Crosstabs and Two Independent Samples T-test (Week 15)

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Data: Dell.sav

- Data is available on Moodle

1 Learning objectives

The aim of this third lab is to help you to use SPSS to examine group differences based on demographic factors. In this lab we will cover:

- Chi-square test
- The two independent samples t test

2 Chi-square Test

The chi-square test is useful for determining if differences exist between two categorical variables. This test can be used to substantiate perceived associations when calculating crosstabs such as those that you did in lab 1. Let's say that you want to explore if there is an association between gender (`Q14_gender`) and number of hours spent on internet (`Q1_online`). A chi-square test would be useful to assess this.

As in lab 1, use the menu options **Analyze→Descriptive statistics→Crosstabs**. I prefer to insert `q14_gender` into column and `q1_online` into row window–this way, you will see the distribution of gender within each category of `q1_online`. Select the statistics tab and click on the Chi-square option. Note that you can also click on `Phi and Cramer's V to` get an indication of the strength of the association.

Using the cells tab you should also select row or column percents to help you to see the pattern of association (in this example, I prefer to select row percentages)

In the output window you will see that three (or four with the addition Phi and Cramer's V) tables are produced. You can ignore the `Case Processing Summary`.

The second table is the crosstab table that you produced in lab 1 and the third table `Chi-Square Tests` gives you the new results. You will see that you have a table and graph like the one below for the gender by online crosstab.

The p-value associated with the crosstabs is given by the following table

The most important column within the table is the "Asymp. Sig. (2-sided)". This is the p-value column and the result above indicates that there is an evidence of an association between the rows and columns (because the p-value is smaller than 0.05), in this case between gender of the consumer and number of hours online. It is important to look at the proportion of consumers in each of the six groups.

If there was a statistically significant association you would ask the following:

1. Where do you see the association between the proportions of consumers?
2. How strong is the association?

> **Task**
>
> Have a look at the clustered bar chart, and explain the pattern of the association between `hours spend online` and `gender`. Is the association significant? (inspect the p-value of the Pearson Chi-Square)

Approximately how many hours per week do you spend online? This would be the total from all the locations you might use * Gender Crosstabulation

			Gender		
			Male	Female	Total
Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	Less than 1 hour	Count	7	13	20
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	35.0%	65.0%	100.0%
	1 to 5 hours	Count	52	87	139
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	37.4%	62.6%	100.0%
	6 to 10 hours	Count	57	48	105
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	54.3%	45.7%	100.0%
	11 to 20 hours	Count	32	23	55
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	58.2%	41.8%	100.0%
	21 to 40 hours	Count	20	14	34
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	58.8%	41.2%	100.0%
	41 hours or more	Count	15	4	19
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	78.9%	21.1%	100.0%
Total		Count	183	189	372
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	49.2%	50.8%	100.0%

