**20Spring PSY302 Lab5 Jamovi tutorial:**
**Two-sample t-tests**

**Independent-samples *t*-tests**

Use cookies.csv for data.

*Example:* Nabisco, the makers of Chips-Ahoy! Cookies are having a feud with rival bakers, the Keebler Elves. Nabisco claims that each bag of Chips-Ahoy! contains more chocolate chips than any other brand, but the Keebler Elves think that their Chips Deluxe cookies have even more chocolate chips per bag! An independent researcher counts the chocolate chips in both bags of cookies. She realizes that it would be best to count chocolate chips in many bags of cookies, in order to get an adequate sample. After counting 12 bags of each brand, she collects the following data on the number of chocolate chips in each bag (not per cookie):

| Chips Ahoy | Chips Deluxe |
|---|---|
| 100 | 95 |
| 98 | 96 |
| 99 | 98 |
| 101 | 93 |
| 96 | 91 |
| 93 | 92 |
| 100 | 93 |
| 97 | 95 |
| 96 | 93 |
| 98 | 92 |
| 100 | 91 |
| 101 | 98 |

*What is the research question?*

*Which test should we use?*

*What are the null and alternative hypotheses?*

**20Spring PSY302 Lab5 Jamovi tutorial:**
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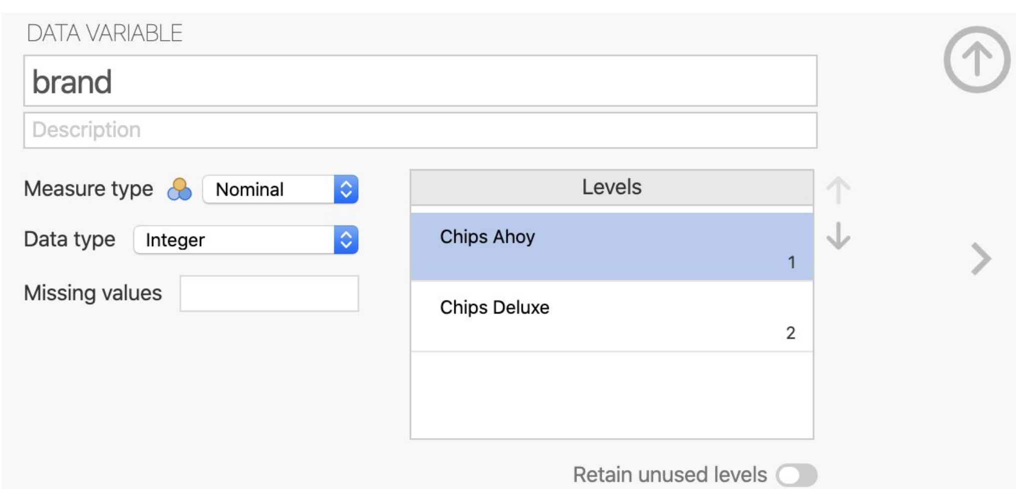
*What is the critical t value(s)? Use an alpha level of .05. (refer to table below)*

**Table 3:** Critical Values of t

| df | α = .05, one-tailed -or- α = .10, two-tailed | α = .025, one-tailed -or- α = .05, two-tailed | α = .01, one-tailed -or- α = .02, two-tailed | α = .005, one-tailed -or- α =.01, two-tailed |
|---|---|---|---|---|
| 1 | 6.314 | **12.706** | 31.821 | 63.657 |
| 2 | 2.920 | **4.303** | 6.965 | 9.925 |
| 3 | 2.353 | **3.182** | 4.541 | 5.841 |
| 4 | 2.132 | **2.776** | 3.747 | 4.604 |
| 5 | 2.015 | **2.571** | 3.365 | 4.032 |
| 6 | 1.943 | **2.447** | 3.143 | 3.707 |
| 7 | 1.895 | **2.365** | 2.998 | 3.499 |
| 8 | 1.860 | **2.306** | 2.896 | 3.355 |
| 9 | 1.833 | **2.262** | 2.821 | 3.250 |
| 10 | 1.812 | **2.228** | 2.764 | 3.169 |
| 11 | 1.796 | **2.201** | 2.718 | 3.106 |
| 12 | 1.782 | **2.179** | 2.681 | 3.055 |
| 13 | 1.771 | **2.160** | 2.650 | 3.012 |
| 14 | 1.761 | **2.145** | 2.624 | 2.977 |
| 15 | 1.753 | **2.131** | 2.602 | 2.947 |
| 16 | 1.746 | **2.120** | 2.583 | 2.921 |
| 17 | 1.740 | **2.110** | 2.567 | 2.898 |
| 18 | 1.734 | **2.101** | 2.552 | 2.878 |
| 19 | 1.729 | **2.093** | 2.539 | 2.861 |
| 20 | 1.725 | **2.086** | 2.528 | 2.845 |
| 21 | 1.721 | **2.080** | 2.518 | 2.831 |
| 22 | 1.717 | **2.074** | 2.508 | 2.819 |

