# EXPERIMENTAL DESIGN



QUANT STUDY? NO WAY, TOO EXPENSIVE AND TAKES TOO LONG

FOCUS GROUPS? NOPE, TOO EASILY SWAYED BY STRONG PERSONALITIES

FINE, WHAT THEN? MONITORING SOCIAL MEDIA CHATTER AND CHERRYPICKING QUOTES WE LIKE

LIBERATING CONSUMER INTELLIGENCE. EMPOWERING MARKETERS. MOTISTA

# LEARNING OBJECTIVES

- ✓ Define confounding variable, and describe how confounding variables are related to internal validity
- ✓ Describe the posttest-only design and the pretest-posttest design, including the advantages and disadvantages of each design
- ✓ Contrast an independent groups (between-subjects) design with a repeated measures (within-subjects) design
- ✓ Summarize the advantages and disadvantages of using a repeated measures design
- ✓ Describe a matched pairs design, including reasons to use this design

# CONFOUNDING

✓ **Confounding variable**: Varies along with the independent variable

- ✓ A goal of conducting a randomized experiment is to make a causal conclusion about the effect of an independent variable on a dependent variable.

- ✓ In order to make a causal conclusion, one must be able to rule out all other explanations for the effect on the dependent variable.

- ✓ *Confounding occurs when the effects of the independent variable and an uncontrolled variable are intertwined*

- ✓ Therefore, one cannot determine which variable is responsible for the effect
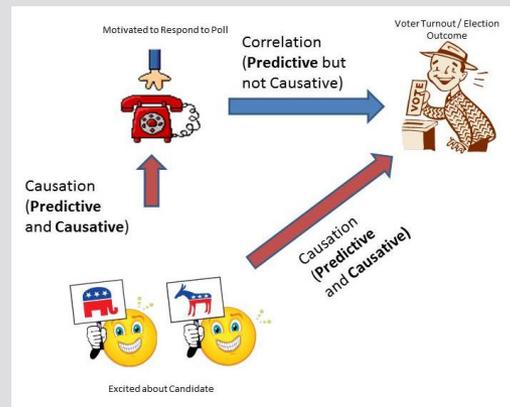
# CONFOUNDING

✓ **Confounding variable**

✓ Example: Testing was conducted on a new cold medicine with 200 volunteer subjects - 100 men and 100 women. The men receive the drug, and the women do not. At the end of the test period, the men report fewer colds.

- In this experiment many variables are confounded.
  - Gender is confounded with drug use. Perhaps, men are less vulnerable to the particular cold virus circulating during the experiment, and the new medicine had no effect at all.
  - Or perhaps the men experienced a placebo effect.
- This experiment could be strengthened with a few controls.
  - Women and men could be randomly assigned to treatments.
  - One treatment could receive a placebo, with blinding. Then, if the treatment group (i.e., the group getting the medicine) had sufficiently fewer colds than the control group, it would be reasonable to conclude that the medicine was effective in preventing colds.

# INTERNAL VALIDITY

✓ **Internal validity**: Ability to draw conclusions about causal relationships from the data

  ✓ Good internal validity = Results can be attributed to the effect of the independent variable

  ✓ Good Experimental Design = Eliminates confounding variables (a.k.a. alternative explanations)

  ✓ *When a confounding variable is present, internal validity is questionable*

# BASIC EXPERIMENTS

✓ The simplest possible experimental design has two variables: IV and DV

✓ The IV has a minimum of two levels
  - ✓ experimental group
  - ✓ control group

✓ Researchers must ensure the only difference between the two groups (i.e., levels) is the manipulated IV.

✓ **Posttest-only design**
  - ✓ Must:
    1. *Obtain two equivalent groups of participants and Introduce the IV to one of them*
    2. *Measure the effect of the IV on the DV*
  - ✓ *To achieve equivalent groups we use randomization to eliminate **selection differences**.*
    - ✓ The people selected for each condition cannot differ in any systematic way (e.g., all women vs all men).

# BASIC EXPERIMENTS

✓ Pretest-posttest design

  ✓ The only difference between the posttest-only design and the **pretest-posttest design** is that in the latter a pretest is given before the experimental manipulation is introduced.

