

Independent Samples t tests in SPSS (Quiz)



Independent Samples t test practical questions

We have seen that, on average, boys in England performed significantly better on the PISA science test than girls. One potential explanation for gender differences in science attainment relates to differences in what is known as instrumental motivation: the belief that science will be useful in supporting the realisation of future goals and plans. PISA contains a measure of instrumental motivation for science learning, INSMOVSCI, derived from four items in which students rated their agreement with such statements as "Many things I learn in my school science subjects will help me to get a job" (see PISA datafile description for further details).

Here you will explore the evidence for this explanation by testing whether instrumental motivation for science learning differs significantly between boys and girls.

The first step is generally to test for the normality of the variable **INSMOVSCI** in each of the two groups that are indicated by **GENDER**, so do this now.

- Question: Looking at the histogram and the normality tests does this variable look normal for **GENDER = Male**?
- Question: How about for **GENDER = Female**?

If both groups can be assumed to follow normal distributions then a first descriptive step before performing the test is to look at an error bar plot to see if the intervals of the two groups overlap, so do this now.

- Question: Does the plot give evidence of a significant difference?

Next conduct the independent samples t-test.

- Question: From the summary stats block which group has the larger mean?
- Question: Which group has the largest variability?
- Question: Using Levene's test can we assume equal variances?
- Question: Is there a significant difference between the groups?
- Question: How would you write up these findings?

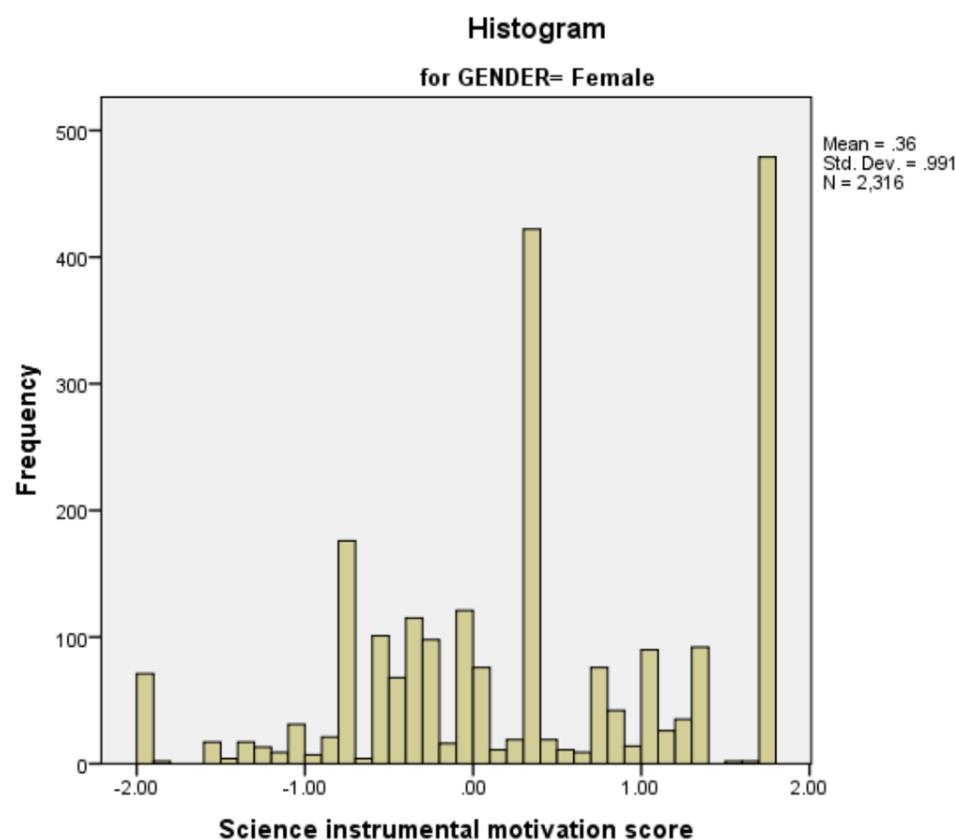
Solutions to Independent Samples t test practical questions

To test the dependent variable for normality in each group:

- Select **Descriptive Statistics** from the **Analyze** menu.
- Select **Explore** from the **Descriptive Statistics** sub-menu.
- Click on the **Reset** button.
- Copy the **Science instrumental motivation score[INSMOVSCI]** variables into the **Dependent List:** box.
- Copy the **Student gender[GENDER]** variable into the **Factor List:** box.
- Click on the **Plots...** button.
- On the screen that appears select the **Histogram** tick box.
- Unselect the **Stem and leaf** button.
- Select the **Normality plots with tests** button.
- Click on the **Continue** button.
- Click on the **OK** button.

Question: Looking at the histogram and the normality tests does this variable look normal for **GENDER = Male**?

Solution: The output from SPSS is as follows:



Ideally for a normal distribution this histogram should look symmetric around the mean of the distribution, in this case .4004. This distribution appears to be negatively skewed.

