# Using SPSS for t Tests

This tutorial will show you how to use SPSS version 12.0 to perform one-sample t-tests, independent samples t-tests, and paired samples t-tests.

This tutorial assumes that you have:

- Downloaded the standard class data set (click on the link and save the data file)
- Started SPSS (click on Start | Programs | SPSS for Windows | SPSS 12.0 for Windows)

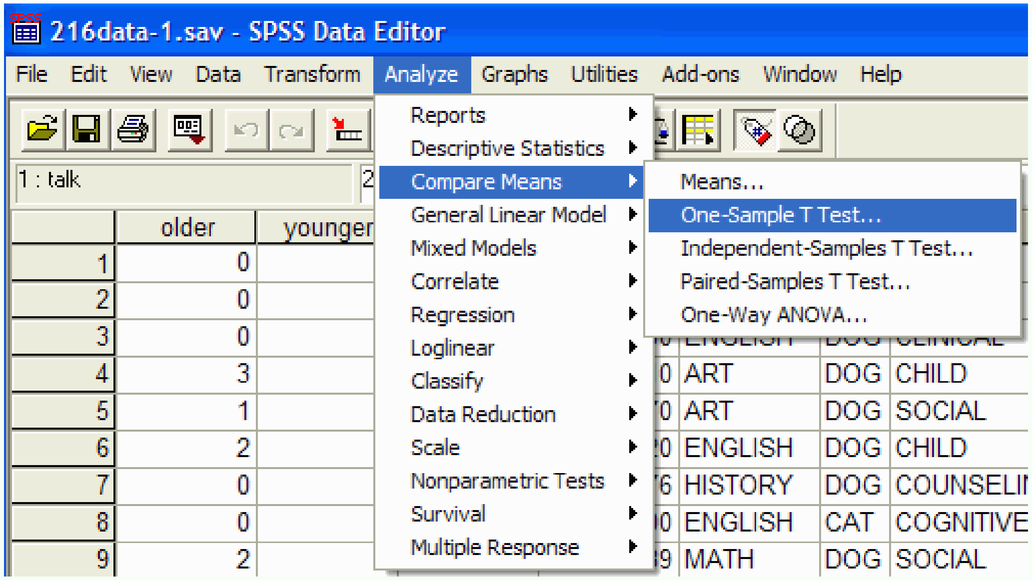
## One Sample t-Tests

One sample t-tests can be used to determine if the mean of a sample is different from a particular value. In this example, we will determine if the mean number of older siblings that the PSY 216 students have is greater than 1.

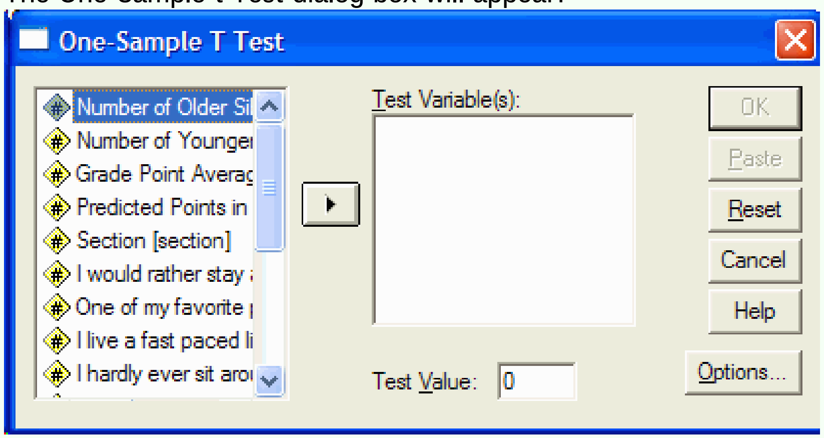
We will follow our customary steps:

1. Write the null and alternative hypotheses first:
   $H_0$: $\mu_{216\ \text{Students}} \leq 1$
   
   $H_1$: $\mu_{216\ \text{Students}} > 1$
   
   Where μ is the mean number of older siblings that the PSY 216 students have.
2. Determine if this is a one-tailed or a two-tailed test. Because the hypothesis involves the phrase "greater than", this must be a one tailed test.
3. Specify the α level: α = .05
4. Determine the appropriate statistical test. The variable of interest, older, is on a ratio scale, so a z-score test or a t-test might be appropriate. Because the population standard deviation is not known, the z-test would be inappropriate. We will use the t-test instead.
5. Calculate the t value, or let SPSS do it for you!

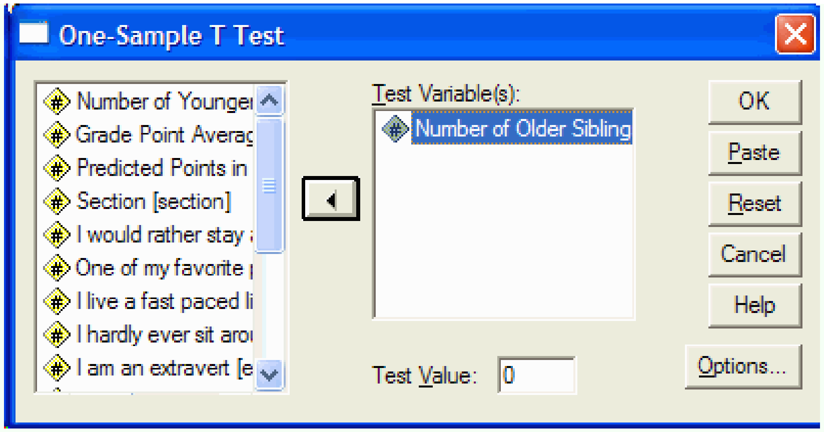
   The command for a one sample t tests is found at Analyze | Compare Means | One-Sample T Test (this is shorthand for clicking on the Analyze menu item at the top of the window, and then clicking on Compare Means from the drop down menu, and One-Sample T Test from the pop up menu.):



