Experiment HP-11: Multisensory Reaction Times

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APPENDIX: Using Excel for Graphing and Performing T-Test Statistics

Note – your version of Excel may be slightly different.

Creating bar graphs with error bars in Excel

Set up the data to be graphed in your spreadsheet.

1. In this example, we want to plot the water consumption of old and young males and females (see table below). Specifically, we will create a bar graph that depicts the means for each group and add error bars to represent the standard deviation of our data.
2. Suppose this is the data set that we'd like to plot:

Glasses of water consumed daily. Presented as mean (standard deviation)

	Males	Females
Old	4 (1)	3 (1)
Young	6 (2)	7 (2)

3. In the table above, the mean and standard deviation data are presented together in the same table. This is often how data is presented in a table format; however, in order to plot this in excel, the mean and standard deviation data need to be separated into two tables, as shown:

Average glasses of water consumed daily

Means

	Males	Females
Old	4	3
Young	6	7

Standard Deviations

	Males	Females
Old	1	1
Young	2	2

Inserting a bar graph

1. To insert a bar graph, first highlight the data that you'd like to plot. TIP: If you select the labels in your chart (in this example: "Old" "Males" etc), Excel will automatically add these labels to your graph and you can save yourself a formatting step later on. (Figure HP-11-A1)

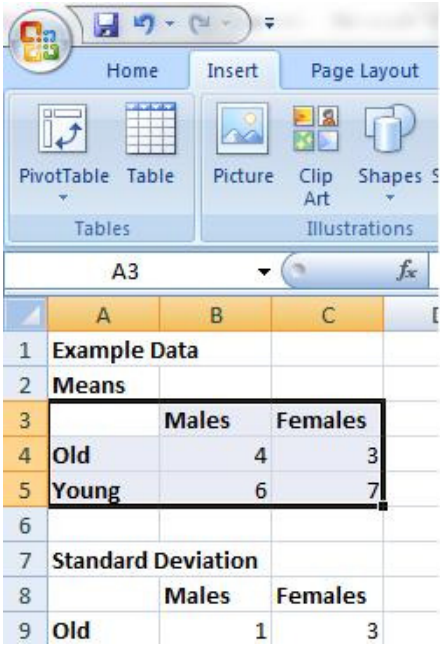


Figure HP-11-A1: Sample Data.

2. Then, click the "Insert" tab -> "Charts" -> "Column" -> 2-D column, clustered column (see Figure HP-11-A2). You can always go back to change the style of your bar graph later.

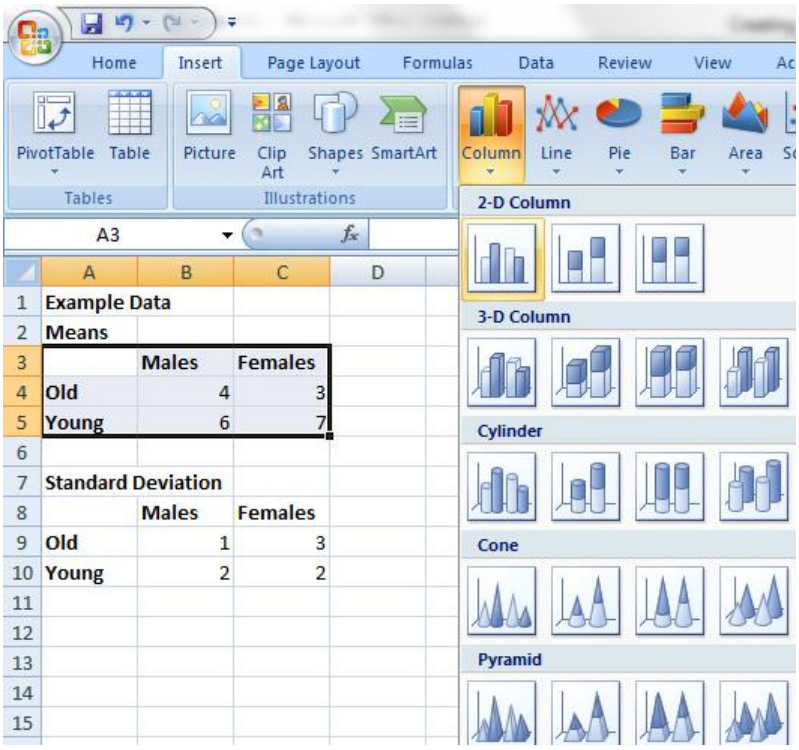


Figure HP-11-A2: Choosing the graph type.

