

# POLITICAL SCIENCE 205

## INTRODUCTION TO RESEARCH METHODOLOGY

ANOVA  
Monday, July 9

**Agenda**


- I. A Brief Refresher
- II. One-Way ANOVAs
- III. Practicing with ANOVAs

Week 4, Day 1

A Brief Refresher
One-Way ANOVA
Practicing with ANOVA

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### Lecture Question



How do we go *beyond* only testing the difference between two groups?

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### T-Tests Reviewed

**Independent Variable**

Two categories  
(nominal or ordinal)

**Dependent Variable**

Interval-ratio variables

**Definition:** The difference in the average scores between two independent groups on the same variable.

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### What does a T-Test give us?

**Definition:** The difference in the average scores between two independent groups on the same variable.

This is the **T-Test for Dependent Samples**. We will only refer to this t-test for the rest of the quarter. Remember, you need:

1. An independent variable with only two categories
2. A dependent variable that is interval-ratio

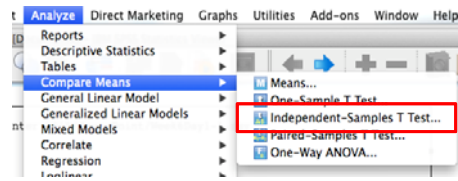
- **T-value**  
Our **test statistic** that we calculated from the equation. The equation calculates a standardized number to evaluate two group means on the normal curve.
- **Degrees of freedom**  
The degrees of freedom helps us find our **critical value** to interpret our T-value. For the t-test, the degrees of freedom is always calculated as  $(n_1-1) + (n_2-1)$ . We use the appendix (p. 403) to find our **critical value** needed to reject the null hypothesis.
- **Significance value**  
Only calculated by SPSS, the significance value tells us if our t-value is higher or lower than our **critical value**, without having to calculate the t-value or degrees of freedom on your own.

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### Using SPSS to calculate a T-Test



Analyze > Compare Means > Independent Samples T Test...

**Note:** You won't ever be asked to calculate a t-value by hand OR evaluate a t-value using the appendix.

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### Interpreting the SPSS T-Test

**Hypothesis:** There is a difference between a) Democrats and b) Republicans on their beliefs that Donald Trump is ready to be president.

|   |                             | Levene's Test for Equality of Variances |      | t-test for Equality of Means |       | 95% Confidence Interval of the Difference |         |        |
|---|-----------------------------|---|------|------------------------------|-------|---|---------|--------|
|   |                             | F                                       | Sig. | t                            | df    | Mean Difference                           | Lower   | Upper  |
| TRUMP (ready to be president of the US, 10-point scale) | Equal variances assumed     | 8.461                                   | .004 | -2.764                       | 11    | -2.2667                                   | -4.0734 | -.4600 |
|   | Equal variances not assumed |   |      | -1.942                       | 2.093 | -.238                                     | -2.2667 | 1.6697 |

① **T-value** When comparing party ID on the belief that Trump is ready to be president, my t-value is **-2.764**.

② **Degrees of freedom** The degrees of freedom for this t-test is **11**.

③ **Significance value** There is a **1.8%** chance that the difference between Democrats and Republicans on this question was random. The relationship is **significant**.

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**Significance Values**

**Definition:** Significance values tells us if our hypothesized relationship is due to random chance.

Every single **test statistic** we calculate in the remaining weeks of the class (T-Tests, ANOVAs, Chi-square, Correlations, Regressions) will have significance values. They are all interpreted in the same exact manner, no matter the test.

**0 < Significance Values < 1**  
Relationships exist only if your significance value is under .05.  
If your significance value is above .05, then the relationship does not exist.

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**Interpretation of Significance**

| Significance Value | Relationship     | Interpretation  |
|--------------------|------------------|---|
| .00                | Significant!     | There is a <b>0%</b> probability the relationship is due to chance. <b>The relationship exists!</b>                   |
| .00-.05            | Significant!     | There is <b>between a 0% and 5%</b> probability the relationship is due to chance. <b>The relationship exists!</b>    |
| .05                | Significant!     | There is a <b>5%</b> probability the relationship is due to chance. <b>The relationship exists!</b>                   |
| > .05              | Not significant! | There is <b>more than a 5%</b> probability the relationship is due to chance. <b>The relationship does not exist!</b> |

How do we get the percentage? **.03 = 3%** **.78 = 78%**

Please note: You can indeed write about insignificant relationships in your research!

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**One-Way ANOVAs**

**One-Way ANOVAs** test the difference in the average scores on **one variable** (dependent variable) between **multiple groups** (multiple categories of one independent variable).