    ✓ Ensures groups are equivalent before the experiment

    ✓ Minimum of 20 to 30 participants are required **per condition** for a statistically significant effect

✓ Comparing posttest-only and pretest-posttest designs

- ✓ For a **true experimental design**: participants must be randomly assigned to groups
- ✓ **Advantages of the Pretest-Posttest Design**:
  - ✓ It assess equivalency of groups with small sample size
  - ✓ Can be used to select participants for the experiment
  - ✓ It can detect changes between two points in time
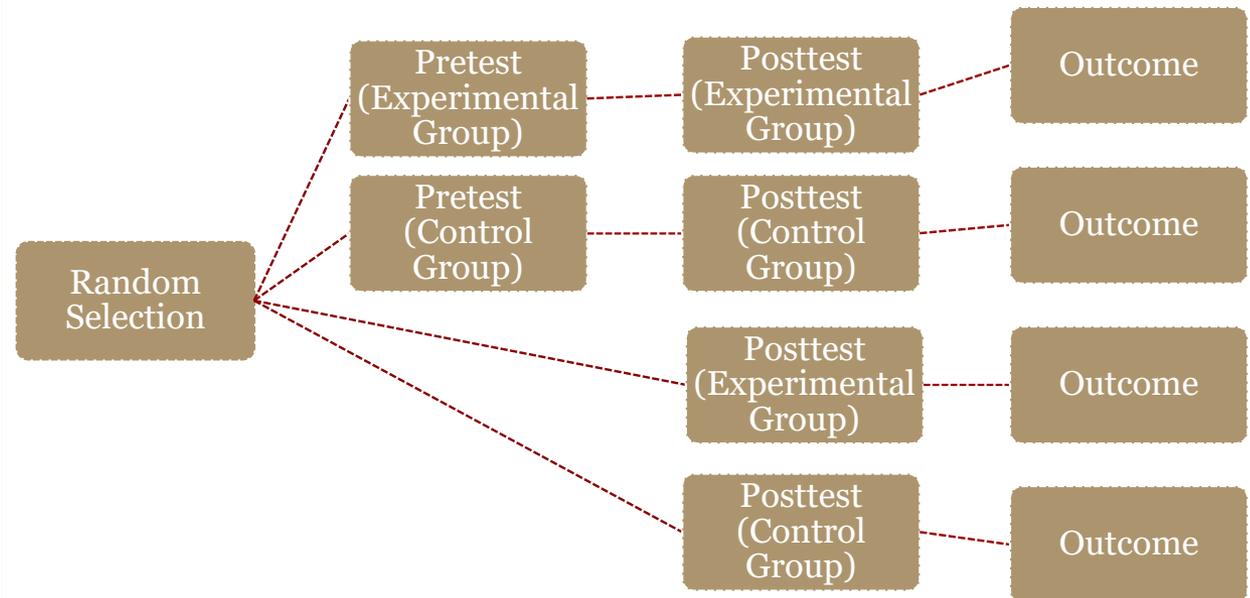    - ✓ (e.g., before and after manipulating the IV)

✓ **Disadvantages of the pretest-posttest design**

  ✓ **Disadvantages:**

    ✓ **Mortality (attrition)** is the Dropout factor in experiments

    ✓ Time consuming

    ✓ Requires more resources

    ✓ Awkward to administer

    ✓ Participants may figure out what is being studied

    ✓ *Practice effects or Carry over effects*

      ✓ *When participants do better on the second test because they learned from the first test.*

      ✓ *It occurs with repeated exposure to a task.*

    ✓ Affects the way participants react to manipulation

✓ It is also possible to assess the impact of the pretest directly with a combination of both the posttest-only and the pretest-posttest design with a <u>Solomon Four-Group Design</u>. *In this design, half the participants receive only the posttest, and the other half receive both the pretest and the posttest.*

# SOLOMON FOUR-GROUP DESIGN

```
Random Selection
  ├─ Pretest (Experimental Group) --- Posttest (Experimental Group) --- Outcome
  ├─ Pretest (Control Group) --- Posttest (Control Group) --- Outcome
  ├─ Posttest (Experimental Group) --- Outcome
  └─ Posttest (Control Group) --- Outcome
```

# Repeated Measures Design
## (a.k.a.Within-subjects )

✓ **Repeated measures design**: *One group of participants are assigned to multiple conditions* (i.e., each level of the independent variable)

  ✓ In an experiment with two conditions, for example, each participant is assigned to both levels of the independent variable., and each participant is measured after receiving each level of the independent variable.