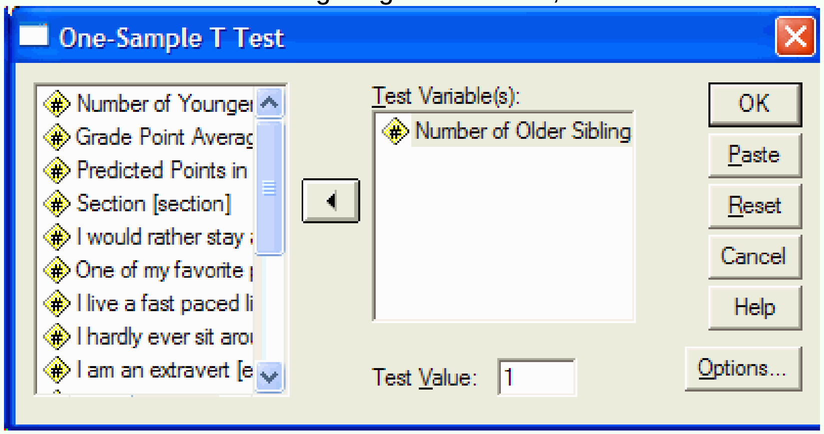

The One-Sample t Test dialog box will appear:




Select the dependent variable(s) that you want to test by clicking on it in the left hand pane of the One-Sample t Test dialog box. Then click on the arrow button to move the variable into the Test Variable(s) pane. In this example, move the Older variable (number of older siblings) into the Test Variables box:




Click in the Test Value box and enter the value that you will compare to. In this example, we are comparing if the number of older siblings is greater than 1, so we should enter 1 into the Test Value box:




Click on the OK button to perform the one-sample t test. The output viewer will appear. There are two parts to the output. The first part gives descriptive statistics for the variables that you moved into the Test Variable(s) box on the One-Sample t Test dialog box. In this example, we get descriptive statistics for the Older variable:

**One-Sample Statistics**

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Number of Older Siblings | 46 | 1.26 | 1.255 | .185 |

This output tells us that we have 46 observations (N), the mean number of older siblings is 1.26 and the standard deviation of the number of older siblings is 1.255. The standard error of the mean (the standard deviation of the sampling distribution of means) is 0.185 (1.255 / square root of 46 = 0.185).

The second part of the output gives the value of the statistical test:

**One-Sample Test**

| | Test Value = 1 | | | | | |
|---|---|---|---|---|---|---|
| | | | | | 95% Confidence Interval of the Difference | |
| | t | df | Sig. (2-tailed) | Mean Difference | Lower | Upper |
| Number of Older Siblings | 1.410 | 45 | .165 | .261 | -.11 | .63 |

The second column of the output gives us the t-test value: (1.26 - 1) / (1.255 / square root of 46) = 1.410 [if you do the calculation, the values will not match exactly because of round-off error). The third column tells us that this t test has 45 degrees of freedom (46 - 1 = 45). The fourth column tells us the *two-tailed* significance (the 2-tailed p value.) But we didn't want a two-tailed test; our hypothesis is one tailed and there is no option to specify a one-tailed test. Because this is a one-tailed test, look in a table of critical t values to determine the critical t. The critical t with 45 degrees of freedom, α = .05 and one-tailed is 1.679.

6. Determine if we can reject the null hypothesis or not. The decision rule is: if the one-tailed critical t value is less than the observed t AND the means are in the right order, then we can reject $H_0$. In this example, the critical t is 1.679 (from the table of critical t values) and the observed t is 1.410, so we fail to reject $H_0$. That is, there is insufficient evidence to conclude that the mean number of older siblings for the PSY 216 classes is larger than 1.

If we were writing this for publication in an APA journal, we would write it as:
A *t* test failed to reveal a statistically reliable difference between the mean number of older siblings that the PSY 216 class has (M = 1.26, s = 1.26) and 1, $t(45) = 1.410$, $p < .05$, $\alpha = .05$.

## Independent Samples t-Tests
## Single Value Groups

When two samples are involved, the samples can come from different individuals who are not matched (the samples are independent of each other.) Or the sample can come from the same individuals (the samples are paired with each other) and the samples are not independent of each other. A third alternative is that the samples can come from different individuals who have been matched on a variable of interest; this type of sample will not be independent. The form of the t-test is slightly different for the independent samples and dependent samples types of two sample tests, and SPSS has separate procedures for performing the two types of tests.

The Independent Samples t-test can be used to see if two means are different from each other when the two samples that the means are based on were taken from different individuals who have not been matched. In this example, we will determine if the students in sections one and two of PSY 216 have a different number of older siblings.

We will follow our customary steps:

