10.3: Practice! Job Satisfaction

You've learned a complicated formula, and what it means. Now, let's try using it to answer a research question! This first scenario will provide the mean of the difference ($\overline{X}_D$) and the standard deviation of the difference (s_D), so you can focus on how the parts work together, not on all of the calculations. The next section will let you use the full formula.

Scenario

In order to be more competitive and hire the best talent, a CEO would like her employees to love working for the company. The CEO hires a consultant to first assesses a sample of the employee's level of job satisfaction (N = 40) with a job satisfaction survey that he developed to identify specific changes that might help. The company institutes some of the changes that the consultant suggests, and six months later the consultant returns to measure job satisfaction with the same survey on the same 40 employees again. You are hired by the consultant to crunch the numbers using an $\alpha = 0.05$ level of significance.

Context

Example 10.3.1

Answer the following questions to understand the variables and groups that we are working with.

1. Who is the sample?
2. Who do might be the population?
3. What is the IV (groups being compared)?
4. What is the DV (quantitative variable being measured)?

Solution

1. The sample is the group of 40 employees who completed the job satisfaction survey twice.
2. The population might be all employees in that company? Other answers may also be correct.
3. The IV is before and after the survey, the time periods. This can also be said as the pretest and post-test.
4. The DV is the job satisfaction survey.

Step 1: State the Hypotheses

First, we state our hypotheses. Let's hope that the changes that the consultant has the knowledge and expertise to suggest useful changes that we can predict an improvement in job satisfaction.

- Research Hypothesis: The average score on the job satisfaction survey in Time 2 will be higher than average score on the job satisfaction survey in Time 1.

Note that the name of the two groups, what we were measuring, and that we are comparing means was all included. The format seems a little backwards to me because it's stated in chronological order, but it highlights that there will be improvement. If you started with Time 1, then it reads like the DV is decreasing. But either is correct.

Exercise 10.3.1

What would the research hypothesis look like in symbols?

Answer

- $\bar{X}_{\mathrm{T2}} > \bar{X}_{\mathrm{T1}}$

  If you but Time 1 first in your sentence, then it would be: $\bar{X}_{\mathrm{T1}} < \bar{X}_{\mathrm{T2}}$

Let's move on to the null hypothesis.

Exercise 10.3.2

What is the null hypothesis in words and then in symbols?

Answer

- Null Hypothesis: The average score on the job satisfaction survey in Time 2 will be similar to the average score on the job satisfaction survey in Time 1. In other words, average job satisfaction scores will not differ between the two time periods.
- Symbols: $\bar{X}_{\text{T2}} = \bar{X}_{\text{T1}}$

In this case, we are hoping that the changes we made will improve employee satisfaction, and, because we based the changes on employee recommendations, we have good reason to believe that they will. Thus, we will use a one-directional hypothesis.

Step 2: Find the Critical Values

Our critical values will once again be based on our level of significance, which we know is $\alpha = 0.05$, the directionality of our test, which is one-tailed, and our degrees of freedom. For our dependent-samples t-test, the degrees of freedom are still given as $df = N - 1$ in which N is the number of pairs. For this problem, we have 40 people, so our degrees of freedom are 39. Using the same t-table from when we learned about one-sample t-tests (or going to the Common Critical Values Table page), we find that the critical value is 1.684 if we use the closest df from the table (df=40), or 1.697 if you round the df down (df=30); ask your professor which rule you should follow (closest or rounding down).

Step 3: Calculate the Test Statistic

Now that the criteria are set, it is time to calculate the test statistic. This first example will be simplified a little by providing the mean of the difference and the standard deviation of the difference.

Example 10.3.2

The data obtained by the consultant found that the difference scores from time 1 to time 2 had a mean of $\overline{X_D}$ = 2.96 and a standard deviation of $s_D = 2.85$. Using this information, plus the size of the sample (N=40). What is the calculated t-score?

Solution

You can start with any parentheses (Please Excuse My Dear Aunt Sally); I like to start at the top and work my way down and to the left. For this formula, starting at the top means to start with the mean of the difference in the numerator!

$$\frac{\left(\frac{\Sigma D}{N}\right)}{\sqrt{\left(\frac{\sum\left((X_D - \overline{X}_D)^2\right)}{(N-1)}\right)}/\sqrt{N}}$$

The mean of the difference was already calculated ($\overline{X}_D = \frac{\Sigma D}{N} = 2.96$)

Next is the numerator, which includes the standard deviation of the difference ($s_D = \sqrt{\frac{\sum\left((X_D - \overline{X}_D)^2\right)}{N-1}} = 2.85$) divided by the square root of the number of pairs:

$$\sqrt{N} = \sqrt{40} = 6.32$$

Now, we can put all of those values into the formula:

$$\frac{2.96}{\left(\frac{2.85}{6.32}\right)} = \frac{2.96}{0.46} = 6.43$$

What's interesting is that when Dr. MO used Excel to calculate this, the denominator was a little lower (0.45) and the final division was a little higher (t = 6.57). The calculations above were by using a hand calculator. Both answers are correct! The difference is based on rounding (Excel keeps hundreds of numbers after the decimal point, rather than just two, which affects the two numbers after the decimal point at the end of the calculation).

Step 4: Make the Decision

The the critical t-score from the table (based on either decision rule) from Step 2 is smaller than the calculated test statistic of $t = 6.43$.

$$(\boldsymbol{Critical} < |\boldsymbol{Calculated}|) = \textbf{Reject null} = \textbf{means are different} = \boldsymbol{p} < \mathbf{.05}$$

$$(\boldsymbol{Critical} > |\boldsymbol{Calculated}|) = \textbf{Retain null} = \textbf{means are similar} = \boldsymbol{p} > \mathbf{.05}$$

Exercise 10.3.3

Based on the critical value from the table and the calculated t-score, should we reject the null hypothesis? Does this mean that the means are similar or different?

Answer

$Critical(1.6xxx) < |6.43| = \textbf{Reject null} = \textbf{means are different} = p < .05$

We reject the null hypothesis, and state that the means are statistically different from each other.

Write-Up

What should the conclusion look like?

Example 10.3.3

Write up a conclusion for this job satisfaction scenario?

Solution

Based on the sample data from 40 workers, we can say that the employees were statistically significantly more satisfied with their job satisfaction after the interventions than before ($t(39) = 6.43$, $p < 0.05$. This supports the research hypothesis.

But remember back to the Reporting Results section and the four required components?

Exercise 10.3.4

What component for Reporting Results is missing from Example $10.3.3$?

Answer

The group means are missing. The mean of the difference between the two groups was provided, but the average job satisfaction at Time 1 (Before) and Time 2 (After) wasn't provided.

Hopefully the above example made it clear that running a dependent samples t-test to look for differences before and after some treatment works similarly to the other t-tests that we've covered. At this point, this process should feel familiar, and we will continue to make small adjustments to this familiar process as we encounter new types of data to test new types of research questions.

Let's try another example with real data on mindset scores!

This page titled 10.3: Practice! Job Satisfaction is shared under a CC BY-NC-SA 4.0 license and was authored, remixed, and/or curated by Michelle Oja.