



### Experimental Design Definitions

**Experimental Design:** Describes the manner in which you test your hypothesis through experimentation. Having correct experimental design is CRUCIAL to accurately testing your hypothesis. The stronger your experimental design is, the more reliable your results will be, and the more confident you can be when you draw conclusions from your data.

**Variables:** Scientists use an experiment to search for **cause and effect** relationships in nature. In other words, they design an experiment so that changes to one item cause something else to vary in a predictable way. A variable is any factor, trait, or condition that can exist in differing amounts or types. An experiment usually has three kinds of variables: *independent, dependent, and controlled*.

**Independent Variable:** this variable is changed by the researcher and observations are made to see if the change of the independent variable has an impact on the dependent variables. **Only ONE** independent variable should change in an experiment

**Dependent Variables:** these variables change as a result of the independent variable. The scientist focuses the observations on the **dependent variable** to see how it responds to the change made to the independent variable. The new value of the dependent variable is caused by and depends on the value of the independent variable. This is where your DATA comes from.

**Controlled Variables:** these are variables in the experiment that you keep the same (YOU MAKE SURE THEY DON'T CHANGE)

**Hypothesis:** This is developed from your question and should be very clear and direct. Every hypothesis needs an independent variable and a dependent variable, and should be written as an "If...Then..." statement. The hypothesis is NOT A QUESTION but a statement that can either be correct or incorrect. YOUR HYPOTHESIS MUST BE TESTABLE (meaning you are able collect data on your hypothesis!)

**Control Group:** This group does not receive the treatment (no change to independent variable). This group is used to compare to as the "normal" or "baseline".

**Experimental Groups:** This group receives the treatment (change in independent variables).

**Trials:** The # of times you replicate the experiment.

**Data:** Anything that can be observed/measured in an experiment. Two types of data: *quantitative and qualitative*.

**Quantitative Data:** Anything that can be measured with numbers (24 horses finished the race, Mr. Miller ate 5 pies, the Flyers scored 3.4 goals per game last month, etc.)

**Qualitative Data:** Observations not related to quantities or numbers (examples: the horse is brown, Mr. Miller is drawing, the Flyers are awesome, etc.)



# Research Experience and Mentoring

## Experimental Design Handout 1: Experimental Design Definitions

**Statistical Variability:** Experiments are never perfect and even the best results often vary between different trials of the same experiment. Variability is normal and is reported as deviation from the average results (sample mean) from the experiment over a number (sample size) of trials. To get a true picture of the average results and variability of an experiment, it is important to conduct enough experiments to be sure that what is being observed is what happens with the experiment given the same conditions, most of the time. Unusually high or low values of results are called outliers, and many statistical methods have been devised to handle these types of data.