Applied Statistical Analysis

EDUC 6050

Week 6

Finding clarity using data

Today

1. Hypothesis Testing with T-tests
2. Confidence Intervals
3. Chapters 9 and 10 in Book

Review

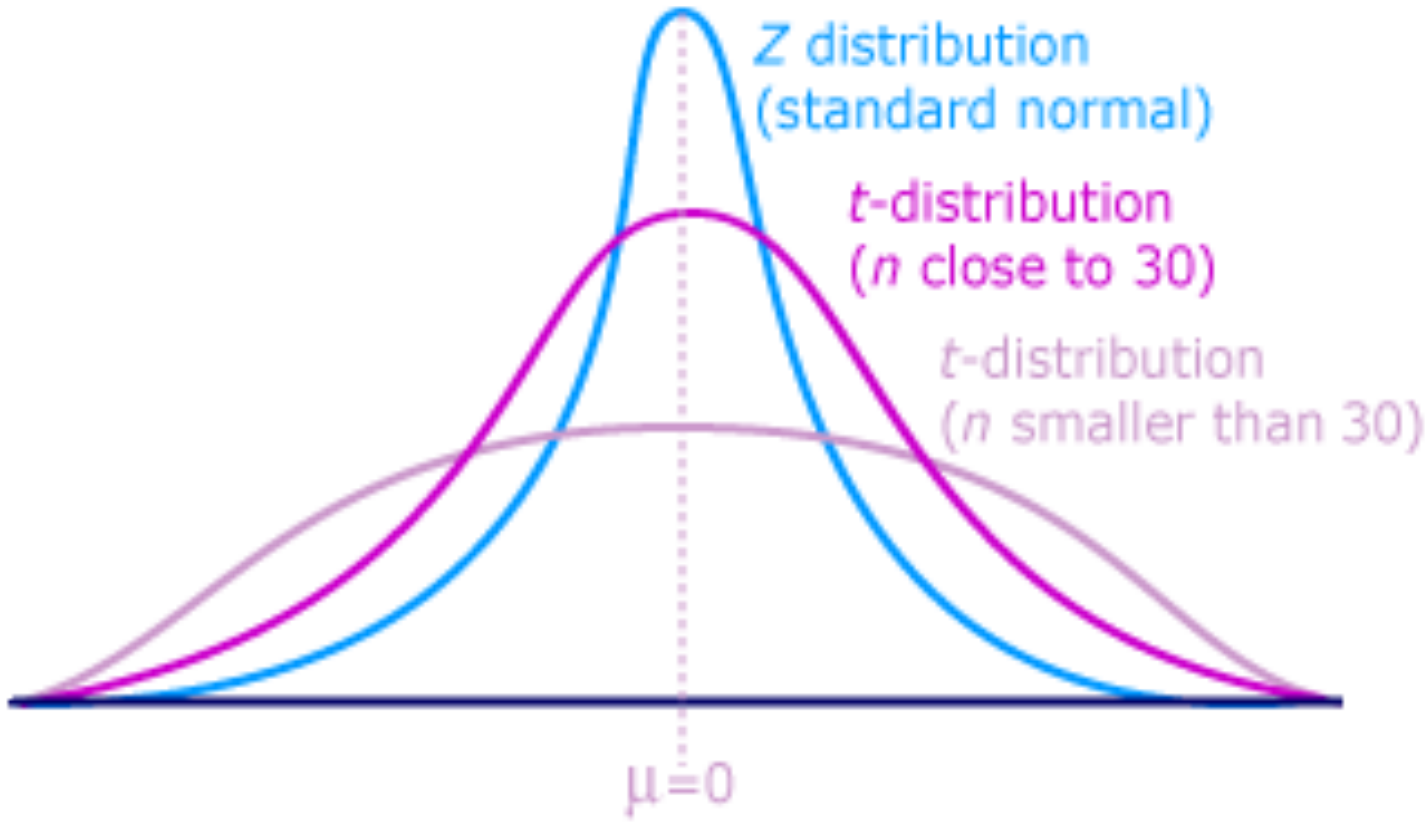
$$? = \frac{X - \mu}{SD / \sqrt{N}}$$

1. What test is this for
2. What situations can be do hypothesis testing for (before what we are talking about today)?
3. What types of t-tests did you read about this week?