1. For an independent t test, the data must be entered in a different format from the way it is presented above.
   - Open cookies.csv. Note that there are ***TWO*** variables (i.e., two columns): *brand* (your independent variable, or IV) and *chips* (your dependent variable, or DV).
   - Keep *brand* as a nominal variable and change *chips* from nominal to continuous
   - Assign value labels to *brand***:** "1 = Chips Ahoy" and "2 = Chips Deluxe"



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Your data should look like the following:

| | brand | chips |
|---|---|---|
| 1 | Chips Ahoy | 100 |
| 2 | Chips Ahoy | 98 |
| 3 | Chips Ahoy | 99 |
| 4 | Chips Ahoy | 101 |
| 5 | Chips Ahoy | 96 |
| 6 | Chips Ahoy | 93 |
| 7 | Chips Ahoy | 100 |
| 8 | Chips Ahoy | 97 |
| 9 | Chips Ahoy | 96 |
| 10 | Chips Ahoy | 98 |
| 11 | Chips Ahoy | 100 |
| 12 | Chips Ahoy | 101 |
| 13 | Chips Deluxe | 95 |
| 14 | Chips Deluxe | 96 |
| 15 | Chips Deluxe | 98 |
| 16 | Chips Deluxe | 93 |
| 17 | Chips Deluxe | 91 |
| 18 | Chips Deluxe | 92 |
| 19 | Chips Deluxe | 93 |
| 20 | Chips Deluxe | 95 |
| 21 | Chips Deluxe | 93 |
| 22 | Chips Deluxe | 92 |
| 23 | Chips Deluxe | 91 |
| 24 | Chips Deluxe | 98 |

Note: You will have 24 rows (instead of 12), and each row has two values for the variables *brand* and *chips*. This entry strategy tells jamovi that the first 12 entries are associated with Chips Ahoy (1) and the second 12 entries with Chips Deluxe (2).

2. Let's make a chart to examine the mean and distribution of similarity ratings for each of the two brand conditions. Follow the steps to choose a box plot as we have done before:

- Under the **Analyses** tab, select **Exploration > Descriptives**.
- Then move the dependent variable, *chips*, to the **Variables** section.
- Move the groups variable, *brand*, to the **Split By** section.
- Under the Plots section of the menu, select **Box Plot**. You may want to see the Data too (it's up to you).

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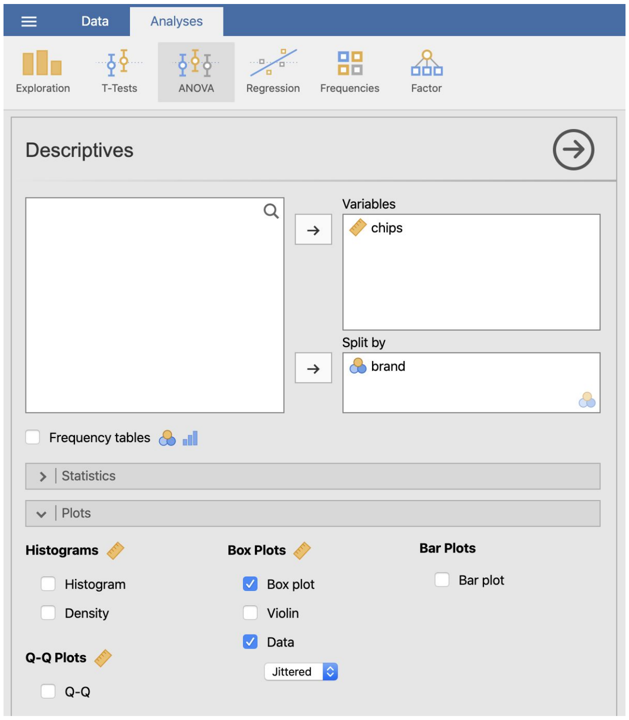
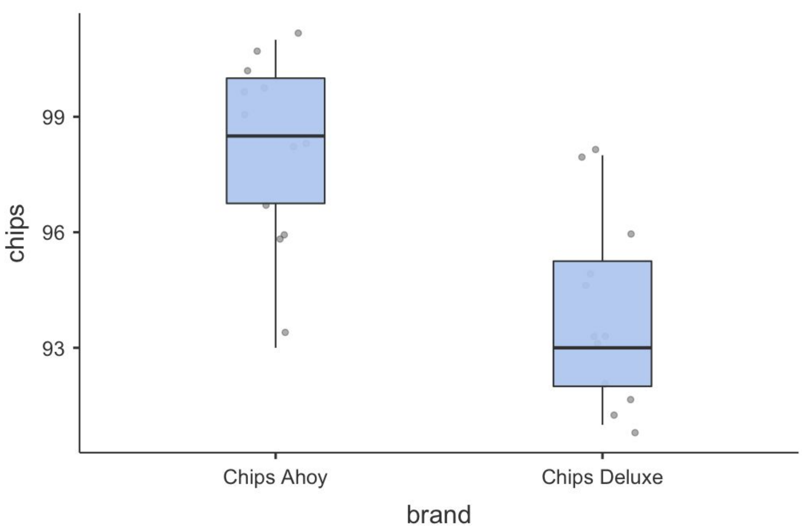



