Key Concepts in Expt'al Design

1. **Variables**: IV & DV; Levels of an IV; Type of IV (within- vs. between subjects).

2. **Hypotheses & Operational Definitions**: Being clear about what you are testing and how you are testing it.

3. **Extraneous Variables & Confounds**: Extraneous variability is in every experiment (it is noise). A confound only occurs when an extraneous variable varies *systematically* with an IV. Good expt'al design should minimize the former and eliminate the latter.

The Goals of Psychological Science

1. **Description**: **To provide a systematic and objective (unbiased) account of behavior & mental activity.**

2. **Prediction**: **To specify in advance when particular thoughts & behaviors will occur.**

3. **Explanation**: **To account for the causes of behaviors in terms of underlying principles and constructs.**

4. **Control**: **To influence thought & behavior to reduce suffering, increase skill, or solve applied problems.**

The Goals of Psychological Science

Example: Pavlovian (Classical) Conditioning

1. **Description**: **Dog salivates whenever research technician entered lab.**

2. **Prediction**: **Dog will salivate to any event that regularly precedes feeding (e.g., a bell).**

3. **Explanation**: **Stimulus-Response Associations; Expectations; Hebbian Learning (LTP).**

4. **Control**: **Advertising (e.g., associating products with sex); Psychotherapy (e.g., desensitization therapy for phobias); Neural control of memory.**

Psychological Research Methods

There are four main methods that psychologists use to explore the nature of mind and behavior

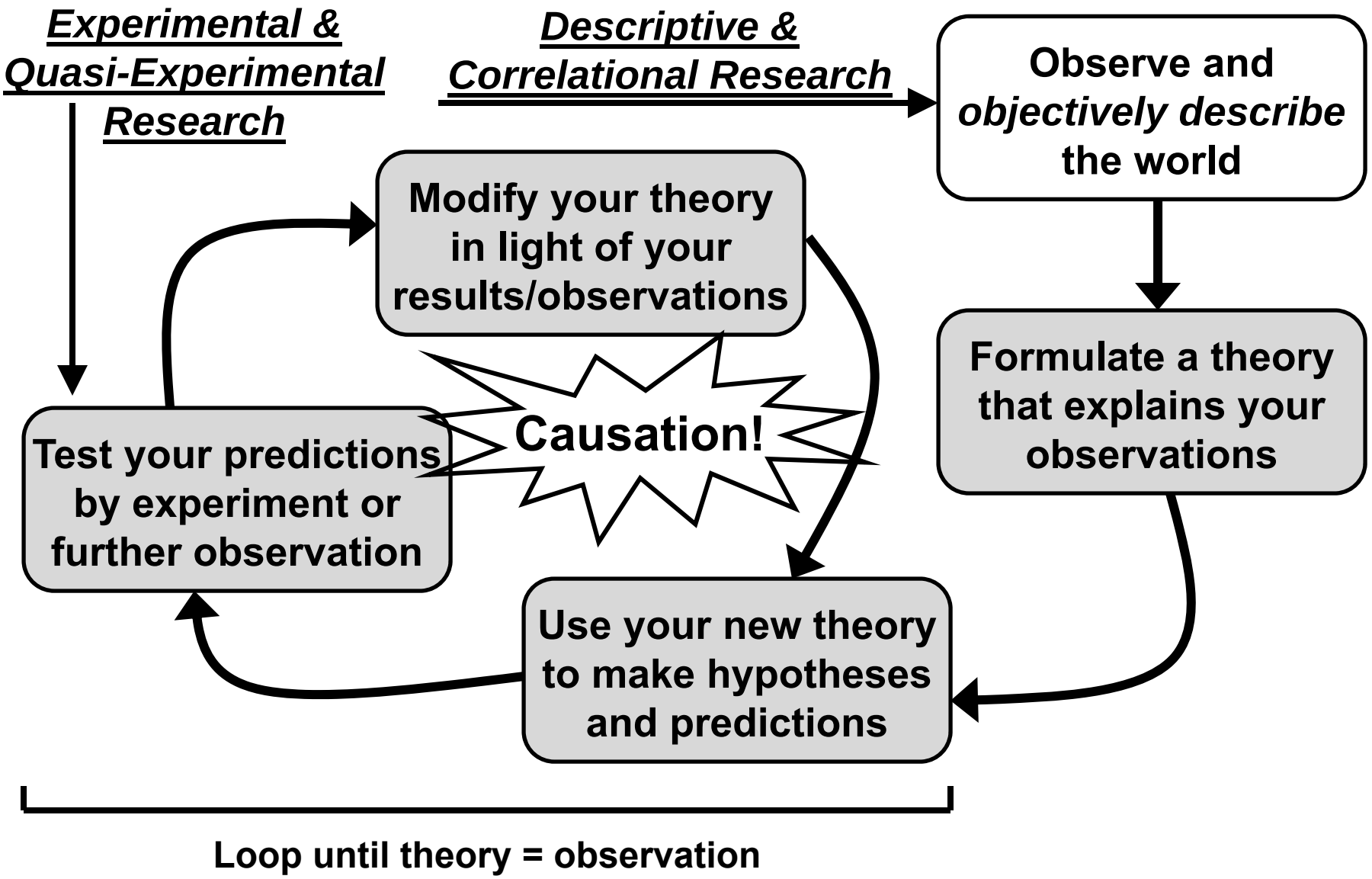
1. **Descriptive (aka Observational) Research**
   - **Systematic & objective recording of behavior.**
2. **Correlational Research**
   - **Examining relations among two or more variables.**
3. **Experimental Research**
   - **Manipulating variables (IVs) in order to determine their influence on other variables (DVs).**
4. **Quasi-Experimental Research**
   - **An experiment in which some variables cannot be fully controlled or manipulated (age, sex, etc.).**