Independent Samples T-test

Situation	Test to Use	Formulas
Know population mean and want to **compare our single sample** to it	One-Sample T-Test	$t = \frac{M - \mu}{SD/\sqrt{N}}$
Have **two independent** groups that you want to compare	Independent Samples T-Test	$t = \frac{M_1 - M_2 - (\mu_1 - \mu_2)}{SD_p/\sqrt{N}}$ SD_p is a pooled standard deviation

Still using the same t-distribution



Requirements

1. Need a DV on an interval/ratio scale,
2. IV defines two different groups
3. The groups are independent (not repeated measures)

ID	Outcome	Group
1	8	1
2	8	1
3	9	1
4	7	1
5	7	2
6	9	2
7	5	2
8	5	2

Hypothesis Testing with T-Tests

The same 6 step approach!

1. Examine Variables to Assess Statistical Assumptions
2. State the Null and Research Hypotheses (symbolically and verbally)
3. Define Critical Regions
4. Compute the Test Statistic
5. Compute an Effect Size and Describe it
6. Interpreting the results

1 Examine Variables to Assess Statistical Assumptions

Basic Assumptions

1. Independence of data
2. Appropriate measurement of variables for the analysis
3. Normality of distributions
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Individuals are independent of each other (one person's scores does not affect another's)

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2. **Appropriate measurement** of variables for the analysis
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Here we need interval/ratio DV and an IV defines two groups

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The outcome needs to be normal (for small samples)

1 Examine Variables to Assess Statistical Assumptions

Basic Assumptions

1. Independence of data
2. Appropriate measurement of variables for the
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4. Homogeneity of variance

The variances of the two groups should be equal (although we can handle not equality)

1 Examine Variables to Assess Statistical Assumptions

Examining the Basic Assumptions

1. **Independence:** random sample
2. **Appropriate measurement:** know what your variables are
3. **Normality:** Histograms, skew and kurtosis
4. **Homogeneity:** Levene's Test

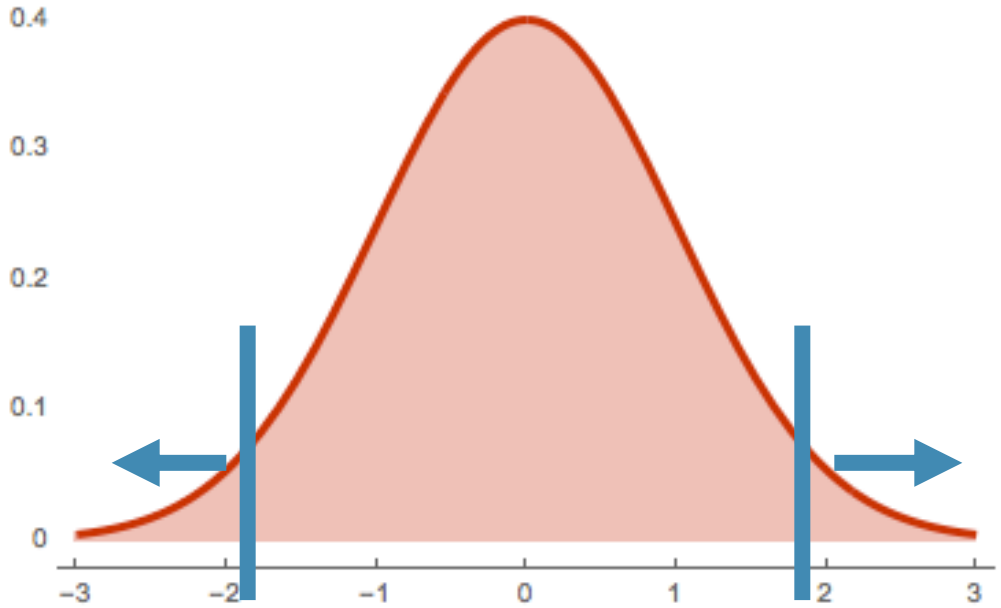
2 State the Null and Research Hypotheses (symbolically and verbally)

Hypothesis Type	Symbolic	Verbal	Difference between means created by:
Research Hypothesis	$\mu_{group\ 1} \neq \mu_{group\ 2}$	One of the groups' means is different than the other	True differences
Null Hypothesis	$\mu_{group\ 1} = \mu_{group\ 2}$	There is no *real* difference between the group 1 and the group 2	Random chance (sampling error)

3 Define Critical Regions

How much evidence is enough to believe the null is not true?