3. This should return a bar graph like this (Figure HP-11-A3):

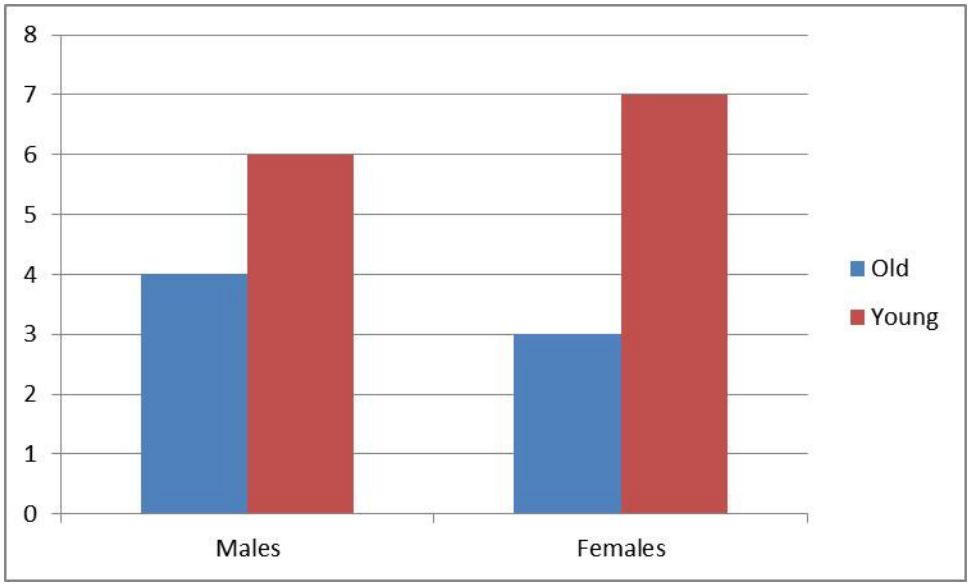


Figure HP-11-A3: Sample bar/column graph.

4. Excel has a number of formatting options which allow you to annotate the graph to make it more readable. At the very least, you'll need to add labels to the axes so that you know what the data represent.
5. When the graph is selected in Excel, a toolbar with the tabs "Design", "Layout", and "Format" appears at the top. Selecting the layout tab will allow you to add labels (Figure HP-11-A4):

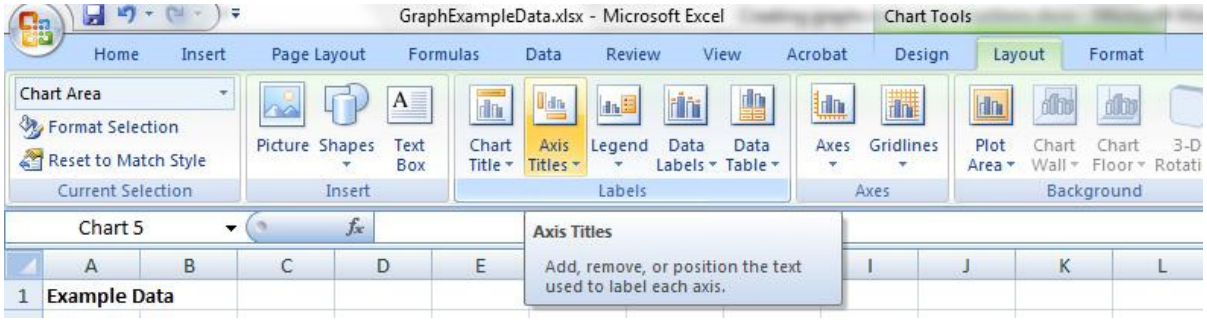


Figure HP-11-A4: Chart tools showing Design, Layout and Format.