If all went well, you should have a box plot that looks like something like this:




*How would you interpret these data? Do you believe there is an effect? In what direction?*

**20Spring PSY302 Lab5 Jamovi tutorial:**
**Two-sample t-tests**

3. Let's run the statistical test and find out if the data support the conclusion that there is an effect.

- Under the **Analyses** tab, select **T-Tests** > **Independent Samples T-Test.** Move *chips* to the Dependent Variables section. Move *brand* to the **Grouping Variable** section.
- Make sure the following options are selected:
  - **Tests:** Student's.
  - **Hypothesis:** Group 1 ≠ Group 2
  - **Additional Statistics:** Mean difference, Effect size, Confidence Interval, Descriptives, Descriptives Plots
  - **Assumption Checks:** Equality of variances

Let's walk through the output together.

## Independent Samples T-Test

*Getting a t-statistic of 4.35 or more extreme (greater than 4.35 or less than -4.35) happens less than 0.1 percent of the time under the null. We reject the null because p < .05 and because observed t-value (4.35) > critical t-value (2.074).*

Independent Samples T-Test

| | | statistic | df | p | Mean difference | SE difference | 95% Confidence Interval Lower | 95% Confidence Interval Upper | Cohen's d |
|---|---|---|---|---|---|---|---|---|---|
| chips | Student's t | 4.35 | 22.00 | <.001 | 4.33 | 1.00 | 2.27 | 6.40 | 1.77 |

*Difference in means (98.25-93.92)*

*Standard error of the difference in means*

*95% CI around difference in means*

*Effect size (large)*

## Assumptions

Test of Equality of Variances (Levene's)

| | F | df | df2 | p |
|---|---|---|---|---|
| chips | 0.09 | 1 | 22 | 0.772 |

*Note.* A low p-value suggests a violation of the assumption of equal variances

[3]

*Levene's test for equality of variance makes sure that the two populations we are comparing are likely to have equal variance. We do not want this test to be significant, because if it is we have a new problem. If they differ, we must correct the t-test results.*

Group Descriptives

| | Group | N | Mean | Median | SD | SE |
|---|---|---|---|---|---|---|
| chips | Chips Ahoy | 12 | 98.25 | 98.50 | 2.42 | 0.70 |
| | Chips Deluxe | 12 | 93.92 | 93.00 | 2.47 | 0.71 |

*"Balanced design"*

*Used to calculate difference in means*

**Conclusion**

An independent samples *t*-test revealed that Chips Ahoy cookies ($M$ = 98.3, $SD$ = 2.42) had significantly more chocolate chips per bag than Chips Deluxe cookies ($M$ = 93.9, $SD$ = 2.47), $t(22) = 4.35$, $p < .001$, two-tailed.

