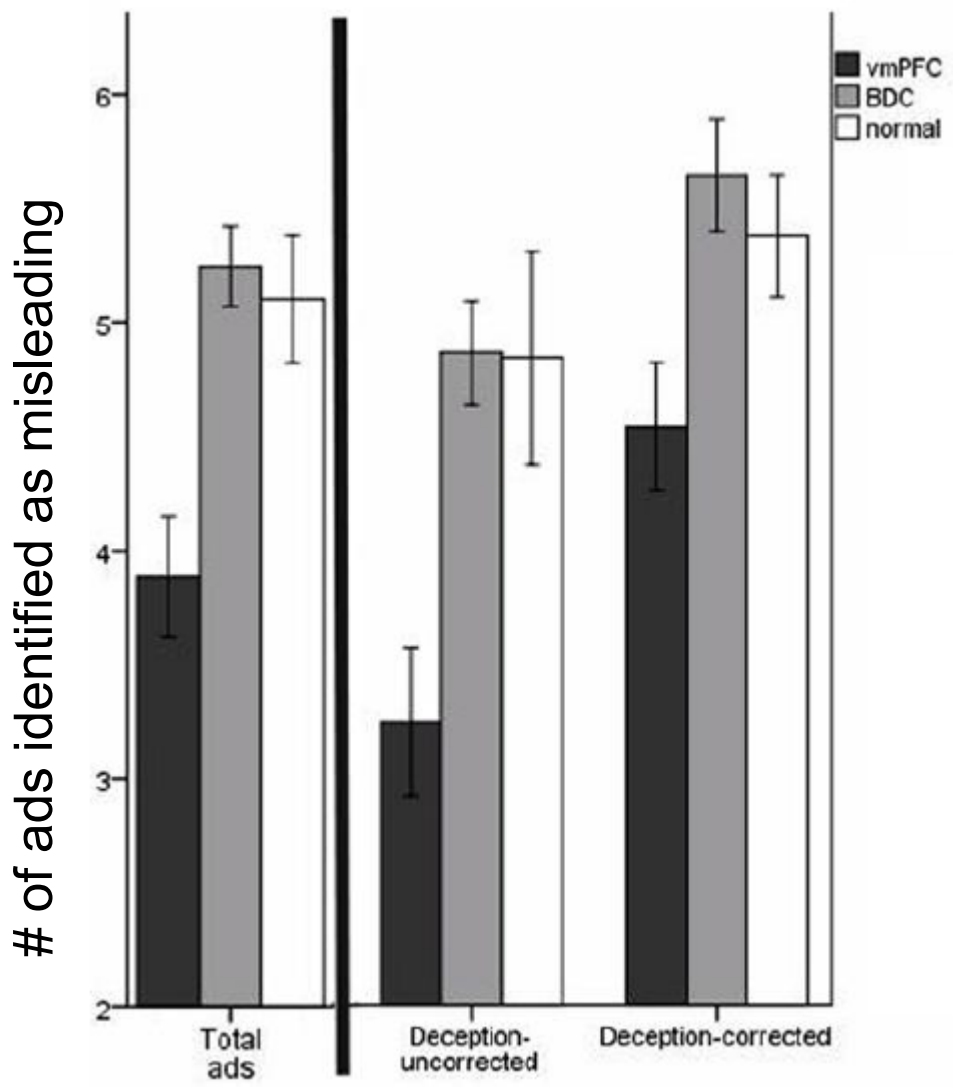
- ✗ Fish2Whale food caused the most fish growth
- ✓ Fish2Whale food caused more fish growth than did Budget Fude



Statements:

✗ In all four regions, more males exhibited the trait measured than did females.

✓ More males in region 3 exhibited the measured trait than did females



Mean belief scores for misleading ads

- vmPFC = damage to ventromedial prefrontal cortex
- BDC = brain damaged comparison group

Statements:

1. ✓ The vmPFC group identified fewer ads as misleading than did the normal group

2. ✗ The BDC group identified more ads as misleading than did the normal group.