

Chapter 9

Independent Samples t-Test: Assessing Differences Between Two Independent Group Means

Jennifer Winqvist
Valparaiso University

9.1 Introduction to the t-Test

In the previous chapters we examined *relationships* among variables to assess covariation between the variables. In this chapter we consider research concerning *differences* between groups. Experiments are designed to establish cause-effect relationships. In the simplest experiment there are two groups of participants created by the manipulation of an independent variable (the cause). The two groups are measured on the same dependent variable (the effect) in order to compare their scores. Data analyses are needed to determine whether the independent variable manipulation produced significant differences in scores between the two groups on the dependent variable.

The t-test is used to determine whether the difference between means of two groups or conditions is due to the independent variable, or if the difference is simply due to chance. Thus, this procedure establishes the probability of the outcome of an experiment, and in doing so enables the researcher to reject or retain the null hypothesis (in this case, H_0 is that any observed differences are *not* significant, but rather, are due to chance).

The null hypothesis states that the experimental manipulation has no effect, therefore the means of the groups will be equal. In this respect, the t-test is an inferential statistic used to test hypotheses. Under ideal conditions, these types of inferential statistics allow the researcher to infer a causal relationship between the independent and dependent variable.

There are two distinct applications of the t-test. When a **between-subjects design** is used, the **independent-samples t-test** is the appropriate test. Use of a **within-subjects design** (sometimes called a *repeated measures* design) or a participant-by-participant matched design requires analysis with the paired samples t-test (also known as the *correlated* or **paired-samples t-test**). In this chapter we will introduce the independent samples t-test. We will address the correlated samples t-test in the next chapter.

There are many hypotheses we could test as part of this project using the t-test. For example, we are interested in any **gender** differences that might exist among EZ employees. Note that in this context, gender is considered to be a *quasi-independent*

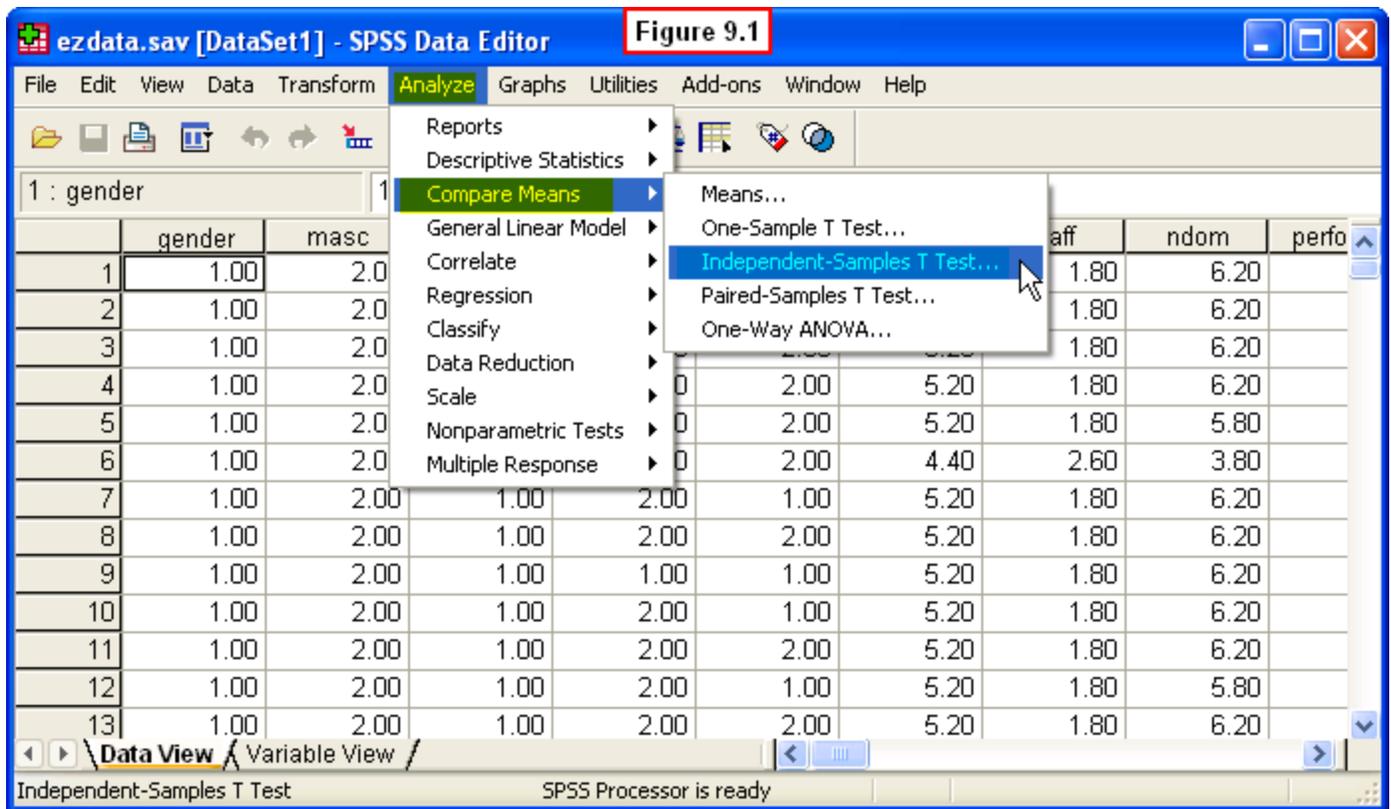
variable because we cannot actually manipulate gender. Nevertheless, the **t-test** can be applied to examine differences between men and women on various dependent variables. For example, we might want to test for gender differences in scores on the task skills scale and/or the social skills scale (both would be considered dependent variables in this context).