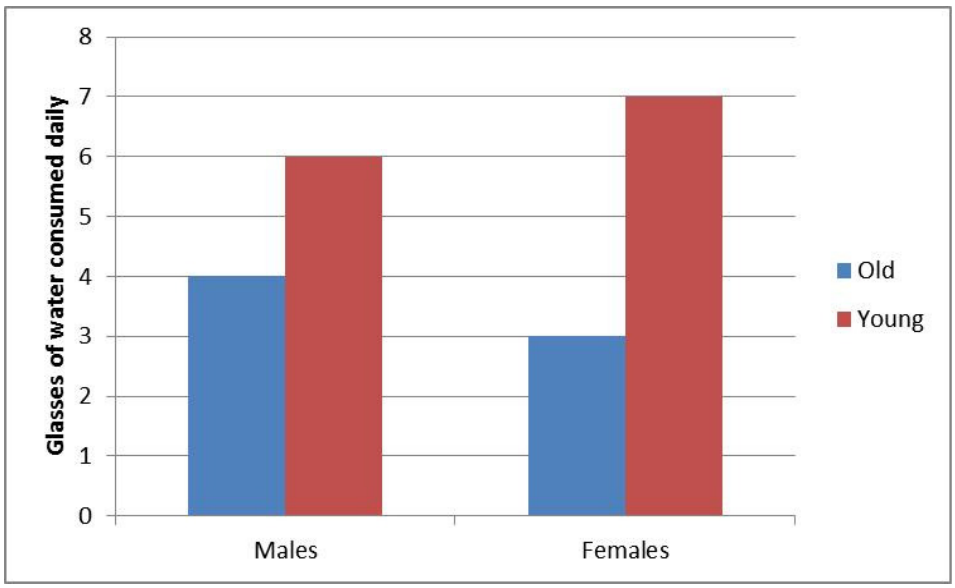


Figure HP-11-A5: Graph showing titles and axes labeled.

Adding Error Bars to the plot

1. First, click on the set of bars to which you'd like to add error bars. In this case, we can start with the "Old" series.
2. Select the Chart Tools->Layout tab. Then, click on the Error Bars button and scroll down to the more error bars options (Figure HP-11-A6).

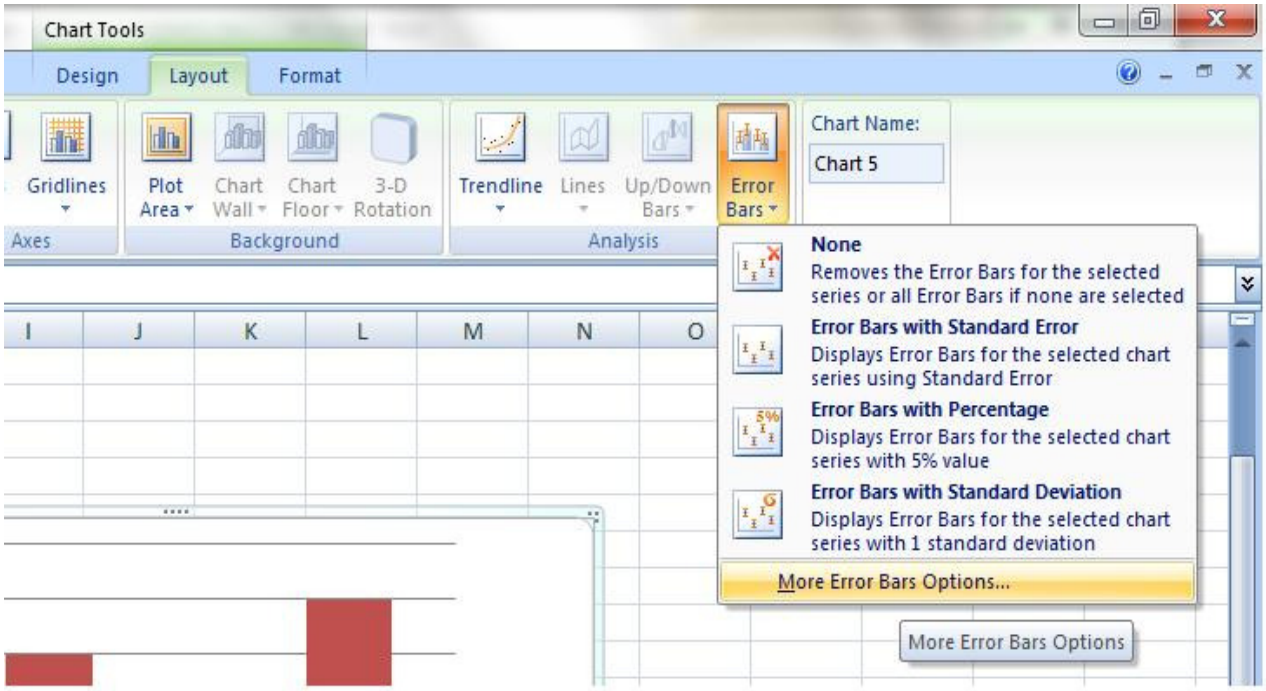


Figure HP-11-A6: Selecting error bars.

