In this case, we could state the following:

> A single-sample t test that compared the mean height of the sample to a population value of 64 was conducted. A significant difference was found ($t(15) = 3.008$, $p = .009$). The sample mean of 66.9375 ($sd = 3.907$) was significantly greater than the population mean.

Phrasing Results That Are Not Significant

In our first example, the **significance** level was greater than .05. Thus, we would state the following:

> A single-sample t test that compared the mean height of the sample to a population value of 67 was conducted. No significant difference was found ($t(15) = -.064$, $p = .95$). The sample mean of 66.9375 ($sd = 3.907$) was not significantly greater than the population mean.

Practice Exercise

The average salary in the United States is $25,000. Determine if the average salary of the participants in Practice Data Set 2 in Appendix B is significantly greater than this value. Note that this is a one-tailed hypothesis.

Section 6.3 Independent-Samples *t* Test

Description

The independent-samples t test compares the means of two samples. The two samples are normally from randomly assigned groups.

Assumptions

The two groups being compared should be independent of each other. Observations are independent when information about one is unrelated to the other. Normally, this means that one group of participants provides data for one sample and a different group of participants provides data for the other sample (and individuals in one group are not matched with individuals in the other group). One way to accomplish this is through using **random assignment** to form two groups.

The scores should be normally distributed, but the t test is **robust** and can handle violations of the assumption of a **normal distribution**.

The **dependent variable** must be measured on an **interval** or **ratio scale**. The **independent variable** should have only two **discrete** levels.

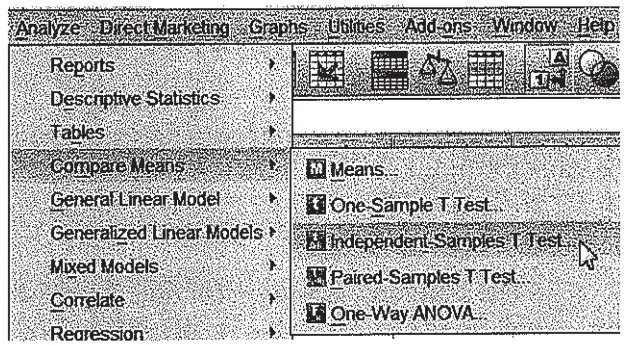
SPSS Data Format

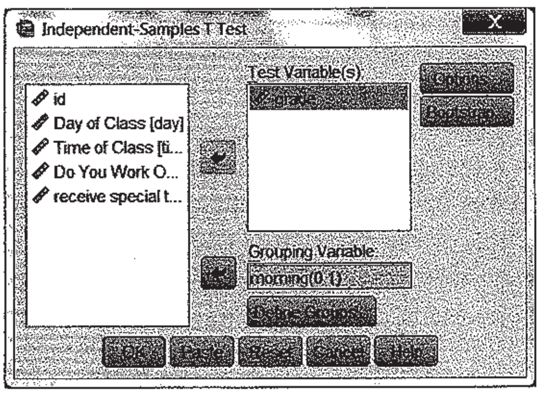
The SPSS data file for the independent t test requires two variables. One variable, the **grouping variable**, represents the value of the **independent variable**. The **grouping variable** should have two distinct values (e.g., 0 for a control group and 1 for an experimental group). The second variable represents the **dependent variable**, such as scores on a test.

Conducting an Independent-Samples t Test

For our example, we will use the SAMPLE.sav data file.[1]

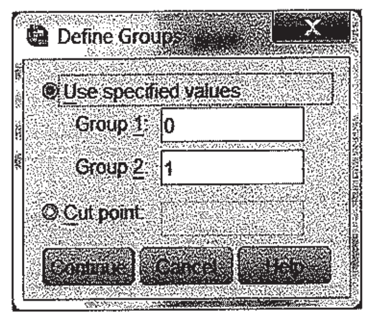
Click *Analyze*, then *Compare Means*, then *Independent-Samples T Test*. This will bring up the main **dialog box**. Transfer the **dependent variable(s)** into the *Test Variable(s)* blank. For our example, we will use the variable GRADE.