1. Write the null and alternative hypotheses first:

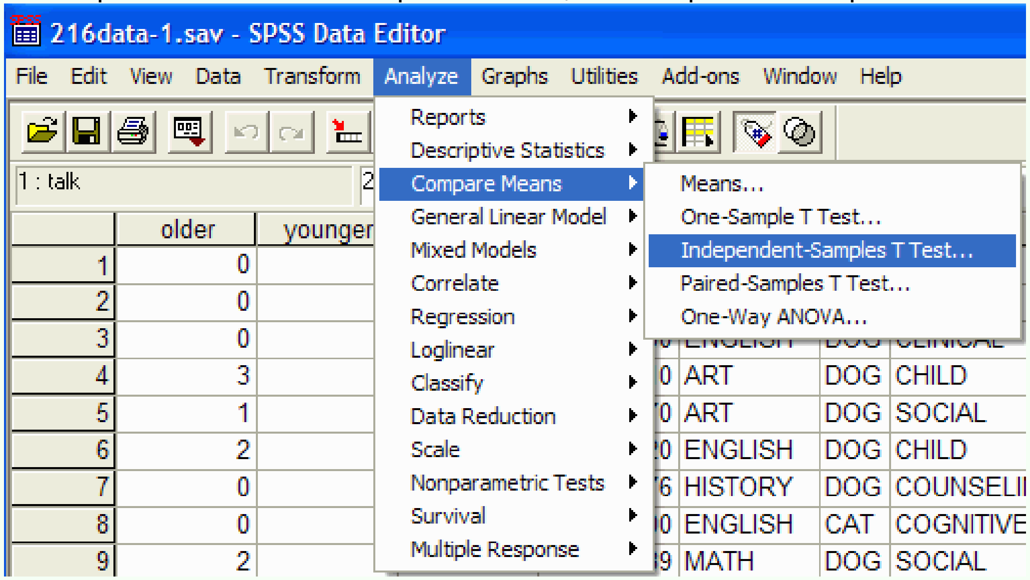
$H_0$: $\mu_{Section\ 1} = \mu_{Section\ 2}$

$H_1$: $\mu_{Section\ 1} \neq \mu_{Section\ 2}$

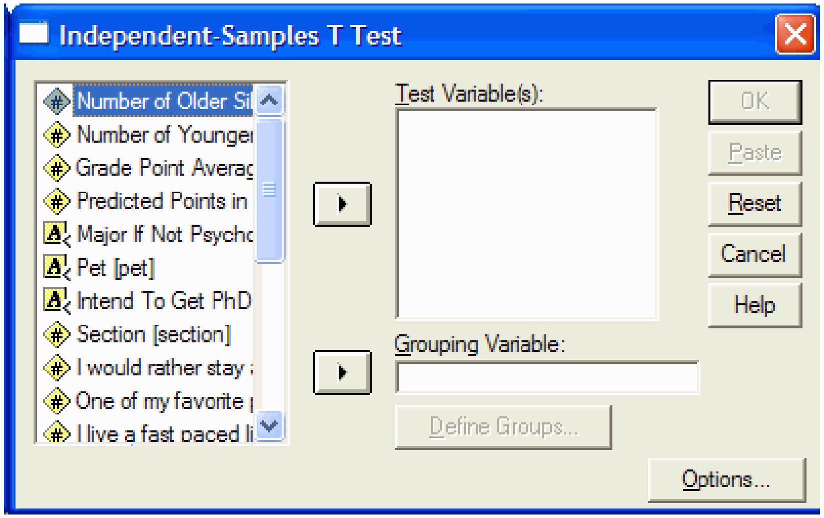
Where μ is the mean number of older siblings that the PSY 216 students have.

2. Determine if this is a one-tailed or a two-tailed test. Because the hypothesis involves the phrase "different" and no ordering of the means is specified, this must be a two tailed test.
3. Specify the α level: α = .05
4. Determine the appropriate statistical test. The variable of interest, older, is on a ratio scale, so a z-score test or a t-test might be appropriate. Because the population standard deviation is not known, the z-test would be inappropriate. Furthermore, there are different students in sections 1 and 2 of PSY 216, and they have not been matched. Because of these factors, we will use the independent samples t-test.
5. Calculate the t value, or let SPSS do it for you!

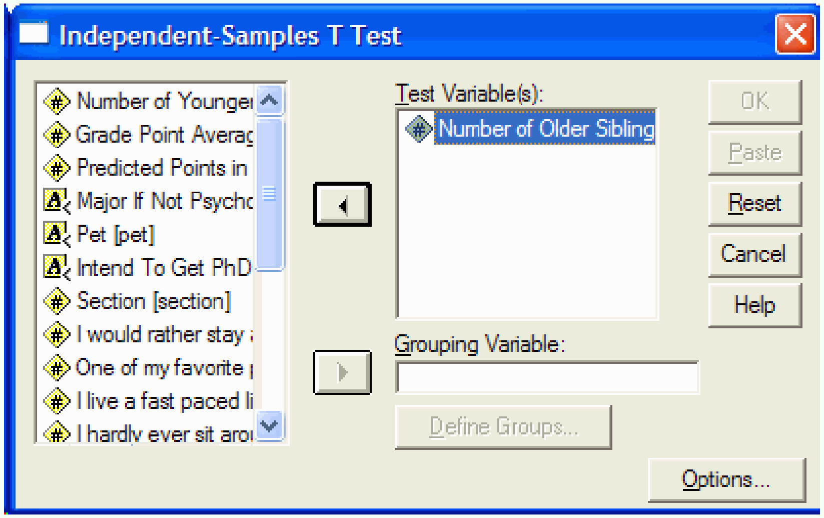
The command for the independent samples t tests is found at Analyze | Compare Means | Independent-Samples T Test (this is shorthand for clicking on the Analyze menu item at the top of the window, and then clicking on Compare Means from the drop down menu, and Independent-Samples T Test from the pop up menu.):