Psychological Research Methods

3. Experimental Research

- **Involves manipulation of one or more variables in order to determine their influence on one or more other variables.**
- **The only method that can establish causation among variables (showing what causes what).**
- Examples include studies showing that…
  - **Students whose attention is divided while studying show less learning than those who study without distraction.**
  - **Older adults given an aerobic exercise regimen show better attention skills than those given a weight-training regimen.**

The Scientific Process & Research Methods



Variables

- **Variable: Anything that can vary (have different values).**
- **For Experimental Research, two main classes:**
  - **Independent Variable (IV)**: The variable that the E *manipulates* (to see if it will influence something).
  - *Amount of drug administered (0, 1, 5, 10 mg.).*
  - *Type of video game played (violent vs. non-violent).*
  - *Number of times study material is examined (1, 2, or 3 times).*
  - *Participants gender (male/female) or age (young/old).**
  - **Dependent Variable (DV)**: The variable that the E *measures* (to see if it was influenced by the IV).
  - *Reaction Time (RT); # or % of correct or incorrect rsps.*
  - *Pupil dilation; skin conductance; neural response.*
  - *Score on an exam or memory test; magnitude of a judgment.*

Independent Variables

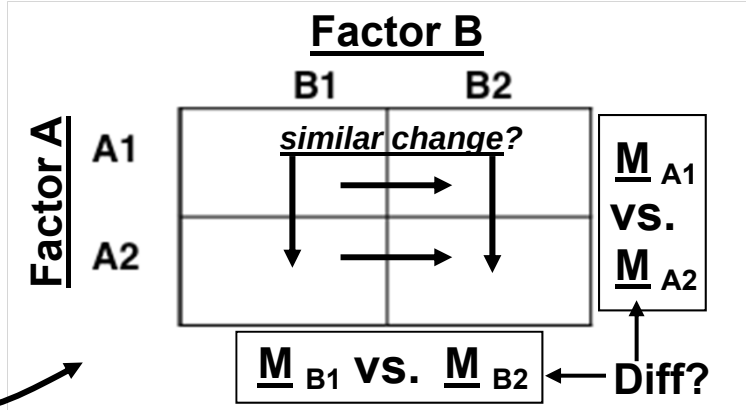
- **Levels of an IV: The different values of the variable.**
  - **All IVs have at least two levels and often more.**
    - **1 IV: Degree of Anxiety; 2 Levels: Calm, Anxious.**
    - **1 IV: Degree of Anxiety; 3 Levels: Low, Moderate, High.**
    - **1 IV: Color of Survey; 4 Levels: White, Red, Blue, Yellow.**
    - **1 IV: Noise Level; 5 Levels: 20dB, 40dB, 60dB, 80dB, 100dB.**

- **More than 1 IV: Factorial Designs.**
  - **Question: Why manipulate more than 1 IV?**
  - **Answer: Because the world is a factorial!**

More than One IV: Factorial Designs

- Two or more independent variables manipulated in a single experiment.
- Simplest is a 2 X 2 factorial design having two independent variables, each with two levels. The 2 X 2 design has four conditions.

This is how you diagram a factorial



- ***Main effect:***
  The effect of each independent variable by itself. In a 2 X 2 design, there are two main effects.
  - ➢ Examine marginal means, averaging across the levels of the other factor.
- ***Interaction:***
  An interaction indicates that the effect of one independent variable depends upon the particular level of the other independent variable.
  - ➢ Examine inner cells; does the effect of one IV depend on the level of the other IV?