3. This dialog box should open showing how to add error bars (Figure HP-11-A7):

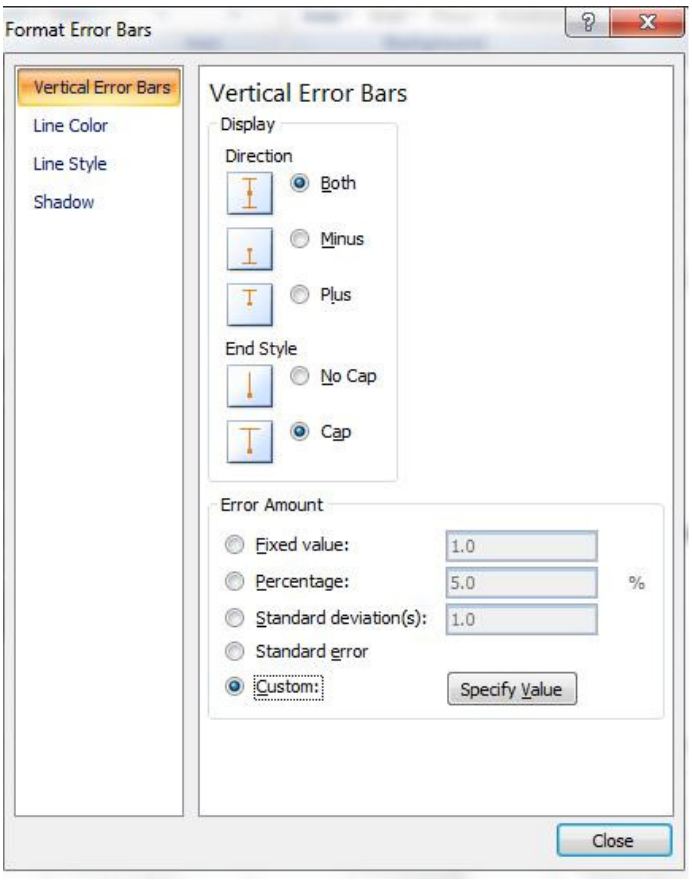


Figure HP-11-A7: Adding error bars dialog box.

4. Under error amount, select the "Custom" radio button. When you click on the specify value button, you will be prompted to enter the error bar values from the spreadsheet.
5. We are using the standard deviation. Select the cells corresponding to the standard deviation for the old group (Figure HP-11-A8).
6. Repeat this procedure for the Young series to produce a plot like the one below.

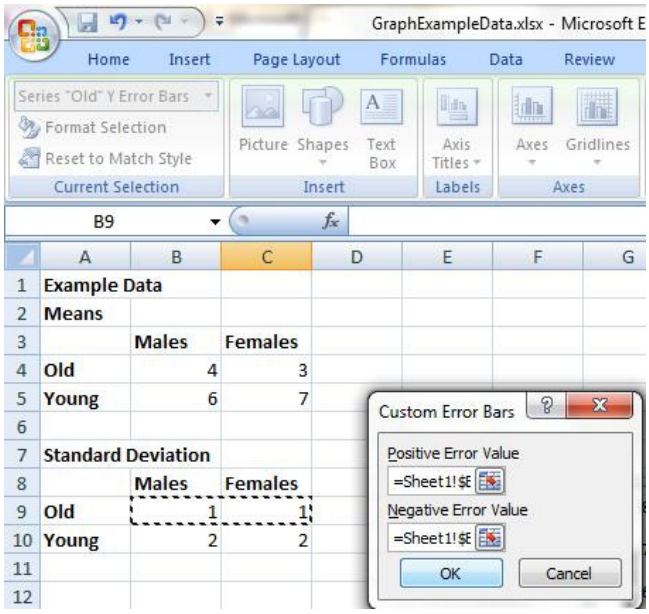


Figure HP-11-A8: Adding error bars based on Standard Deviation.