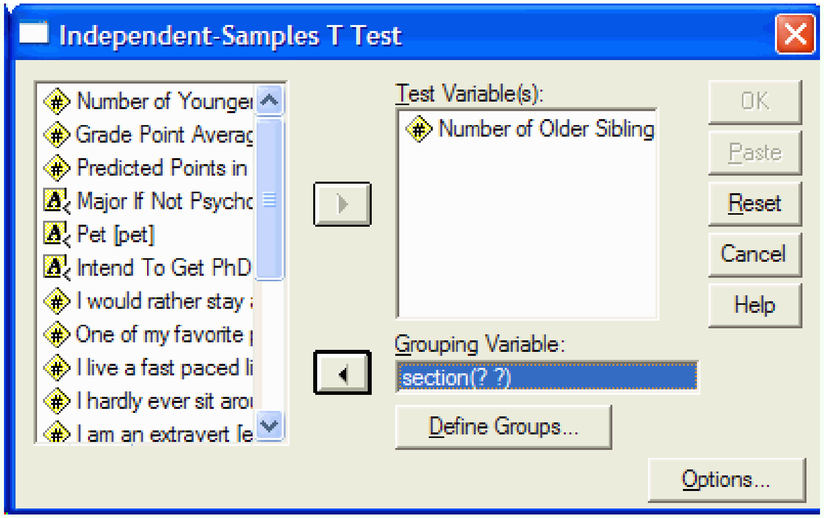

The Independent-Samples t Test dialog box will appear:



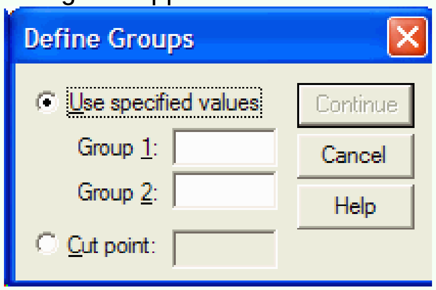

Select the dependent variable(s) that you want to test by clicking on it in the left hand pane of the Independent-Samples t Test dialog box. Then click on the upper arrow button to move the variable into the Test Variable(s) pane. In this example, move the Older variable (number of older siblings) into the Test Variables box:



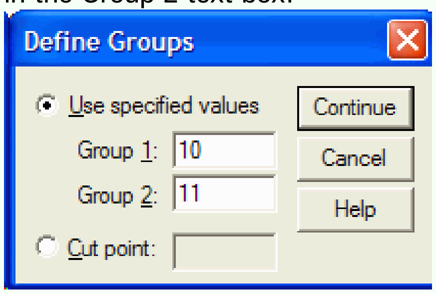

Click on the independent variable (the variable that defines the two groups) in the left hand pane of the Independent-Samples t Test dialog box. Then click on the lower arrow button to move the variable in the Grouping Variable box. In this example, move the Section variable into the Grouping Variable box:




You need to tell SPSS how to define the two groups. Click on the Define Groups button. The Define Groups dialog box appears:




In the Group 1 text box, type in the value that determines the first group. In this example, the value of the 10 AM section is 10. So you would type 10 in the Group 1 text box. In the Group 2 text box, type the value that determines the second group. In this example, the value of the 11 AM section is 11. So you would type 11 in the Group 2 text box:




Click on the Continue button to close the Define Groups dialog box. Click on the OK button in the Independent-Samples t Test dialog box to perform the t-test. The output viewer will appear with the results of the t test. The results have two main parts: descriptive statistics and inferential statistics. First, the descriptive statistics:

**Group Statistics**

| | Section | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Number of Older Siblings | 10 | 14 | .86 | 1.027 | .275 |
| | 11 | 32 | 1.44 | 1.318 | .233 |

This gives the descriptive statistics for each of the two groups (as defined by the grouping variable.) In this example, there are 14 people in the 10 AM section (N), and they have, on average, 0.86 older siblings, with a standard deviation of 1.027 older siblings. There are 32 people in the 11 AM section (N), and they have, on average, 1.44 older siblings, with a standard deviation of 1.318 older siblings. The last column gives the standard error of the mean for each of the two groups.

The second part of the output gives the inferential statistics:

**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 |
| Number of Older Siblings | Equal variances assumed | 1.669 | .203 | -1.461 | 44 | .151 | -.580 | .397 | -1.381 | .220 |
| | Equal variances not assumed | | | -1.612 | 31.607 | .117 | -.580 | .360 | -1.314 | .153 |

The columns labeled "Levene's Test for Equality of Variances" tell us whether an assumption of the t-test has been met. The t-test assumes that the variability of each group is approximately equal. If that assumption isn't met, then a special form of the t-test should be used. Look at the column labeled "Sig." under the heading "Levene's Test for Equality of Variances". In this example, the significance (p value) of Levene's test is .203. If this value is less than or equal to your α level for the test (usually .05), then you can reject the null hypothesis that the variability of the two groups is equal, implying that the variances are unequal. If the p value is less than or equal to the α level, then you should use the bottom row of the output (the row labeled "Equal variances not assumed.") If the p value is greater than your α level, then you should use the middle row of the output (the row labeled "Equal variances assumed.") In this example, .203 is larger than α, so we will assume that the variances are equal and we will use the middle row of the output.

The column labeled "t" gives the observed or calculate t value. In this example, assuming equal variances, the t value is 1.461. (We can ignore the sign of t for a two tailed t-test.) The column labeled "df" gives the degrees of freedom associated with the t test. In this example, there are 44 degrees of freedom.

The column labeled "Sig. (2-tailed)" gives the two-tailed p value associated with the test. In this example, the p value is .151. If this had been a one-tailed test, we would need to look up the critical t in a table.

6. Decide if we can reject $H_0$: As before, the decision rule is given by: If p ≤ α , then reject $H_0$. In this example, .151 is not less than or equal to .05, so we fail to reject $H_0$. That implies that we failed to observe a difference in the number of older siblings between the two sections of this class.