➢ In factorials, you test whether there is a main effect for each IV (factor) and whether any factors interact. As IVs are added, there are more possible main effects (one for each IV) & interactions (one for each IV combination).

Overview of Experimentation

Experiments are the most powerful research methods in science because, if done correctly (if high in internal validity) they allow us to establish cause & effect.

Establishing Cause & Effect is the first step toward Explanation & Control.

- **The Main Components of Any Experiment:**

1. **Statement of a Hypothesis.**
2. **Random Assignment of Participants to Conditions.**
3. **Manipulation of Antecedent Conditions (IVs).**
4. **Measurement of Behavior (DVs).**
5. **(Statistical) Analysis of Results.**

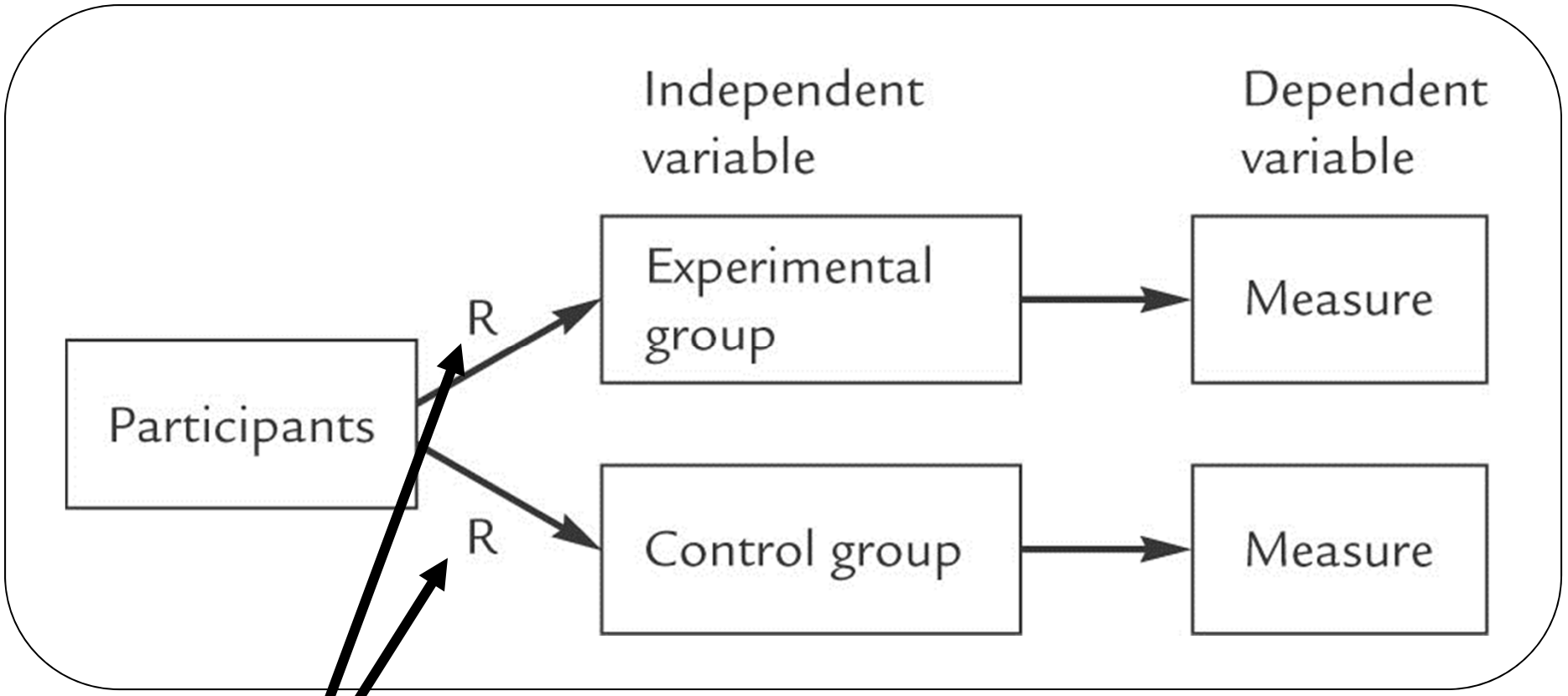
Hypotheses & Operational Definitions

- **Hypothesis**: *A statement about the relation between two or more variables. To be useful, a hypothesis must be...*
  - *Concrete: Based on operationally defined variables.*
  - *Testable: Procedures must be available to test it.*
  - *Falsifiable: Able to be proven incorrect.*

- **Operational Definition**: *Defining a variable in terms of the operations used to measure or implement it.*
  - *Often involves some combination of Behavioral, Physiological, & Self-Report measures.*
  - *Must be specific enough for another researcher to repeat it.*

- ***Intelligence?***
- ***Paying Attention?***
- ***Anxiety?***

Let's Design an Experiment!