You might hypothesize that men would score higher than women on task skills, because research indicates that task orientation in leadership is a stereotyped male characteristic. Comparing the scores of women on task skills against those of men on independent-samples t-test would enable you to determine whether this was indeed the case. On the other hand, you might expect women to exhibit greater social skills (a stereotyped female characteristic) than men, a hypothesis that could also be tested with the independent-samples t-test. But let's not stop there.

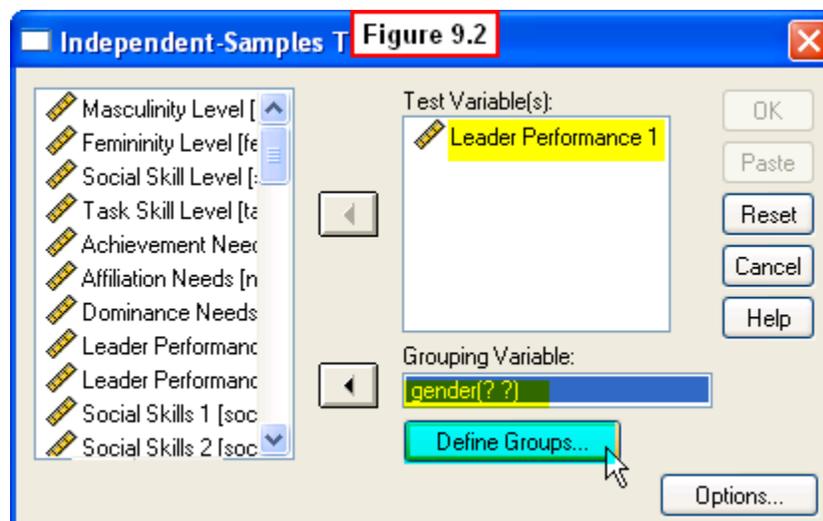
Ultimately we're interested in understanding leadership performance (**perform**) of employees, so why not determine if there are **gender** differences in overall performance? Although in this instance there may be no clear *a priori* reason to suspect that there should be gender differences in performance, it is certainly a question worth investigating. We will use the independent samples t-test to examine gender differences in performance for the example in this chapter. You will be asked to examine gender differences in social skills for the exercise at the end.