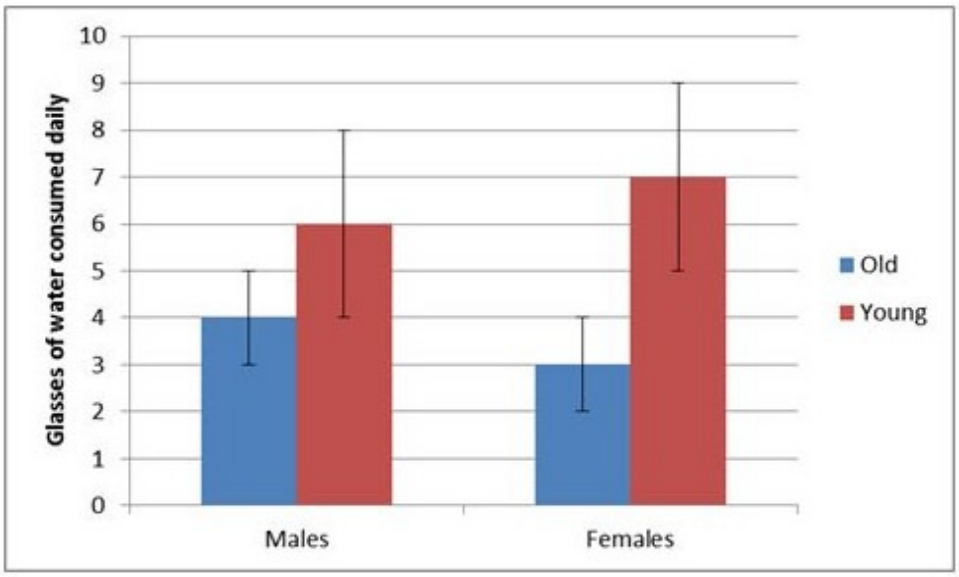
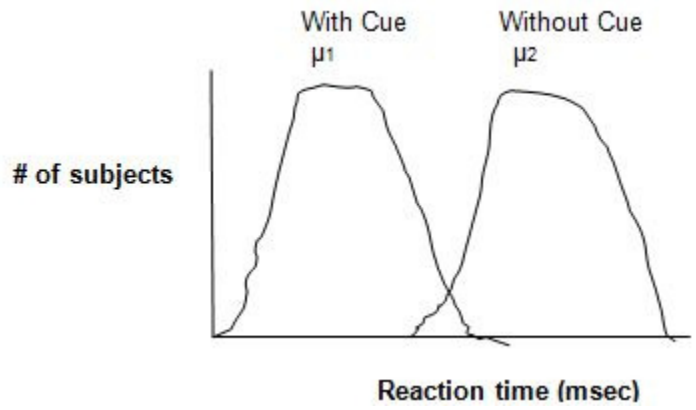


Figure HP-11-A9: Bar graph showing error bars.

Finally, be sure to describe, either in a caption (if presented in a paper) or directly on the graph (if presented in a presentation) what the error bars represent. In this case, you could simply state "Error bars represent standard deviation"

Introduction to T-Tests – this will be explained by the Instructor

If we have 2 sample populations, and we assume that both have normal distributions, how do we determine if these 2 sample groups come from distinct populations? Are the two distributions of data truly different?



The **Null** hypothesis states that there is no difference between the means: $\mu_1 = \mu_2$
The **Alternate hypothesis** states that there **IS** a difference between the means: $\mu_1 \neq \mu_2$

Should we accept or reject H_0? We decide this by generating a T statistic:

$$\text{T statistic} = \frac{\text{Difference in the means}}{\left(\frac{\text{standard deviation}}{\sqrt{n}}\right)}$$

Some Definitions:

1. n = # of samples
2. Mean (x) = $\frac{\sum x_i}{n}$
3. Variance (σ) = Average difference from the mean = $\frac{\sum_i (x_i - \text{mean})^2}{n}$
4. Standard Deviation (SD) = Average absolute value of the difference from the mean = $\sqrt{\sigma}$
5. The T Test is not infallible, errors are possible:
6. Type I Error (α) = Rejecting H_0 when it is actually true
7. Type II Error (β) = Accepting H_0 when it is actually false

8. We usually would like the probability of committing a Type I Error to be less than 5% ($\alpha < 0.05$).

9. The higher the value of the T statistic, the lower α will be.

Types of T Tests

Paired T Test

Example: Is there a difference in the blood pressure of a patient after treatment with a new antihypertensive drug as compared to before treatment?

Unpaired T Test

Example: Is there a difference in the blood pressures of males as compared to females?

- Two Tailed T Test: $H_A: \mu_1 \neq \mu_2$
- One Tailed T Test: $H_A: \mu_1 < \mu_2$ or $\mu_1 > \mu_2$

It is easier to reject H_0 with a 1 tailed test

- Think about what type of T Test you will run on the reaction time data.

Doing T Tests with Excel

Tools
- Data Analysis
  - T Test – Paired 2 sample for means, for frog skin data (unpaired, assuming equal variances, for metabolism data)
  - Select variable 1 range – first set of data points to be tested
  - Select variable 2 range – second set of data points to be tested
    - Select output range – where you want the T Test results to go
    - Select an $\alpha = 0.05$

In the output, look at T statistic and two tailed P (probability, or α)