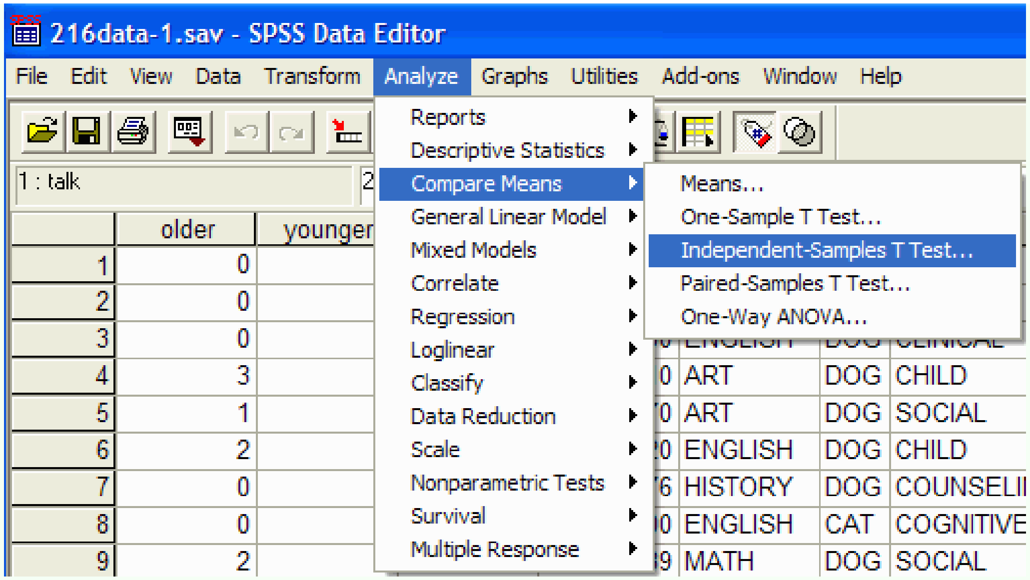
If we were writing this for publication in an APA journal, we would write it as:
A *t* test failed to reveal a statistically reliable difference between the mean number of older siblings that the 10 AM section has (M = 0.86, s = 1.027) and that the 11 AM section has (M = 1.44, s = 1.318), $t(44) = 1.461$, $p = .151$, $\alpha = .05$.

## Independent Samples t-Tests
## Cut Point Groups

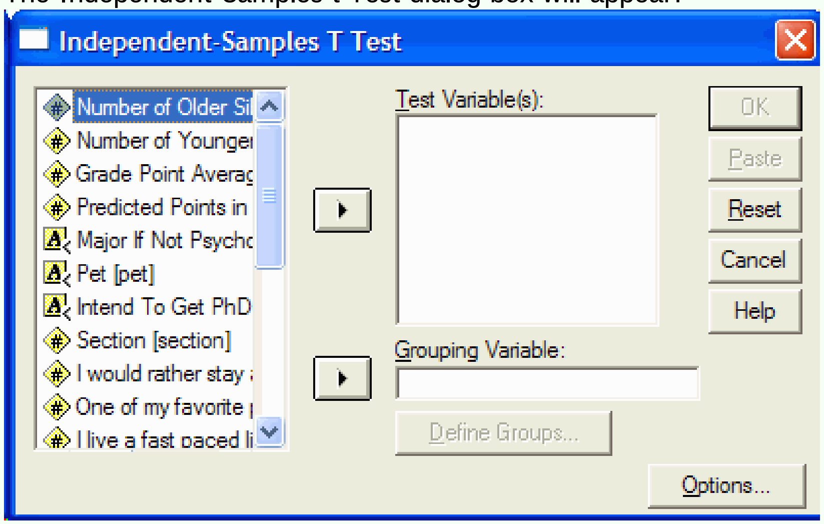
Sometimes you want to perform a t-test but the groups are defined by a variable that is not dichotomous (i.e., it has more than two values.) For example, you may want to see if the number of older siblings is different for students who have higher GPAs than for students who have lower GPAs. Since there is no single value of GPA that specifies "higher" or "lower", we cannot proceed exactly as we did before. Before proceeding, decide which value you will use to divide the GPAs into the higher and lower groups. The median would be a good value, since half of the scores are above the median and half are below. (If you do not remember how to calculate the median see the frequency command in the descriptive statistics tutorial.)

1. Write the null and alternative hypotheses first:
   $H_0$: $\mu_{\text{lower GPA}} = \mu_{\text{higher GPA}}$
   $H_1$: $\mu_{\text{lower GPA}} \neq \mu_{\text{Higher GPA}}$
   Where μ is the mean number of older siblings that the PSY 216 students have.
2. Determine if this is a one-tailed or a two-tailed test. Because the hypothesis involves the phrase "different" and no ordering of the means is specified, this must be a two tailed test.
3. Specify the α level: α = .05
4. Determine the appropriate statistical test. The variable of interest, older, is on a ratio scale, so a z-score test or a t-test might be appropriate. Because the population standard deviation is not known, the z-test would be inappropriate. Furthermore, different students have higher and lower GPAs, so we have a between-subjects design. Because of these factors, we will use the independent samples t-test.
5. Calculate the t value, or let SPSS do it for you.

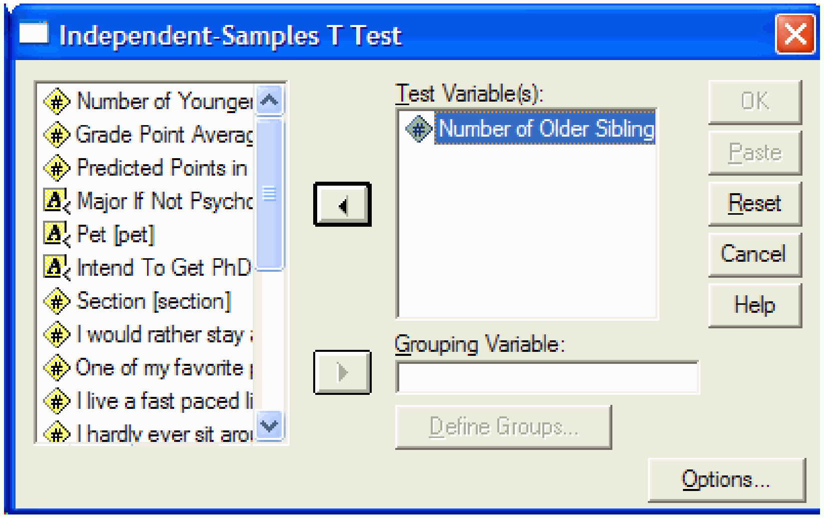
   The command for the independent samples t tests is found at Analyze | Compare Means | Independent-Samples T Test (this is shorthand for clicking on the Analyze menu item at the top of the window, and then clicking on Compare Means from the drop down menu, and Independent-Samples T Test from the pop up menu.):