Before analyzing the data, we define the critical regions (generally based on an alpha = .05)



3 Define Critical Regions

We decide on an alpha level first

↳ Then calculate the critical value (based on sample size)

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- Base on alpha and a specific df

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12	0.259033	0.695483	1.356217	1.782288	2.17881	2.68100	3.05454	43178
13	0.258591	0.693829	1.350171	1.770933	2.16037	2.65031	3.01228	4.2208
14	0.258213	0.692417	1.345030	1.761310	2.14479	2.62449	2.97684	4.1405
15	0.257885	0.691197	1.340606	1.753050	2.13145	2.60248	2.94671	4.0728
16	0.257599	0.690132	1.336757	1.745884	2.11991	2.58349	2.92078	4.0150
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21	0.256580	0.686352	1.323188	1.720743	2.07961	2.51765	2.83136	3.8193
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23	0.256297	0.685306	1.319460	1.713872	2.06866	2.49987	2.80734	3.7676
24	0.256173	0.684850	1.317836	1.710882	2.06390	2.49216	2.79694	3.7454
25	0.256060	0.684430	1.316345	1.708141	2.05954	2.48511	2.78744	3.7251
26	0.255955	0.684043	1.314972	1.705618	2.05553	2.47863	2.77871	3.7066
27	0.255858	0.683685	1.313703	1.703288	2.05183	2.47266	2.77068	3.6896
28	0.255768	0.683353	1.312527	1.701131	2.04841	2.46714	2.76326	3.6739
29	0.255684	0.683044	1.311434	1.699127	2.04523	2.46202	2.75639	3.6594
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z	0.253347	0.674490	1.281552	1.644854	1.95996	2.32635	2.57583	3.2905
CI	———	———	80%	90%	95%	98%	99%	99.9%

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4	0.270722	0.740697	1.533206	2.131847	2.7[illegible]645	3.74695	4.60409	8.6103
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↳ Then calculate the critical value (based on sample size)

$$t_{critical,\,29} = 2.05$$

So our critical regions is defined as:

$$\alpha = .05$$

$$t_{critical,\,29} = 2.05$$

4 Compute the Test Statistic

$$t = \frac{M_1 - M_2 - (\mu_1 - \mu_2)}{SD/\sqrt{N}}$$

The SEM, μ, and M will be given to you

Calculate it and compare to $t_{critical}$
Or
Calculate it, look up its p-value, and compare to our α level

5 Compute an Effect Size and Describe it

One of the main effect size estimates is **Cohen's d**

$$d = \frac{M_1 - M_2}{SD_p}$$

d	Estimated Size of the Effect
Close to .2	Small
Close to .5	Moderate
Close to .8	Large

6 Interpreting the results

Put your results into words

Use the example on page XX as a template

Independent Samples T-test

Let's practice!

- Study about attention span and our "Creation of Totally Distracted People" intervention
- Two groups: 1) Treatment and 2) Control
- $M_1 = 70, M_2 = 75$ and $SD_1 = 10, SD_2 = 10$ with a N = 100 in both groups
- We think our intervention works so we want to test it

- Can we say that it does work?

Let’s use Jamovi

Independent Samples T-test

Break Time

Paired Samples T-test

Situation	Test to Use	Formulas
Have **two independent** groups that you want to compare	Independent Samples T-Test	$t = \frac{M_1 - M_2 - (\mu_1 - \mu_2)}{SD_p / \sqrt{N}}$
Have **same individuals measured two times**	Paired Samples T-Test (Dependent Samples T-Test)	$t = \frac{M_{diff} - (\mu_{diff})}{SD_{DIFF} / \sqrt{N}}$ SD_{DIFF} is the standard devation of the difference

Requirements

1. Need a DV on an interval/ratio scale,
2. IV defines two time points
3. Same individuals measured twice

ID	Time 1	Time 2
1	8	7
2	8	8
3	9	6
4	7	6
5	7	8
6	9	5
7	5	3
8	5	3

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Basic Assumptions

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Here we need two interval/ratio DVs (one for each time point)