9.2 Running the t-test

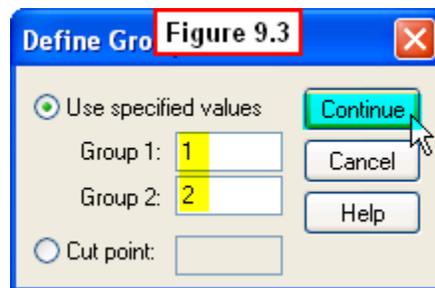
Open your **ezdata.sav** file in the Data Editor. Select **Analyze, Compare Means, Independent-Samples T Test...** from the menu (Figure 9.1).



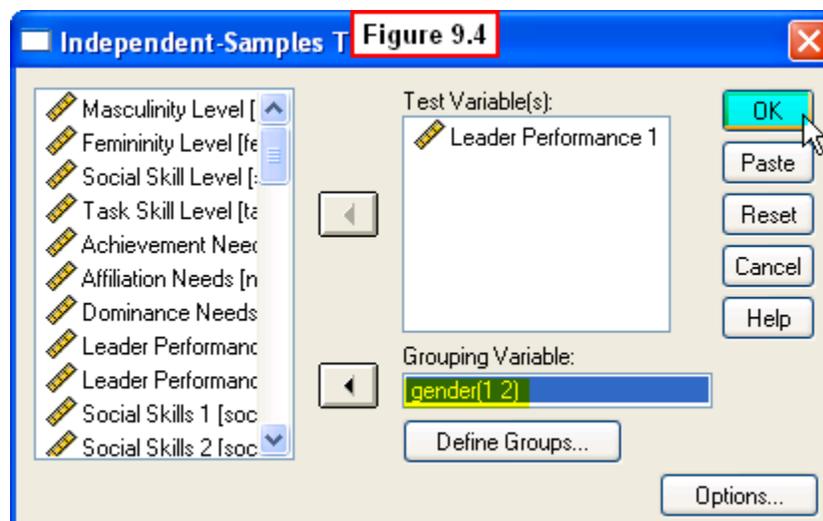
The **Independent-Samples T Test** dialog window will appear (Figure 9.2). In the left pane select our dependent variable, **Leader Performance 1 (perform1)**, and move it to the **Test Variable(s):** pane on the right by clicking the arrow button between the panes. To choose the independent variable, **Employee Gender (gender)**, select it in the left pane and move it to the **Grouping Variable:** pane.



Now, we need to define the two groups to be compared. To do this, click the **Define Groups...** button below the dialog window. The **Define Groups** dialog window will appear (Figure 9.3).



The two groups we want to compare are males and females. Females were given a code of 1, so type **1** in the **Group 1:** box. Males were given a code of 2, so type **2** in the **Group 2:** dialogue box. Next, click the **Continue** button. This will take you back to the **Independent Samples T Test** window. To run the t-test simply click on the **OK** button (Figure 9.4).



[Show Me Video!](#)

9.3 Interpreting the Output

The first table, **Group Statistics**, is shown in Figure 9.5. This table includes descriptive statistics for each group. Specifically, the table includes the number of cases (N), the mean leader performance score, the standard deviation, and the estimated standard error of the mean (the standard deviation divided by N).

Figure 9.5
Group Statistics

Employee Gender		N	Mean	Std. Deviation	Std. Error Mean
Leader Performance 1	Male	110	5.6818	2.74257	.26149
	Female	118	6.1441	1.94046	.17863

Of greatest interest here are the mean performance scores for men (5.68) and for women (6.14). You might be tempted to conclude that this indicates that women had significantly higher average performance scores than men. However, this would be premature - in fact, the whole point of the t-test is to determine whether this is a real difference (statistically significant), or one that could be attributed to random chance. To do this, we need to examine the next table, **Independent Samples Test** (Figure 9.6).

Figure 9.6
Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Leader Performance 1	Equal variances assumed	42.802	.000	-1.477	226	.141	-.46225
	Equal variances not assumed			-1.460	194.923	.146	-.46225

9.3a Testing for Homogeneity of Variance

The first two columns labeled **Levene's Test for Equality of Variances** provides a test of one of the assumptions of the t-test, i.e., that the variance in the two groups are equal (i.e., similar or homogeneous). If this assumption is violated in the data, a statistical adjustment needs to be made. The **F** statistic in the first column and its probability in the second column (**Sig.**, an abbreviation for significance) provides this test. If the probability of the **F** value (i.e., **Sig.**) is less than or equal to **.05**, then the variances in the groups being compared are different, and the condition of homogeneity of variance has not been satisfied.