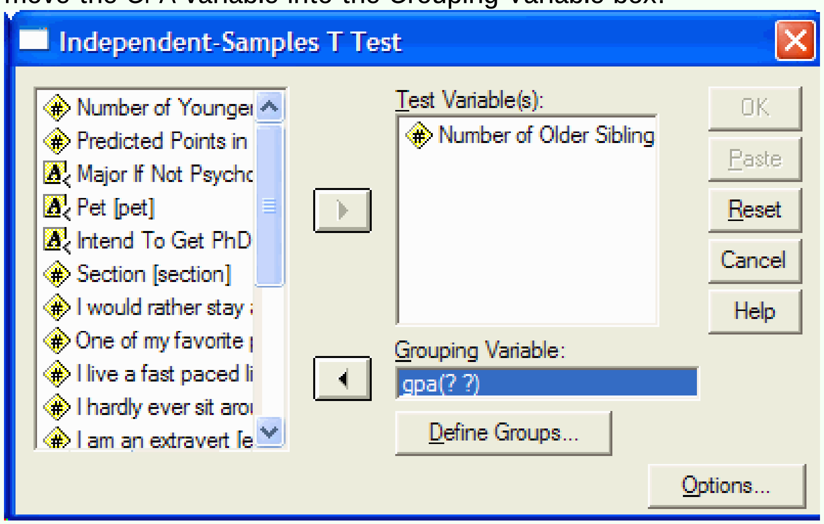

The Independent-Samples t Test dialog box will appear:



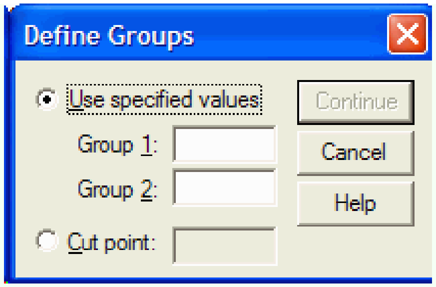

Select the dependent variable(s) that you want to test by clicking on it in the left hand pane of the Independent-Samples t Test dialog box. Then click on the upper arrow button to move the variable into the Test Variable(s) pane. In this example, move the Older variable (number of older siblings) into the Test Variables box:



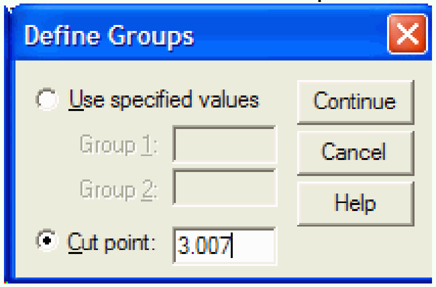

Click on the independent variable (the variable that defines the two groups) in the left hand pane of the Independent-Samples t Test dialog box. Then click on the lower arrow button to move the variable in the Grouping Variable box. (If there already is a variable in the Grouping Variable box, click on it if it is not already highlighted, and then click on the lower arrow which should be pointing to the left.) In this example, move the GPA variable into the Grouping Variable box:




You need to tell SPSS how to define the two groups. Click on the Define Groups button. The Define Groups dialog box appears:




Click in the circle to the left of "Cut Point:". Then type the value that splits the variable into two groups. Group one is defined as all scores that are greater than or equal to the cut point. Group two is defined as all scores that are less than the cut point. In this example, use 3.007 (the median of the GPA variable) as the cut point value:




Click on the Continue button to close the Define Groups dialog box. Click on the OK button in the Independent-Samples t Test dialog box to perform the t-test. The output viewer will appear with the results of the t test. The results have two main parts: descriptive statistics and inferential statistics. First, the descriptive statistics:

**Group Statistics**

| | Grade Point Average | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Number of Older Siblings | >= 3.01 | 23 | 1.04 | 1.186 | .247 |
| | < 3.01 | 23 | 1.48 | 1.310 | .273 |

This gives the descriptive statistics for each of the two groups (as defined by the grouping variable.) In this example, there are 23 people with a GPA greater than or equal to 3.01 (N), and they have, on average, 1.04 older siblings, with a standard deviation of 1.186 older siblings. There are 23 people with a GPA less than 3.01 (N), and they have, on average, 1.48 older siblings, with a standard deviation of 1.310 older siblings. The last column gives the standard error of the mean for each of the two groups.

The second part of the output gives the inferential statistics:

**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 |
| Number of Older Siblings | Equal variances assumed | .776 | .383 | -1.180 | 44 | .244 | -.435 | .368 | -1.177 | .308 |
| | Equal variances not assumed | | | -1.180 | 43.575 | .244 | -.435 | .368 | -1.178 | .308 |

As before, the columns labeled "Levene's Test for Equality of Variances" tell us whether an assumption of the t-test has been met. Look at the column labeled "Sig." under the heading "Levene's Test for Equality of Variances". In this example, the significance (p value) of Levene's test is .383. If this value is less than or equal to your α level for this test, then you can reject the null hypothesis that the variabilities of the two groups are equal, implying that the variances are unequal. In this example, .383 is larger than our α level of .05, so we will assume that the variances are equal and we will use the middle row of the output.