Tests of Normality

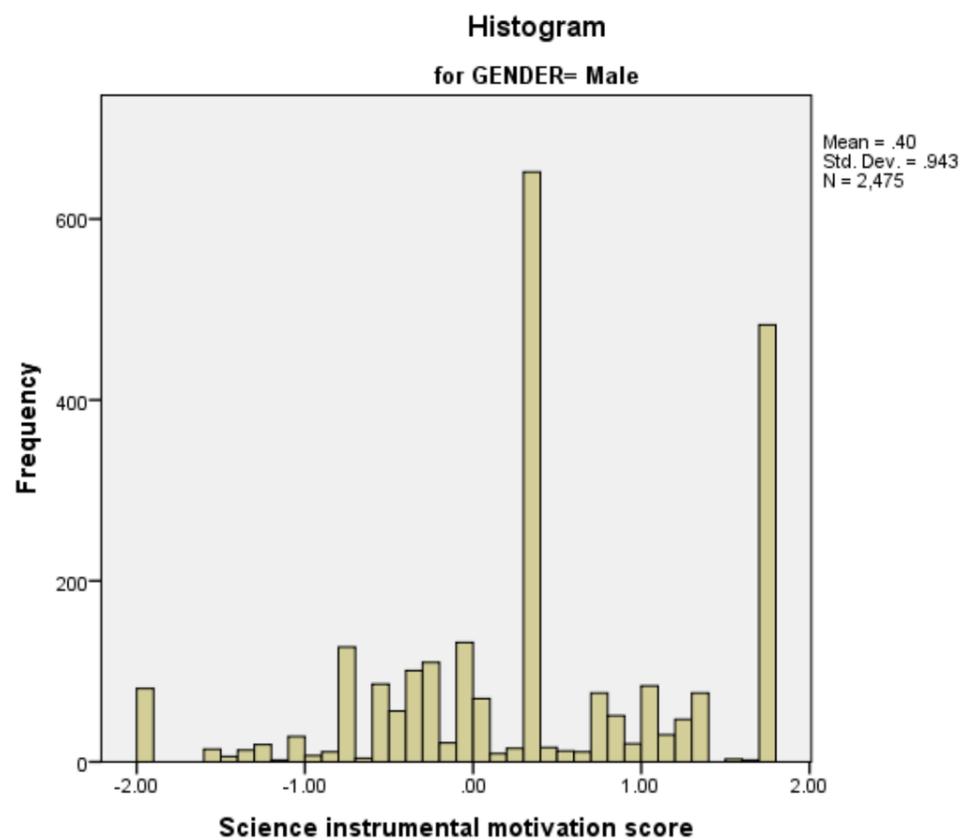
	Student gender	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Science instrumental motivation score	Female	.123	2316	.000	.938	2316	.000
	Male	.144	2475	.000	.937	2475	.000

a. Lilliefors Significance Correction

The relevant Kolmogorov-Smirnov statistic from the table has degrees of freedom equal to the sample size for which **GENDER = Male**, i.e. 2475. The p-value provided by SPSS (quoted under Sig. for Kolmogorov-Smirnov) is .000 (reported as $p < .001$). We therefore have significant evidence to reject the null hypothesis that the variable follows a normal distribution. As noted in the Practical, however, formal tests of normality must be considered in the light both of sample sizes and of whether the data seem "sufficiently" normal on the basis of visual inspection.

Question: How about for **GENDER = Female**?

Solution: The output from SPSS is as follows:



Ideally for a normal distribution this histogram should look symmetric around the mean of the distribution, in this case .3621. This distribution appears to be negatively skewed.

Tests of Normality

	Student gender	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Science instrumental motivation score	Female	.123	2316	.000	.938	2316	.000
	Male	.144	2475	.000	.937	2475	.000