**20Spring PSY302 Lab5 Jamovi tutorial:**
**Two-sample t-tests**

## Paired-samples *t*-tests

Use assistants.csv for data

*Example:* Naomi Campbell wants to know whether a new cognitive-behavioral therapy program will help her assistants deal with the anxiety of working for her. She enrolls her 12 assistants in the 6-week program, which teaches them deep breathing techniques to reduce stress, cognitive skills for re-evaluating Naomi's unrealistic demands in a more positive light, and how to dodge flying cell phones. To measure their progress, her assistants are given an Anxiety Scale before they begin ***and*** after they return. Naomi Campbell obtains the following data (lower numbers indicate a lower anxiety score):

| Assistant | Before | After |
|---|---|---|
| A | 10 | 5 |
| B | 12 | 6 |
| C | 8 | 7 |
| D | 12 | 8 |
| E | 15 | 10 |
| F | 18 | 11 |
| G | 6 | 3 |
| H | 5 | 4 |
| I | 6 | 6 |
| J | 10 | 7 |
| K | 12 | 8 |
| L | 15 | 9 |

*What is the research question?*

*Which test should we use?*

*What are the null and alternative hypotheses?*

**20Spring PSY302 Lab5 Jamovi tutorial:**
**Two-sample t-tests**

*What is the critical t value(s)? Use an alpha level of .05. (refer to table below)*

**Table 3:** Critical Values of *t*

| df | α = .05, one-tailed -or- α = .10, two-tailed | α = .025, one-tailed -or- α = .05, two-tailed | α = .01, one-tailed -or- α = .02, two-tailed | α = .005, one-tailed -or- α =.01, two-tailed |
|---|---|---|---|---|
| 1 | 6.314 | **12.706** | 31.821 | 63.657 |
| 2 | 2.920 | **4.303** | 6.965 | 9.925 |
| 3 | 2.353 | **3.182** | 4.541 | 5.841 |
| 4 | 2.132 | **2.776** | 3.747 | 4.604 |
| 5 | 2.015 | **2.571** | 3.365 | 4.032 |
| 6 | 1.943 | **2.447** | 3.143 | 3.707 |
| 7 | 1.895 | **2.365** | 2.998 | 3.499 |
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| 21 | 1.721 | **2.080** | 2.518 | 2.831 |
| 22 | 1.717 | **2.074** | 2.508 | 2.819 |

1. Unlike the independent samples *t*-test, we create separate columns for each measure of the dependent variable. One way to remember this is the guide of **one-row-per-person**. When you have people randomly assigned to different groups, you list all measurements of the DV in a single column. But when the same person receives both "treatments" or "groups," then you create a separate variable for each time they are measured. This will not always be the case, but generally for this course, you can use this guide to help you organize your data.

- Open assistants.csv. Keep *Assistant* as a nominal variable and change *Before* and *After* from nominal to continuous.

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**Two-sample t-tests**

Your data should look like the following:

| | Assistant | Before | After |
|---|---|---|---|
| 1 | A | 10 | 5 |
| 2 | B | 12 | 6 |
| 3 | C | 8 | 7 |
| 4 | D | 12 | 8 |
| 5 | E | 15 | 10 |
| 6 | F | 18 | 11 |
| 7 | G | 6 | 3 |
| 8 | H | 5 | 4 |
| 9 | I | 6 | 6 |
| 10 | J | 10 | 7 |
| 11 | K | 12 | 8 |
| 12 | L | 15 | 9 |

2. To analyze the data, go the **Analyses** tab and select **T-Tests > Paired Samples T-Test**.

- Move the variable *Before* and *After* into the **Paired Variables** section. You'll see that they'll automatically appear next to each other in the window. That's how you know that jamovi has appropriately paired these variables.

- Make sure the following options are selected:
  - **Tests:** Student's
  - **Hypothesis:** Measure 1 ≠ Measure 2
  - **Additional Statistics:** Mean difference, Effect size, Confidence Interval, Descriptives, Descriptives Plots