The column labeled "t" gives the observed or calculated t value. In this example, assuming equal variances, the t value is 1.180. (We can ignore the sign of t when using a two-tailed t-test.) The column labeled "df" gives the degrees of freedom associated with the t test. In this example, there are 44 degrees of freedom.

The column labeled "Sig. (2-tailed)" gives the two-tailed p value associated with the test. In this example, the p value is .244. If this had been a one-tailed test, we would need to look up the critical t in a table.

6. Decide if we can reject $H_0$: As before, the decision rule is given by: If $p \le \alpha$ , then reject $H_0$. In this example, .244 is greater than .05, so we fail to reject $H_0$. That implies that there is not sufficient evidence to conclude that people with higher or lower GPAs have different number of older siblings.

If we were writing this for publication in an APA journal, we would write it as:
An equal variances *t* test failed to reveal a statistically reliable difference between the mean number of older siblings for people with higher (M = 1.04, s = 1.186) and lower GPAs (M = 1.48, s = 1.310), *t*(44) = 1.18, *p* = .244, α = .05.

## Paired Samples t-Tests

When two samples are involved and the values for each sample are collected from the same individuals (that is, each individual gives us two values, one for each of the two groups), or the samples come from matched pairs of individuals then a paired-samples t-test may be an appropriate statistic to use.

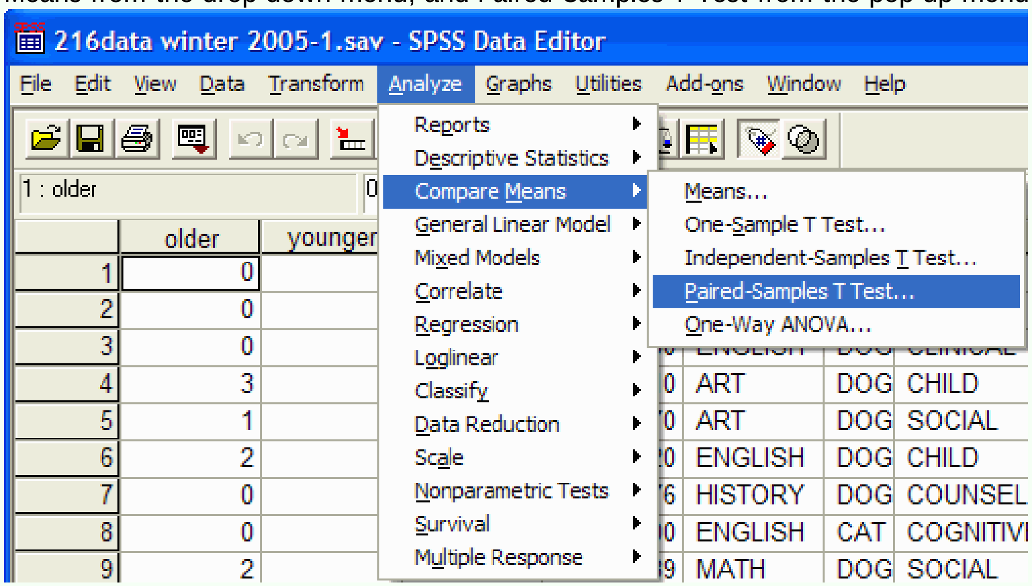
The paired samples t-test can be used to determine if two means are different from each other when the two samples that the means are based on were taken from the matched individuals or the same individuals. In this example, we will determine if the students have different numbers of younger and older siblings.

1. Write the null and alternative hypotheses:
   $H_0: \mu_{older} = \mu_{younger}$

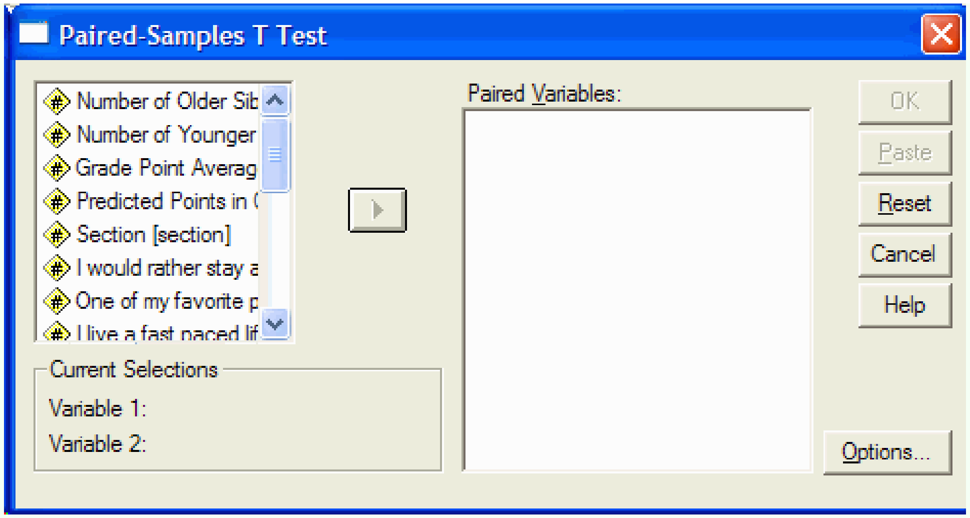
   $H_1: \mu_{older} \neq \mu_{younger}$

   Where µ is the mean number of siblings that the PSY 216 students have.
2. Determine if this is a one-tailed or a two-tailed test. Because the hypothesis involves the phrase "different" and no ordering of the means is specified, this must be a two tailed test.
3. Specify the α level: α = .05
4. Determine the appropriate statistical test. The variables of interest, older and younger, are on a ratio scale, so a z-score test or a t-test might be appropriate. Because the population standard deviation is not known, the z-test would be inappropriate. Furthermore, the same students are reporting the number of older and younger siblings, we have a within-subjects design. Because of these factors, we will use the paired samples t-test.
5. Let SPSS calculate the value of t for you.