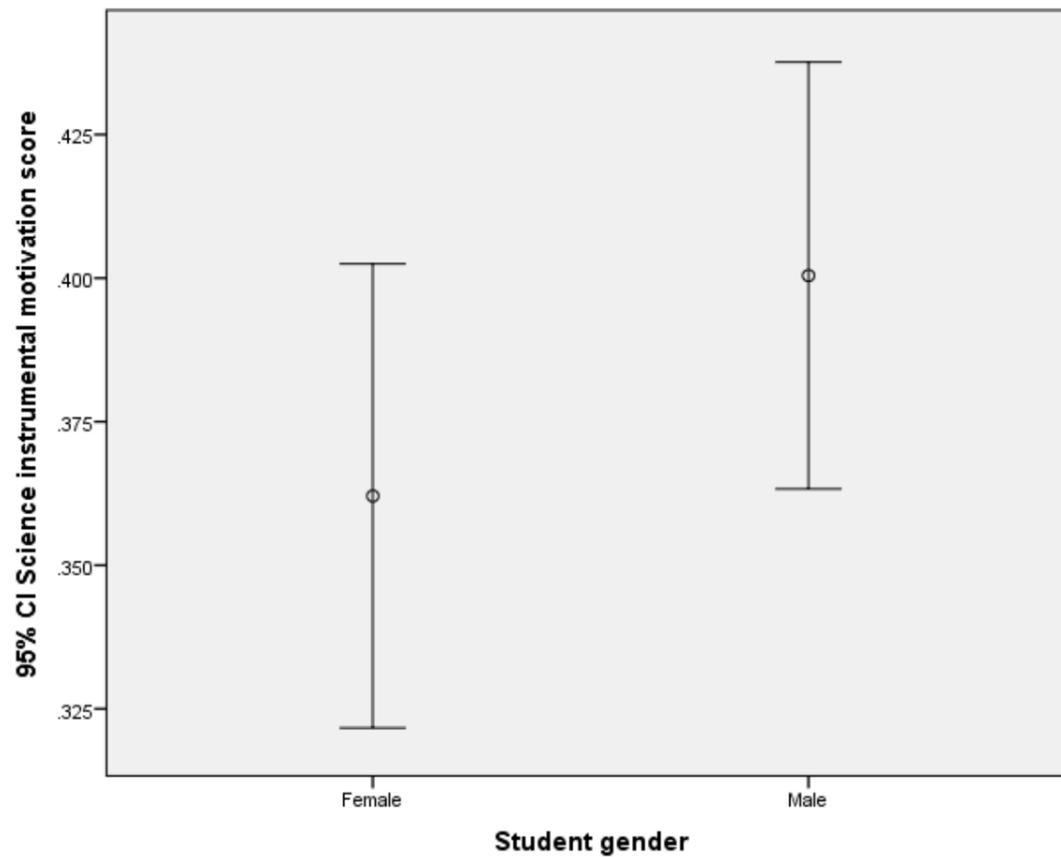
a. Lilliefors Significance Correction

The relevant Kolmogorov-Smirnov statistic from the table has degrees of freedom equal to the sample size for which **GENDER = Female**, i.e. 2316. The p-value provided by SPSS (quoted under Sig. for Kolmogorov-Smirnov) is .000 (reported as $p < .001$). We therefore have significant evidence to reject the null hypothesis that the variable follows a normal distribution, though with the caveats noted above. To plot the error bar chart in SPSS:

- Select **Error Bar** from the **Legacy Dialogs** submenu of the **Graphs** menu.
- Select **Simple** and **Summaries for groups of cases** as for the boxplot and click on the **Define** button.
- Transfer the Science instrumental motivation score[INSMOVSCI] variable to the **Variable** box.
- Transfer the **Student gender[GENDER]** variable to the **Category Axis** box.
- Click on the **OK** button.

Question: Does the plot give evidence of a significant difference?

Solution: The output from SPSS is as follows:



Here the bars overlap and so we are not sure whether there is a significant difference.

Here are the instructions to perform the t test in SPSS. They will produce the two tabular outputs embedded in the answers below.

- Select **Compare Means** from the **Analyze** menu.
- Select **Independent-Sample T Test...** from the **Compare Means** sub-menu.
- Click on the **reset** button.
- Copy the **Science instrumental motivation score[INSMOVSCI]** variable into the **Test Variable(s):** box.
- Copy the **Student gender[GENDER]** variable into the **Grouping Variable:** box.
- Click on the **Define Groups...** button.
- Click on the **Use specified values** button.
- Type **2** into the **Group 1** box.
- Type **1** into the **Group 2** box.
- Click on the **Continue** button.
- Click on the **OK** button.

- Question: From the summary stats block which group has the larger mean?
- Question: Which group has the largest variability?

Solutions: The output from SPSS is as follows:

Group Statistics

	Student gender	N	Mean	Std. Deviation	Std. Error Mean
Science instrumental motivation score	Male	2475	.4004	.94270	.01895
	Female	2316	.3621	.99145	.02060

The answers are as follows:

- The group **GENDER = Male** has the larger mean.
- The group **GENDER = Female** has the larger variability.
- Question: Using Levene's test can we assume equal variances?
- Question: Is there a significant difference between the groups?

Solutions: The output from SPSS is as follows:

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	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Science instrumental motivation score	Equal variances assumed	20.613	.000	1.373	4789	.170	.03837	.02794	-.01641	.09316
	Equal variances not assumed			1.371	4724.670	.170	.03837	.02799	-.01650	.09325

- No, we cannot assume equal variances.
- No, there are no significant differences between the two groups.
- Question: How would you write up these findings?

Solution:

In conclusion, we could report this to a reader as follows: Mean test scores were higher among **GENDER = Male** (N=2475, M=.4004, SD=.94270) than **GENDER = Female** (N=2316, M=.3621, SD=.99145). Levene's test rejected the null hypothesis of equal variances between the two groups (F=20.613, $p < .001$) so an adjusted version of the independent samples t-test that relaxes this assumption was chosen. The difference in means (difference = .03837) was not statistically significant, $t(4724.670) = 1.371$, $p=.170$.

Hence we do not find support for the proposition that boys report greater instrumental motivation in the study of science than girls. This does not appear to be the likely explanation for the gender difference in science achievement.