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**Assumptions for the One-Way ANOVA**

1. Independent variable has more than two categories (nominal or ordinal)
2. Dependent variable is interval-ratio.

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**Hypothesis**




**Hypothesis:** There is a difference amongst a) people who didn't graduate high school, b) high school graduates, c) people with some college education, d) people with an associates degree, e) people with a bachelor's degree, and f) people with a post-graduate degree on their feeling thermometer score for Donald Trump.

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**Non-Directional Hypotheses**

Like T-tests, ANOVAs only use **non-directional hypotheses**... thereby using a two-tailed test.



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**F-Statistic**

Named after the guy who invented it, the **F-Statistic** is our **test statistic** for **One-Way ANOVAs**.

So what does it do?

$$F = \frac{\text{Variability}_{(\text{between})}}{\text{Variability}_{(\text{within})}}$$

Variability<sub>(between)</sub> = The variability between groups is due to genuine differences between the groups.

Variability<sub>(within)</sub> = The variability within groups is due to random chance.

In short, this equation compares the difference between groups to differences we see by chance.

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**The F-Statistic for Our Hypothesis**

$F = 1.079$

Use the appendix on page 406 to find the F-statistic needed to reject the null hypothesis

We need to calculate the degrees of freedom for both numerator & denominator:

$$df_{(\text{numerator})} = \# \text{ of groups} - 1 = 6 - 1 = 5$$

$$df_{(\text{denominator})} = \# \text{ of observations} - \# \text{ of groups} = 1197 - 6 = 1191$$

**Hypothesis:** There is a difference amongst education on their feeling thermometer score for Donald Trump.

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Appendix B • Tables

| df for the denominator | Type I Error Rate | 1    | 2    | 3    | 4    | 5    |
|------------------------|-------------------|------|------|------|------|------|
| 10                     | 0.10              | 4.10 | 3.10 | 2.76 | 2.59 | 2.45 |
| 20                     | 0.10              | 3.85 | 2.85 | 2.51 | 2.34 | 2.20 |
| 30                     | 0.10              | 3.68 | 2.68 | 2.34 | 2.17 | 2.03 |
| 40                     | 0.10              | 3.56 | 2.56 | 2.22 | 2.05 | 1.91 |
| 50                     | 0.10              | 3.48 | 2.48 | 2.14 | 1.97 | 1.83 |
| 60                     | 0.10              | 3.42 | 2.42 | 2.08 | 1.91 | 1.77 |
| 70                     | 0.10              | 3.37 | 2.37 | 2.03 | 1.86 | 1.72 |
| 80                     | 0.10              | 3.33 | 2.33 | 1.99 | 1.82 | 1.68 |
| 90                     | 0.10              | 3.30 | 2.30 | 1.96 | 1.79 | 1.65 |
| 100                    | 0.10              | 3.27 | 2.27 | 1.93 | 1.76 | 1.62 |
| 120                    | 0.10              | 3.23 | 2.23 | 1.89 | 1.72 | 1.58 |
| 140                    | 0.10              | 3.20 | 2.20 | 1.86 | 1.69 | 1.55 |
| 160                    | 0.10              | 3.18 | 2.18 | 1.84 | 1.67 | 1.53 |
| 180                    | 0.10              | 3.16 | 2.16 | 1.82 | 1.65 | 1.51 |
| 200                    | 0.10              | 3.15 | 2.15 | 1.81 | 1.64 | 1.50 |
| 250                    | 0.10              | 3.12 | 2.12 | 1.78 | 1.61 | 1.47 |
| 300                    | 0.10              | 3.10 | 2.10 | 1.76 | 1.59 | 1.45 |
| 350                    | 0.10              | 3.08 | 2.08 | 1.74 | 1.57 | 1.43 |
| 400                    | 0.10              | 3.07 | 2.07 | 1.73 | 1.56 | 1.42 |
| 450                    | 0.10              | 3.06 | 2.06 | 1.72 | 1.55 | 1.41 |
| 500                    | 0.10              | 3.05 | 2.05 | 1.71 | 1.54 | 1.40 |
| 600                    | 0.10              | 3.03 | 2.03 | 1.69 | 1.52 | 1.38 |
| 700                    | 0.10              | 3.02 | 2.02 | 1.68 | 1.51 | 1.37 |
| 800                    | 0.10              | 3.01 | 2.01 | 1.67 | 1.50 | 1.36 |
| 900                    | 0.10              | 3.00 | 2.00 | 1.66 | 1.49 | 1.35 |
| 1000                   | 0.10              | 2.99 | 1.99 | 1.65 | 1.48 | 1.34 |
| 1200                   | 0.10              | 2.97 | 1.97 | 1.63 | 1.46 | 1.32 |
| 1400                   | 0.10              | 2.96 | 1.96 | 1.62 | 1.45 | 1.31 |
| 1600                   | 0.10              | 2.95 | 1.95 | 1.61 | 1.44 | 1.30 |
| 1800                   | 0.10              | 2.94 | 1.94 | 1.60 | 1.43 | 1.29 |
| 2000                   | 0.10              | 2.93 | 1.93 | 1.59 | 1.42 | 1.28 |
| 2500                   | 0.10              | 2.91 | 1.91 | 1.57 | 1.40 | 1.26 |
| 3000                   | 0.10              | 2.90 | 1.90 | 1.56 | 1.39 | 1.25 |
| 3500                   | 0.10              | 2.89 | 1.89 | 1.55 | 1.38 | 1.24 |
| 4000                   | 0.10              | 2.88 | 1.88 | 1.54 | 1.37 | 1.23 |
| 4500                   | 0.10              | 2.87 | 1.87 | 1.53 | 1.36 | 1.22 |
| 5000                   | 0.10              | 2.86 | 1.86 | 1.52 | 1.35 | 1.21 |
| 6000                   | 0.10              | 2.85 | 1.85 | 1.51 | 1.34 | 1.20 |
| 7000                   | 0.10              | 2.84 | 1.84 | 1.50 | 1.33 | 1.19 |
| 8000                   | 0.10              | 2.83 | 1.83 | 1.49 | 1.32 | 1.18 |
| 9000                   | 0.10              | 2.82 | 1.82 | 1.48 | 1.31 | 1.17 |
| 10000                  | 0.10              | 2.81 | 1.81 | 1.47 | 1.30 | 1.16 |