  ✓ a.k.a. **Within-subjects design**

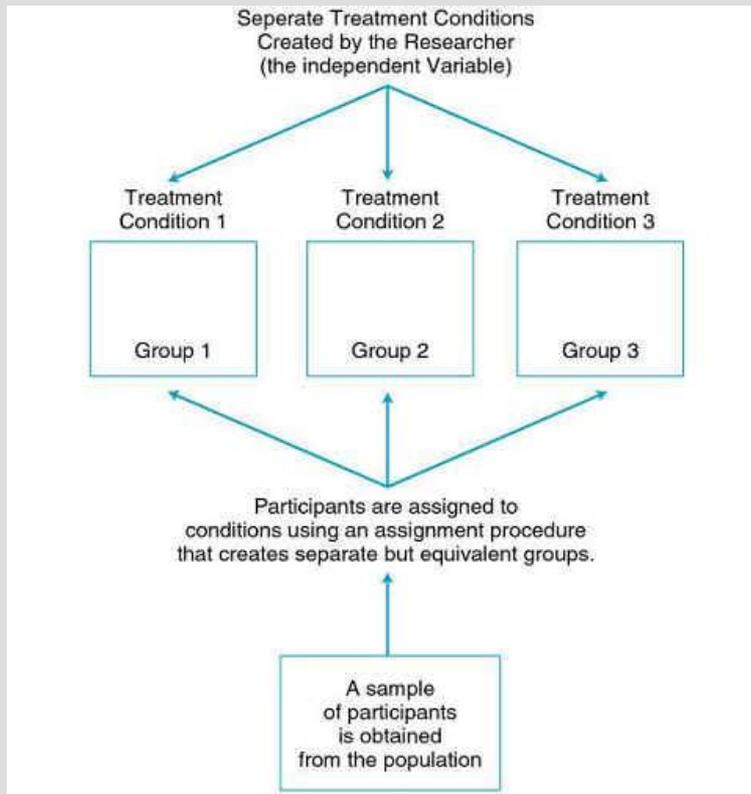    ✓ because comparisons are made within the **same** group of participants

✓ **Independent groups design**: *More than one group of participants participate in one or more conditions*

  ✓ a.k.a. **Between-subjects design**

    ✓ comparisons are made between **different** groups of participants.

    ✓ Example: Experiment with two conditions/levels of the IV

      ✓ each group is assigned to only one of the conditions

      ✓ each participant is measured after experiencing that condition
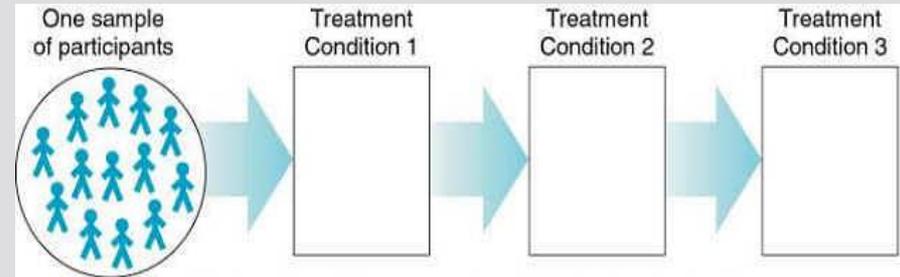
# Between vs. Within Subjects Designs

**INDEPENDENT GROUPS (Between Subjects Design)**

**REPEATED MEASURES (Within Subjects Design)**



Seperate Treatment Conditions Created by the Researcher (the independent Variable)

Treatment Condition 1 — Group 1

Treatment Condition 2 — Group 2

Treatment Condition 3 — Group 3

Participants are assigned to conditions using an assignment procedure that creates separate but equivalent groups.

A sample of participants is obtained from the population



One sample of participants → Treatment Condition 1 → Treatment Condition 2 → Treatment Condition 3

## Advantages

- ✓ The repeated measures design has several advantages.
  - ✓ <u>Fewer participants are needed</u>
    - ✓ because each participant is in all conditions
  - ✓ Saves money and resources
  - ✓ Greater control over participant differences
    - ✓ thus greater ability to detect an effect of the IV
      - ✓ It is extremely sensitive to statistical differences between groups
        - ✓ Statistically speaking, repeated measures calculations do not need to allow for the random differences found between groups in an independent groups design.
        - ✓ These random differences between individuals and groups is often called "**random error**" or **error**.

## Disadvantages

- ✓ In a repeated measures design the different conditions must be presented in a particular sequence.
  - ✓ **Order effect**: *The order of presenting the treatments affects the dependent variable*
  - ✓ **Practice** (**learning**) **effect**: Performance improves because of the practice gained from previous tasks
  - ✓ **Fatigue effect**: *Performance deteriorates because the participant becomes tired, bored, or distracted from previous tasks.*
    - ✓ *The participants performance deteriorates with the passage of time.*
  - ✓ **Carryover effect**: Effect of the previous treatment carry over to influence the response of the next treatment.
    - ✓ *This could be especially important for some experimental conditions.*
      - ✓ *For example, when testing alcohol or drugs*
      - ✓ *if there is not enough time between treatments, prior testing can carry over to later testing*

✓ **Counterbalancing**

✓ *To counteract the influence of order effects, researchers often use a counterbalanced design.*

✓ *It reduces the chances of the order of treatment or other factors adversely influencing the results.*

## ✓ **2 Types of Counterbalancing**

- ✓ **Complete counterbalancing**: All possible orders of presentation are included in the experiment

- ✓ **Latin square**: Constructed for using the technique to control for order effects without having all possible orders

  - ✓ It is a limited set of orders constructed to ensure that each condition appears at each ordinal position, and each condition precedes and follows each condition one time.