The results of the **F** test determine whether to use the **Equal variances assumed** rows or the **Equal variances not assumed** rows in evaluating the t statistic. The decision rule for determining which rows to use is as follows:

- **If the variances for the two groups are equal (i.e., Sig. > .05)**, then use the output in the **Equal variances assumed** rows. These rows represent the more

conventional method of evaluating the t value based upon degrees of freedom (df) equal to the total number of scores minus 2 (this is the method that is described in most introductory statistics or research methods textbooks).

- **If the variances for the two groups are significantly different** (i.e., **Sig. < .05**), then use the output in the **Equal variances not assumed** row. Evaluation of the t statistic in this row is based upon an adjusted degrees of freedom which takes into account the dissimilar variances in the two groups.

Since the probability (**Sig.** = .000) for the **F** value is less than **.05**. Thus, the variances of the two groups are **not equal**, and therefore the output in the **Equal variances not assumed** row should be used.

9.3b Testing the null hypothesis: Interpreting the significance of the t -value

To determine if the difference in performance between men and women is significant, we need to look in the columns labeled **t-test for equality of Means**. We are currently only interested in the obtained t -value and its probability, which can be seen in the columns labeled **ten Sig. (2-tailed)**. Looking in the **Equal variances not assumed** row, we see a t value of 1.46. The probability in the **Sig. (2-tailed)** column in the ($p = .146$) is greater than **.05**, meaning that we need to retain the null hypothesis of no differences, concluding that there was no significant difference in leadership performance between male and female EZ employees.

The following sentence illustrates how these results would be written according to APA format.

The results indicate that there was no significant difference in performance between women and men, $t(195) = 1.46, p = .15$. That is, the average performance score of women ($M = 6.14, SD = 1.94$) was not significantly different from that of men ($M = 5.69, SD = 2.74$).

Note that while researchers generally are interested in finding "significant differences," sometimes the *absence* of a significant difference is of either theoretical or practical value. That certainly is the case here. In particular, these results indicate that *there is no reliable difference in performance* between men and women at EZ Manufacturing. This is an important because this information may be useful in calming the anxieties of upper-level executives who might adhere to the stereotype that women are less capable of men in leadership situations

9.3c Additional Information in the t -table

There is additional information in the t -table that might be of use to you. The first is the **Mean Difference**. This is simply the difference between the two means. The **Standard Error of the Mean Difference** is the denominator used in computing the t -statistic. Finally, the **95% Confidence Interval for the Difference** consists of two

numbers indicating the lower and the upper bound of the confidence interval. We can be 95% confident that the difference between the two means falls between the lower and upper bounds.

As mentioned, there are numerous other hypotheses we could test using the independent samples t-test on the data from our EZ Manufacturing study. The exercise at the end of the chapter illustrates one of these, and you are encouraged to explore others on your own. In the next chapter we will discuss a similar approach to hypothesis testing using the **correlated samples t-test**.

9.4 Chapter Review Video

[Review Me!](#)

9.5 Try It! Exercises

1. Using the t-test to Examine Gender Differences in Need for Affiliation

Use the procedures described in Section 9.2 to determine if male and female employees differ in their level of affiliation motivation. Thus, select **Affiliation Needs (naff)** as the **Test Variable** (the dependent variable), and select **Employee Gender (gender)** as the **Grouping Variable** (the independent variable).

- **Print** your output file to submit to your instructor.
- Answer the following questions for the affiliation variable:
 - What is the mean affiliation score and standard deviation for males?
 - What is the mean affiliation score and standard deviation for females?
 - Does this data violate the assumption of homogeneity of variance? Why?
 - How many degrees of freedom are associated with this test?
 - What is the value of the t-statistic?
 - What is the significance level?
 - Should you reject or fail to reject the null hypothesis of no difference in affiliation needs?
- **Write an interpretation of the results** along with your answers to the above questions to submit to your instructor. Follow the example in Section 9.3.