$df_{(\text{numerator})} = 5$

$df_{(\text{denominator})} = 1191$

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**The F-Statistic for Our Hypothesis**

$F = 1.079$

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We need to calculate the degrees of freedom for both numerator & denominator:

$$df_{(\text{numerator})} = \# \text{ of groups} - 1 = 6 - 1 = 5$$

$$df_{(\text{denominator})} = \# \text{ of observations} - \# \text{ of groups} = 1197 - 8 = 1191$$

$F = 2.22$

**Hypothesis:** There is a difference amongst education on their feeling thermometer score for Donald Trump.

This is our value needed to reject the null hypothesis

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**Interpreting the Critical Value**

A confirmed relationship falls into either of these boxes.

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**What does an ANOVA give us?**

**Definition:** The test the difference in the average scores on **one variable** (dependent variable) between **multiple groups** (multiple categories of an independent variable).

This is the **One-Way ANOVA**. We will use this ANOVA for the rest of the quarter. Remember, you need:

1. An independent variable with more than two categories
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- **F-statistic**  
Our **test statistic** that we calculated from the equation. The equation compares the differences between groups to differences we see by random chance.
- **Degrees of freedom**  
The degrees of freedom helps us find our **critical value** to interpret our T-value. For the f-statistic, we calculate two values for this: numerator and denominator. We use the appendix (p. 406) to find our **critical value** needed to reject the null hypothesis.
- **Significance value**  
Only calculated by SPSS, the significance value tells us if our f-statistic is higher or lower than our **critical value**, without having to calculate the f-statistic or degrees of freedom on your own.

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## Using SPSS to calculate an ANOVA

Analyze > Compare Means > One-Way ANOVA

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## Interpreting the SPSS F-Statistic

**Hypothesis:** There is a difference amongst a) people who didn't graduate high school, b) high school graduates, c) people with some college education, d) people with an associates degree, e) people with a bachelor's degree, and f) people with a post-graduate degree on their feeling thermometer score for Donald Trump.

|                | Sum of Squares | df   | Mean Square | F     | Sig. |
|----------------|----------------|------|-------------|-------|------|
| Between Groups | 11368.929      | 5    | 2273.786    | 1.709 | .130 |
| Within Groups  | 1584532.63     | 1191 | 1330.422    |       |      |
| Total          | 1595901.56     | 1196 |             |       |      |

- F-statistic** When comparing education on the feeling thermometer for Donald Trump, my f-statistic is **1.709**.
- Degrees of freedom** The first degrees of freedom (between groups) is **5**, the second (within groups) is **1191**.
- Significance value** There is a **13.0%** probability that the difference amongst education on the feeling thermometer for Donald Trump is random. The relationship does not exist, we accept the null.

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## Practicing with ANOVA

| Test Statistic                      | When do we do it?   | Independent Variable                       | Dependent Variable       |
|-------------------------------------|---|--|--------------------------|
| T-Test (Independent Samples T-Test) | Non-directional hypothesis comparing two groups on one variable.          | Two categories ONLY (nominal/ordinal)      | Interval-ratio variables |
| ANOVA (One-Way ANOVA)               | Non-directional hypothesis comparing multiple categories on one variable. | More than two categories (nominal/ordinal) | Interval-ratio variables |

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## Activity 4, Part A

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