## ✓ Consider **Time Interval between Treatments**

- ✓ In addition to counterbalancing, researchers need to determine the time interval between treatments and possible activities between them.

# Latin Square Design

- ## For Example:
  - Four types of materials are to be tested in the laboratory.
  - Four laboratories will do the testing on four different days.
  - There is a known "lab effect" in the outcome
  - There is also a known "day" effect in the outcome because the response is very sensitive to small changes in temperature and humidity.

- One possibility is to have all four laboratories test all four materials on all four days.
  - This experimental design would require 4 x 4 x 4 = 64 runs.
- An alternative experimental design is a "Latin Square"

- Let A, B, C, D denote the four types of material.
  - Remember the question of interest is whether there are differences among these four types. We do not want laboratory or day effects to bias the results.
- Here is a suitable design that could be used to conduct this experiment.

| Day | Laboratory | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 1 | C | D | B | A |
| 2 | A | B | D | C |
| 3 | D | C | A | B |
| 4 | B | A | C | D |

- Treatment levels always appear once in each row and column

- In behavioral research, if Subjects are <u>assigned to each cell</u>, then the design is a between-subjects (independent measures) design, the Latin Square design allows us to use 16 tests rather than 64.

- If Subjects are assigned so that a Subjects are <u>tested across the levels of a factor</u>, then the design is a within-subject (repeated measures) design, the Latin Square design allows us to use only 4 tests.

- **Random assignment**: Is used in an independent groups design to assign different participants to each of the condition

  - This means that the decision to assign an individual to a particular condition is completely random

  - Participants are randomly selected in a number of ways:

    - Coin toss

    - Random number generator

    - Based on day of the week or dates

## ✓ **Advantages**

- ✓ Participants are not likely to be affected by order effects (as in the repeated measures design) they are only involved in one of the conditions.
- ✓ Sample drop off is not an issue
- ✓ Participant reactivity bias is not an issue
  - ✓ since they only take part in one condition
- ✓ they are less likely to guess the aim of the experiment
  - ✓ so more likely to behave normally
- ✓ Demand Characteristics are less likely, as there are fewer clues about the research hypothesis in an independent groups design.
  - ✓ **Demand Characteristic**: a subtle cue that makes participants aware of what the experimenter expects to find or how participants are expected to behave

✓ **Disadvantages**

  ✓ Participant variables are the main disadvantage

    ✓ Participants are different in each condition,

      ✓ difference between conditions in the DV may be due to different characteristics and abilities of the participants

  ✓ More participants are needed for Independent Groups design (Between-subjects) compared to a Repeated Measures design (Within-subjects)

✓ A somewhat more complicated method of assigning participants to conditions in an experiment called a **matched pairs design**.

✓ Instead of simply randomly assigning participants to groups, the g*oal is to match people on a participant characteristic and then randomly assigning one member of each pair to each group:*

  ✓ Age, Gender, Ethnicity, IQ score, Personality Trait, etc.

✓ The matching variable will be either the dependent measure or a variable that is strongly related to the dependent variable.

✓ For example: Different participants take part in each condition,

  ✓ each participant in one condition has been matched with another participant in the other condition on important characteristics.

    ✓ If one participant is male, aged 41, middle-class, has an IQ of 98 etc,

    ✓ then the other condition must have a similar participant.

  ✓ Identical twins are ideal for a matched-pairs designs.

  ✓ Researchers often used identical twins when doing genetic research to search for diseases, disorders, and other characteristics that may be inherited.

# ✓ **Advantages**

- ✓ This has the same advantages as the independent groups design, but with a lower risk of participant variables influencing the DV.
  - ✓ So the matched-pairs design eliminates order effects, whilst reducing participant variables

# MATCHED PAIRS DESIGN

✓ **Disadvantages**

- ✓ It can be difficult to find similar participants to take part in either condition,

- ✓ It may be challenging to know exactly which characteristics are required to match.

- ✓ It is considered that this design takes the longest to prepare,

- ✓ So is often overlooked in research where resources are limited.