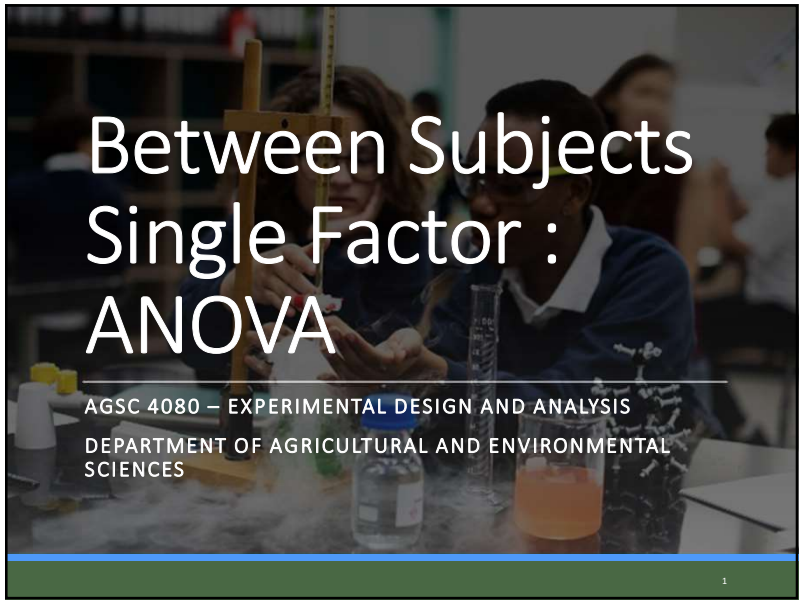

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Objectives

- Understand the Between-Subjects Single Factor Design
- Comprehend Random Assignment
- Master One-Way ANOVA
- Learn to Compute the F-statistic
- Explore Post Hoc Tests

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Between-Subjects Design

Definition
In a between-subjects design, each participant is tested in only one condition or treatment group.

Example
Assigning half of 100 students to write about a traumatic event and half about a neutral event.

Single Factor
Studies with one independent variable are called between-subjects single factor designs.

Contrast
Different from within-subjects design, where participants experience multiple conditions.

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Random Assignment

1 Purpose
Random assignment is the primary method researchers use to control for extraneous variables across conditions.

2 Key Criteria
Each participant has an equal chance of being assigned to each condition, and assignments are made independently.

3 Methods
Techniques include coin flips for two conditions or computer-generated random integers for multiple conditions.

4 Importance
While not infallible, random assignment is considered a strength of research design and works well for large samples.

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Activity: Basketball Shootout

We want to test the accuracy of different shooting methods: left hand vs right hand vs both hands. We will randomly assign students to each group using an online random assignment tool

- Discuss the potential weaknesses of random assignment

A: Left Hand	B: Right Hand	C: Both Hands

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One-Way ANOVA Overview

1. **Definition**
   One-way ANOVA is a statistical test used when there is one independent variable with at least two levels.
2. **Comparison to t-test**
   For two-level designs, ANOVA gives similar results to a t-test, with F-value being equivalent to t^2 value.
3. **F-statistic**
   The key output of ANOVA is the F-value, which is a ratio of the effect measure to the error measure.

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Understanding the F-statistic

$$\text{name of statistic} = \frac{\text{measure of effect}}{\text{measure of error}}$$

$$F = \frac{\text{measure of effect}}{\text{measure of error}}$$

$$F = \frac{\text{Can Explain}}{\text{Can't Explain}}$$

1. **Concept**
   The F-statistic represents a ratio of what can be explained by the experimental manipulation to what cannot be explained (error).
2. **Interpretation**
   F = 1: Equal explanation and error
   F > 1: More explanation than error
   F < 1: Less explanation than error
3. **Example**
   An F-value of 5 indicates researchers can explain 5 times more variation than they can't explain, which is considered **good**.

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Computing the F-statistic

$$SS_{\text{total}} = SS_{\text{Effect}} + SS_{\text{Error}}$$

1. **Total Variation**
   The ANOVA process begins by splitting total variation in the data into two parts: variation due to manipulation and variation due to sampling error.
2. **Sums of Squares**
   Variation is measured using sums of squares (SS), following the formula: SSTotal = SSEffect + SSError
3. **Calculating SSTotal**
   Find the difference between each score and the grand mean, square the differences, and sum them up.
4. **Calculating SSEffect and SSError**
   SSEffect is calculated using group means, while SSError represents unexplained variation within groups.

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Activity: Computing SS_{total}, SS_{Effect} , SS_{Error}

Let's imagine we had some data in three groups, A, B, and C. The data looks like below. Let's compute SS_{total}, SS_{Effect} , and SS_{Error}

groups	scores
A	20
A	11
A	2
B	6
B	2
B	7
C	2
C	11
C	2

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Degrees of Freedom in ANOVA

Component	Formula	Example (3 groups, 9 scores)
dfEffect	Groups - 1	3 - 1 = 2
dfError	Scores - Groups	9 - 3 = 6

Degrees of freedom (df) are crucial in ANOVA calculations. For SSEffect, df represents the freedom of group means relative to the grand mean. For SSError, df accounts for the constraints imposed by calculating group means.

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Mean Squares Calculation

Purpose

Mean Squares normalize the Sums of Squares by dividing them by their respective degrees of freedom.

1

MSEffect

Calculated as SSEffect / dfEffect, representing the average variation due to the experimental effect.

2

MSError

Calculated as SSError / dfError, representing the average unexplained variation.

3

Interpretation

Mean Squares provide a standardized measure of variation, allowing for meaningful comparison between effect and error.

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Final F-statistic Calculation

Formula

F = MSEffect / MSError

Interpretation

The F-statistic represents the ratio of explained variation to unexplained variation.

Significance

A larger F-value suggests a stronger effect of the independent variable on the dependent variable.

Next Steps

After calculating F, determine the corresponding p-value to assess statistical significance.

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Activity: Basketball Shootout

We want to test the accuracy of different shooting methods: left hand vs right hand vs both hands. Each member of each group will shoot using the assigned shooting metho. We will record the number of shots made out of 5 and then compute the F-statistics

Individuals	Groups	Score

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Conclusion: The Power of ANOVA

Analysis Tool

ANOVA provides a powerful method for analyzing variance in experimental data.

Versatility

It can be applied to various research designs with different numbers of groups and participants.

Insight

ANOVA helps researchers determine if differences between groups are statistically significant.

Decision Making

Results guide researchers in accepting or rejecting null hypotheses and drawing conclusions.

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F-Statistic & ANOVA Challenge

- We will play this game in group of 3. The winner has a bonus point of 1 on ICEs
- To play the game:
  - Click on this link: https://abdelawani.shinyapps.io/F-Statistic_ANOVA_Challenge_Game_Show/
  - or scan the QR Code

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