Transfer the **independent variable** into the *Grouping Variable* section. For our example, we will use the variable MORNING.

Next, click *Define Groups* and enter the values of the two **levels** of the **independent variable** (0 for nonmorning and 1 for morning). Independent *t* tests are capable of comparing only two **levels** at a time. Click *Continue*, then click *OK* to run the analysis.



Output From the Independent-Samples t Test

The output will have a section labeled "Group Statistics." This section provides the basic **descriptive statistics** for the **dependent variable(s)** for each value of the **independent variable**. It should look like the output below.

Group Statistics

	morning	N	Mean	Std. Deviation	Std. Error Mean
grade	No	2	82.5000	3.53553	2.50000
	Yes	2	78.0000	7.07107	5.00000

[1] In the example, we have deleted from the dataset the previously created "Zgrade" variable.

Next, there will be a section with the results of the *t* test. It should look like the output below.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
grade	Equal variances assumed	.	.	.805	2	.505	4.50000	5.59017	-19.55256	28.55256
	Equal variances not assumed			.805	1.471	.530	4.50000	5.59017	-30.09261	39.09261

The columns labeled *t*, *df*, and *Sig.* (*2-tailed*) provide the standard answer for the *t* test. They provide the value of *t*, the degrees of freedom (number of participants minus 2 in this case), and the **significance** level (often called *p*). Normally, we use the "Equal variances assumed" row. This will provide you with an answer equivalent to what you would calculate by hand.

Drawing Conclusions

Recall from the previous section that the *t* test assumes an equality of **means**. Therefore, a significant result indicates that the **means** are not equivalent. When drawing conclusions about a *t* test, you must state the direction of the difference (i.e., which **mean** was larger than the other). You should also include information about the value of *t*, the degrees of freedom, the **significance** level, and the **means** and **standard deviations** for the two groups.

Phrasing Results That Are Significant

For a significant *t* test (e.g., the output below), you might state the following:

Group Statistics

	group	N	Mean	Std. Deviation	Std. Error Mean
score	Control	4	41.0000	4.24264	2.12132
	Experimental	3	33.3333	2.08167	1.20185

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
score	Equal variances assumed	5.058	.074	2.835	5	.036	7.66667	2.70391	.71605	14.61728
	Equal variances not assumed			3.144	4.534	.029	7.66667	2.43812	1.20060	14.13273

> An independent-samples t test comparing the mean scores of the experimental and control groups found a significant difference between the means of the two groups ($t(5) = 2.835, p < .05$). The mean of the experimental group was significantly lower ($m = 33.333$, $sd = 2.08$) than the mean of the control group ($m = 41.000$, $sd = 4.24$).

Phrasing Results That Are Not Significant

In our example at the start of this section, we compared the scores of the morning people to the scores of the nonmorning people. We did not find a significant difference, so we could state the following:

> An independent-samples t test was calculated comparing the mean score of participants who identified themselves as morning people to the mean score of participants who did not identify themselves as morning people. No significant difference was found ($t(2) = .805$, $p > .05$). The mean of the morning people ($m = 78.00$, $sd = 7.07$) was not significantly different from the mean of nonmorning people ($m = 82.50$, $sd = 3.54$).

Practice Exercise

Use Practice Data Set 1 in Appendix B to solve this problem. We believe that young individuals have lower mathematics skills than older individuals. We would test this hypothesis by comparing participants 25 or younger (the "young" group) with participants 26 or older (the "old" group). Hint: You may need to create a new variable that represents each age group. See Chapter 2 for help.

Section 6.4 Paired-Samples *t* Test

Description

The paired-samples t test (also called a dependent t test) compares the **means** of two scores from related samples. For instance, comparing a pretest and a posttest score for a group of participants would require a paired-samples t test.

Assumptions

The paired-samples t test assumes that both variables are at the **interval** or **ratio** levels and are normally distributed. The two variables should also be measured with the same scale. If the scales are different, the scores should be converted to z-scores before the t test is conducted.