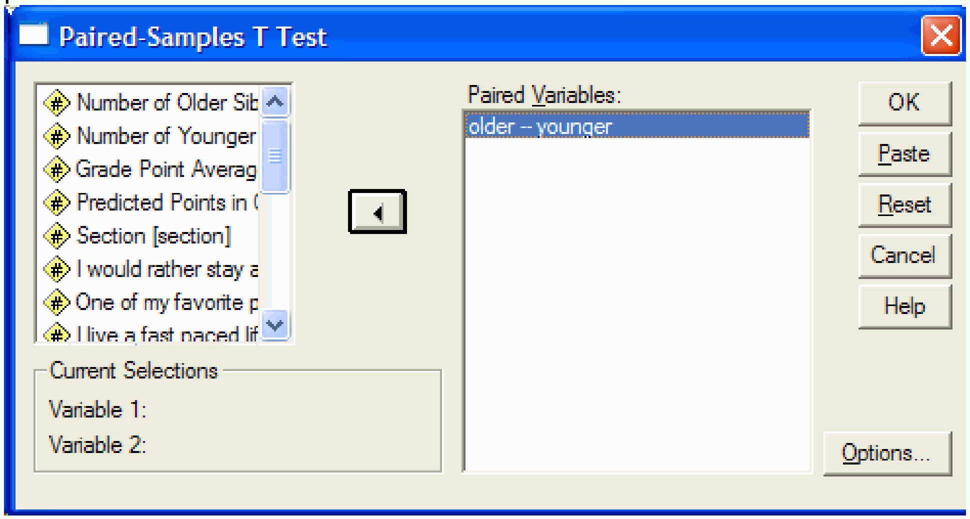
   The command for the paired samples t tests is found at Analyze | Compare Means | Paired-Samples T Test (this is shorthand for clicking on the Analyze menu item at the top of the window, and then clicking on Compare Means from the drop down menu, and Paired-Samples T Test from the pop up menu.):




The Paired-Samples t Test dialog box will appear:




You must select a pair of variables that represent the two conditions. Click on one of the variables in the left hand pane of the Paired-Samples t Test dialog box. Then click on the other variable in the left hand pane. Click on the arrow button to move the variables into the Paired Variables pane. In this example, select Older and Younger variables (number of older and younger siblings) and then click on the arrow button to move the pair into the Paired Variables box:




Click on the OK button in the Paired-Samples t Test dialog box to perform the t-test. The output viewer will appear with the results of the t test. The results have three main parts: descriptive statistics, the correlation between the pair of variables, and inferential statistics. First, the descriptive statistics:

**Paired Samples Statistics**

| | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | Number of Older Siblings | 1.24 | 45 | 1.264 | .188 |
| | Number of Younger Siblings | 1.13 | 45 | 1.198 | .179 |

This gives the descriptive statistics for each of the two groups (as defined by the pair of variables.) In this example, there are 45 people who responded to the Older siblings question (N), and they have, on average, 1.24 older siblings, with a standard deviation of 1.26 older siblings. These same 45 people also responded to the Younger siblings question (N), and they have, on average, 1.13 younger siblings, with a standard deviation of 1.20 younger siblings. The last column gives the standard error of the mean for each of the two variables.

The second part of the output gives the correlation between the pair of variables:

**Paired Samples Correlations**

| | | N | Correlation | Sig. |
|---|---|---|---|---|
| Pair 1 | Number of Older Siblings & Number of Younger Siblings | 45 | -.292 | .052 |

This again shows that there are 45 pairs of observations (N). The correlation between the two variables is given in the third column. In this example r = -.292. The last column give the p value for the correlation coefficient. As always, if the p value is less than or equal to the alpha level, then you can reject the null hypothesis that the population correlation coefficient (ρ) is equal to 0. In this case, p = .052, so we fail to reject the null hypothesis. That is, there is insufficient evidence to conclude that the population correlation (ρ) is different from 0.

The third part of the output gives the inferential statistics:

**Paired Samples Test**

| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | Upper | | | |
| Pair 1 | Number of Older Siblings - Number of Younger Siblings | .111 | 1.980 | .295 | -.484 | .706 | .377 | 44 | .708 |

The column labeled "Mean" is the difference of the two means (1.24 - 1.13 = 0.11 in this example (the difference is due to round off error).) The next column is the standard deviation of the difference between the two variables (1.98 in this example.)

The column labeled "t" gives the observed or calculated t value. In this example, the t value is 0.377 (you can ignore the sign.) The column labeled "df" gives the degrees of freedom associated with the t test. In this example, there are 44 degrees of freedom. The column labeled "Sig. (2-tailed)" gives the two-tailed p value associated with the test. In this example, the p value is .708. If this had been a one-tailed test, we would need to look up the critical value of t in a table.

6. Decide if we can reject $H_0$: As before, the decision rule is given by: If $p \leq \alpha$, then reject $H_0$. In this example, .708 is not less than or equal to .05, so we fail to reject $H_0$. That implies that there is insufficient evidence to conclude that the number of older and younger siblings is different.

If we were writing this for publication in an APA journal, we would write it as:
A paired samples *t* test failed to reveal a statistically reliable difference between the mean number of older (M = 1.24, s = 1.26) and younger (M = 1.13, s = 1.20) siblings that the students have, *t*(44) = 0.377, *p* = .708, α = .05.