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Hypothesis Type	Symbolic	Verbal	Difference between means created by:
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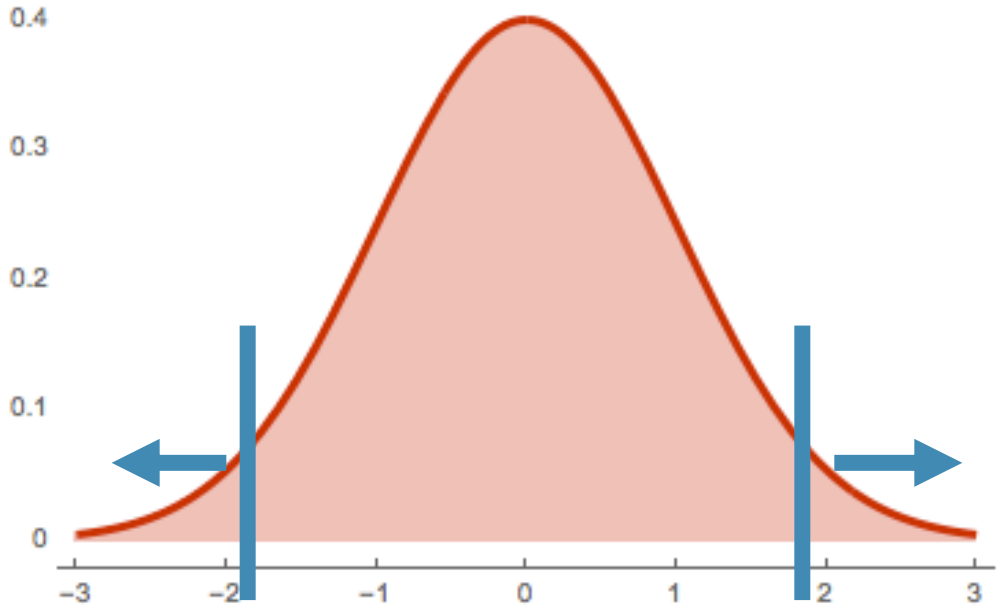
Before analyzing the data, we define the critical regions (generally based on an alpha = .05)



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13	0.258591	0.693829	1.350171	1.770933	2.1 037	2.65031	3.01228	4.2208
14	0.258213	0.692417	1.345030	1.761310	2.1 479	2.62449	2.97684	4.1405
15	0.257885	0.691197	1.340606	1.753050	2.1 145	2.60248	2.94671	4.0728
16	0.257599	0.690132	1.336757	1.745884	2.1 991	2.58349	2.92078	4.0150
17	0.257347	0.689195	1.333379	1.739607	2.1 982	2.56693	2.89823	3.9651
18	0.257123	0.688364	1.330391	1.734064	2.1 092	2.55238	2.87844	3.9216
19	0.256923	0.687621	1.327728	1.729133	2.0 302	2.53948	2.86093	3.8834
20	0.256743	0.686954	1.325341	1.724718	2.0 596	2.52798	2.84534	3.8495
21	0.256580	0.686352	1.323188	1.720743	2.0 961	2.51765	2.83136	3.8193
22	0.256432	0.685805	1.321237	1.717144	2.0 387	2.50832	2.81876	3.7921
23	0.256297	0.685306	1.319460	1.713872	2.0 866	2.49987	2.80734	3.7676
24	0.256173	0.684850	1.317836	1.710882	2.0 390	2.49216	2.79694	3.7454
25	0.256060	0.684430	1.316345	1.708141	2.0 954	2.48511	2.78744	3.7251
26	0.255955	0.684043	1.314972	1.705618	2.0 553	2.47863	2.77871	3.7066
27	0.255858	0.683685	1.313703	1.703288	2.0 183	2.47266	2.77068	3.6896
28	0.255768	0.683353	1.312527	1.701131	2.04841	2.46714	2.76326	3.6739
29	0.255684	0.683044	1.311434	1.699127	2.04523	2.46202	2.75639	3.6594
30	0.255605	0.682756	1.310415	1.697261	2.04227	2.45726	2.75000	3.6460
z	0.253347	0.674490	1.281552	1.644854	1.95996	2.32635	2.57583	3.2905
CI	———	———	80%	90%	95%	98%	99%	99.9%

3 Define Critical Regions

We decide on an alpha level first

↳ Then calculate the critical value (based on sample size)

$$t_{critical,\,29} = 2.05$$

So our critical regions is defined as:

$$\alpha = .05$$

$$t_{critical,\,29} = 2.05$$

4 Compute the Test Statistic

$$t = \frac{M_1 - M_2 - (\mu_1 - \mu_2)}{SD/\sqrt{N}}$$

The SEM, μ, and M will be given to you

Calculate it and compare to $t_{critical}$
Or
Calculate it, look up its p-value, and compare to our α level

5 Compute an Effect Size and Describe it

One of the main effect size estimates is **Cohen's d**

$$d = \frac{M_1 - M_2}{SD_{diff}}$$

d	Estimated Size of the Effect
Close to .2	Small
Close to .5	Moderate
Close to .8	Large

6 Interpreting the results

Put your results into words

Use the example on page XX as a template

Related Samples T-test

Let's practice!