- **What's our IV?**
- **What's our DV?**
- **What does "R" mean here?** ***Random Assignment***

Let's Run the Experiment!

	Experimental Group	Control Group	
Aka:	63	49	Aka:
	72	62	
	87	40	
Treatment Group	55	38	Non-Treatment Group
	49	66	
Condition 1	71	33	Condition 2
	79	42	
Etc.	95	28	Etc.
	88	35	
	80	27	
Mean =	73.9	52.2	
SD =	14.9	15.3	

Do the groups differ? Did our IV affect our DV?

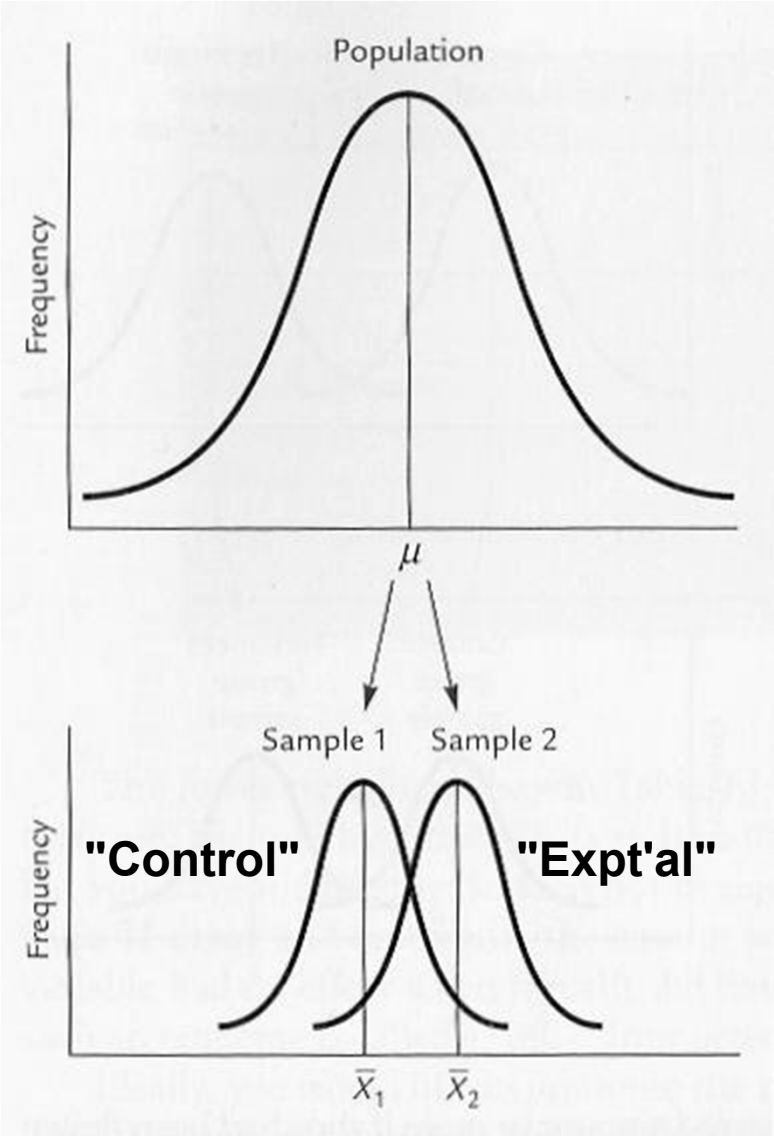
The Null & Alternative Hypotheses

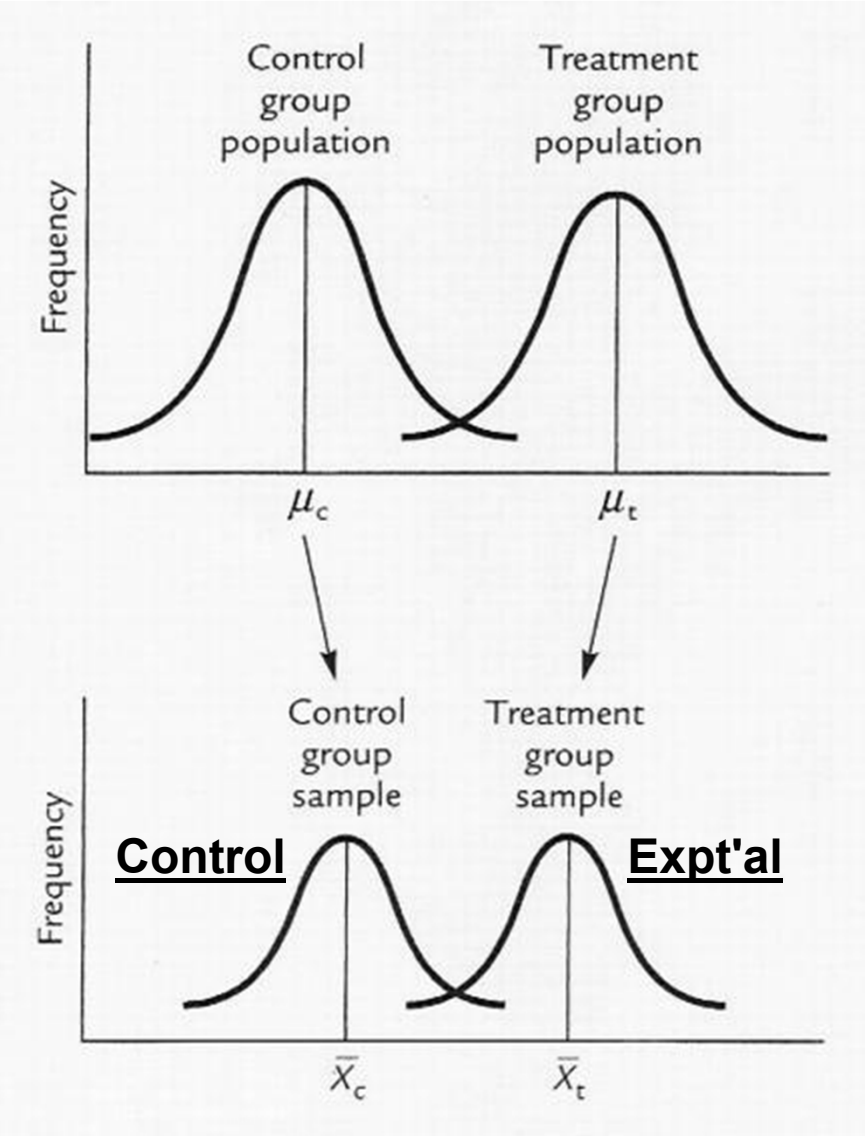
- **The Null Hypothesis.**
  - **H_o ("H-sub-oh"): $\mu_e = \mu_c$**
  - **Assumes there is no difference *in the underlying population* from which your experimental & control groups (conditions) were drawn.**
  - ***Innocent until proven guilty!***

- **The Alternative Hypothesis.**
  - **H_1 ("H-sub-one"): $\mu_e \neq \mu_c$**
  - **Assumes that there *is* a difference in the populations underlying your two groups or conditions.**
  - ***Guilty!***

The Null & Alternative Hypotheses

- **Null Hypothesis** [H_o].
- **Alternative Hypothesis** [H_1].





The Logic Behind Inferential Statistics

Where is the variability (variance) in your data coming from?

❑ Systematic (Treatment) Variance.

- **Variance in your DV that occurs between groups or conditions that is actually due to your IV.**
- **In our design, this would be called "Between-Group Variance".**

❑ Error (Chance) Variance.

- **Non-systematic variance in your DV due to individual differences among subjects & uncontrolled random effects (e.g., amount of sleep, motivation, pre-existing knowledge, medications, etc.).**
- **In our design, this would be called "Within-Group Variance".**

$$\text{Inferential Stat} = \frac{\text{Systematic + Error}}{\text{Error}} = \frac{\text{Between-Group}}{\text{Within-Group}}$$

The Logic Behind Inferential Statistics

❑ Confounds.

- **Any factors in your experiment that are uncontrolled but nevertheless *systematically* related to your IV.**
- **Examples include the weather, day-of-week, time-of day, room, Experimenter (e.g., male vs. female), etc.**
- **Confounds often go unnoticed and thus represent one of the largest threats to an experiment's validity.**

❑ Confound Variance.

- **Variance between groups or conditions that is due, not to your IV, but to confounds that are systematically (but unknowingly) linked to your IV.**

$$\text{Inferential Stat} = \frac{\text{Systematic [Treatment + Confound] + Error}}{\text{Error}} = \frac{\text{Btw-Group}}{\text{W/i-Group}}$$