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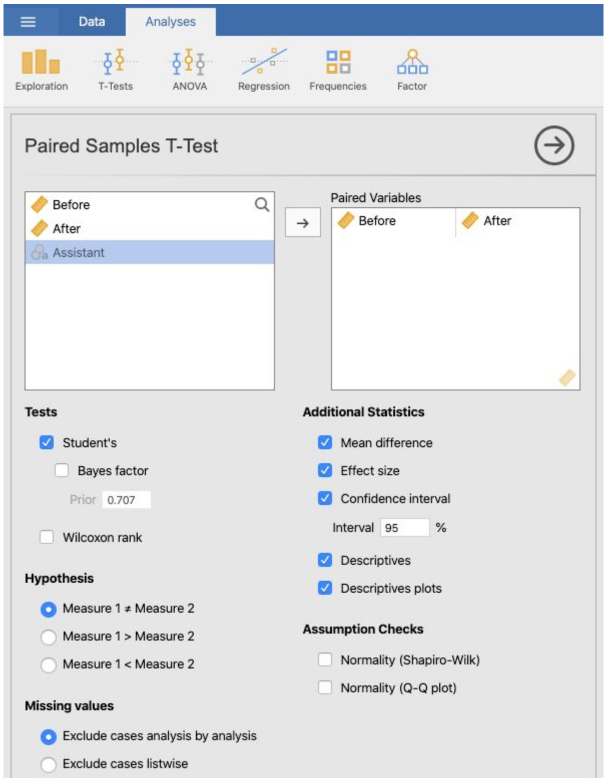
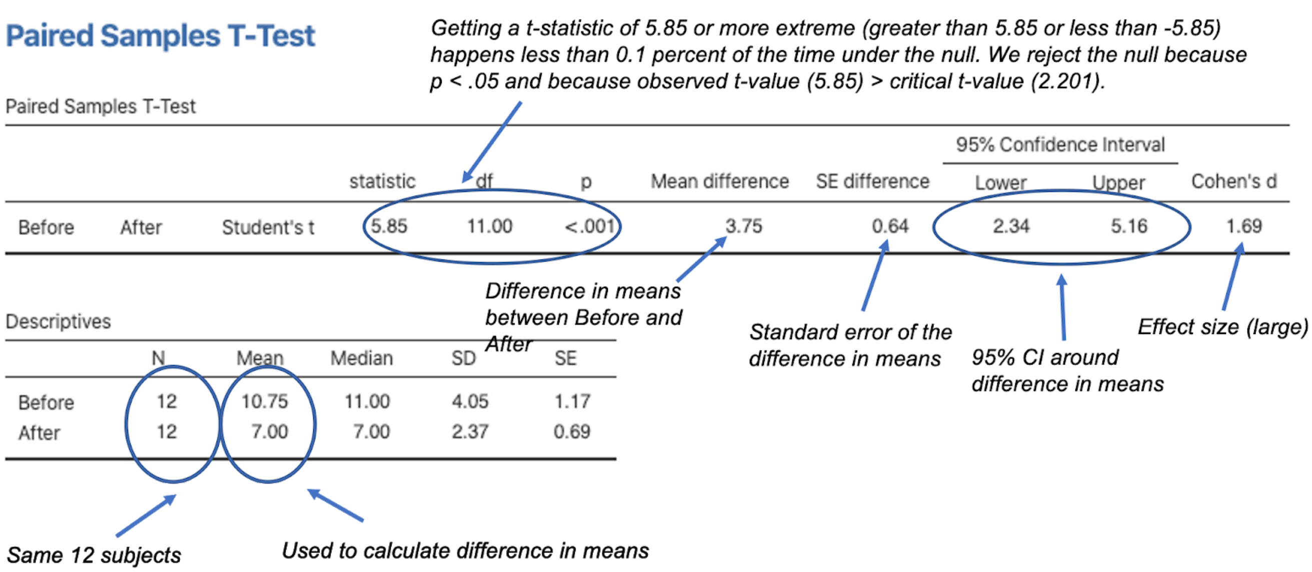



Now let's go through the output.



**Paired Samples T-Test**

Paired Samples T-Test

| | | | statistic | df | p | Mean difference | SE difference | 95% Confidence Interval Lower | 95% Confidence Interval Upper | Cohen's d |
|---|---|---|---|---|---|---|---|---|---|---|
| Before | After | Student's t | 5.85 | 11.00 | <.001 | 3.75 | 0.64 | 2.34 | 5.16 | 1.69 |

Descriptives

| | N | Mean | Median | SD | SE |
|---|---|---|---|---|---|
| Before | 12 | 10.75 | 11.00 | 4.05 | 1.17 |
| After | 12 | 7.00 | 7.00 | 2.37 | 0.69 |



## Conclusion

There is a significant effect of the therapy program on anxiety, $t(11) = 5.85$, $p < .001$. Pre-treatment anxiety scores ($M = 10.75$, $SD = 4.05$) were significantly higher than post-treatment anxiety scores ($M = 7.00$, $SD = 2.37$).