- Study about ping pong ability and our "Creation of Pong-ers" intervention
- $M_{Time1} = 10, M_{Time2} = 8$ and $SD_{diff} = 1$ with a N = 36
- We think our intervention works so we want to test it

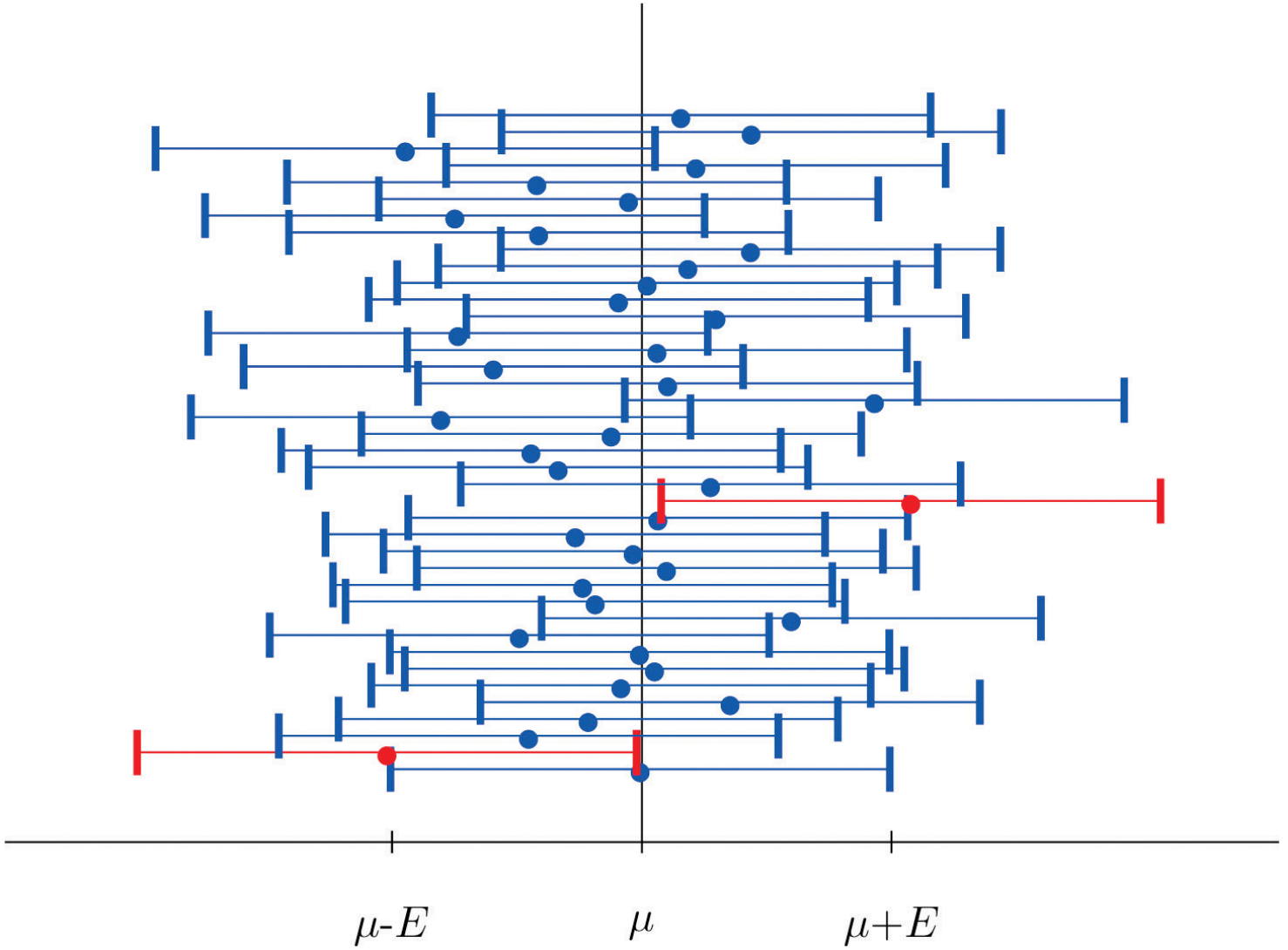
- Can we say that it does work?

Break Time

CI

Confidence Intervals

Theory Behind It →



CI Confidence Intervals

How we use it →

$$Estimate \pm t_{critical} * SE_{est}$$

CI Confidence Intervals

Interpretation: We are 95% (when $\alpha = .05$) confident that the true population value is between [Lower] and [Upper].

Confidence Intervals

Let's practice!

- Study about attention span and our "Creation of Totally Distracted People" intervention
- Two groups: 1) Treatment and 2) Control
- $M_1 = 70, M_2 = 75$ and $SD_1 = 10, SD_2 = 10$ with a N = 100 in both groups
- We think our intervention works so we want to test it

- Can we say that it does work?

Let’s use Jamovi

Confidence Intervals

Questions?

Next week:

1. Intro to ANOVA
2. Chapter 11 in Book
3. Keep updating your Statistical Organizer