Figure 1: Frequency Table

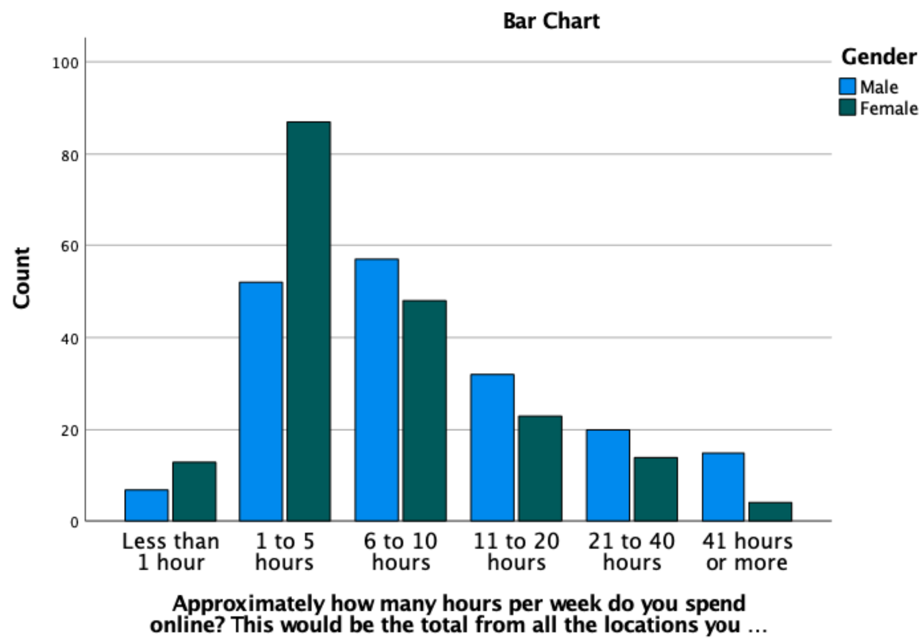


Figure 2: Clustered Bar Chart

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	20.193[a]	5	.001
Likelihood Ratio	20.739	5	<.001
Linear-by-Linear Association	17.521	1	<.001
N of Valid Cases	372		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.35.

The result is not reliable if count is less than 5

Figure 3: SPSS Output: Chi-Square Tests

Task

Based on the Phi value, assess the strength the association between `hours spend online` and `gender`?

Symmetric Measures

		Value	Approximate Significance
Nominal by Nominal	Phi	.233	.001
	Cramer's V	.233	.001
N of Valid Cases		372	

Figure 4: Effect size

What a Phi value tells us

Phi tells us about the strength of an association. Its value ranges from 0 to 1. Cohen (1988) provides the following guideline:

- 0.1 is considered small
- 0.3 medium
- 0.5 large

2.1 Post-Hoc Test

If the association were significant, you would want to know further which group comparisons are actually significantly different. This is called post-hoc tests or multiple comparison tests. In essence, you want to test all pairwise comparisons to detect where the significant occurs. For example, is the proportion of male vs female significantly different within "less than 1-hour", within "1-5 hours" group, etc?

How?

Use the menu options **Analyze→Descriptive statistics→Crosstabs**. Insert `gender` into "Columns" and `q1_online` into "rows". Tick `Row percentages`. Under z-test, tick `Compare columns proportions` and `Adjust p-values (Bonferroni method)`.

What does SPSS do with "Adjust p-values"? The answer is that SPSS will conduct z-tests for each comparison. Because of conducting multiple comparisons tests, the significance level at each test should not be 5% anymore. It should be divided by the number of comparisons. For example, if you have 6 pairwise comparisons, the sig. level at each test would be 0.05/6=0.008. This is to make sure that all comparisons tests were maintained at alpha=5%. If you do not adjust it and use alpha=5% in each of the pairwise tests, the probability of getting at least one significant result due to chance is high.

2.2 Post-Hoc Test Output

The output of the post-hoc test is given below

Approximately how many hours per week do you spend online? This would be the total from all the locations you might use * Gender Crosstabulation

			Gender		
			Male	Female	Total
Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	Less than 1 hour	Count	7_a	13_a	20
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	35.0%	65.0%	100.0%
	1 to 5 hours	Count	52_a	87_b	139
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	37.4%	62.6%	100.0%
	6 to 10 hours	Count	57_a	48_a	105
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	54.3%	45.7%	100.0%
	11 to 20 hours	Count	32_a	23_a	55
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	58.2%	41.8%	100.0%
	21 to 40 hours	Count	20_a	14_a	34
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	58.8%	41.2%	100.0%
	41 hours or more	Count	15_a	4_b	19
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	78.9%	21.1%	100.0%
Total		Count	183	189	372
		% within Approximately how many hours per week do you spend online? This would be the total from all the locations you might use	49.2%	50.8%	100.0%

Each subscript letter denotes a subset of Gender categories whose column proportions do not differ significantly from each other at the .05 level.

"If a pair of values is significantly different, the values have *different* subscript letters assigned to them" (IBM SPSS)

Figure 5: Output of the post-hoc test

Task

Looking at the output of the post-hoc test, what do you conclude?

3 Two Independent Samples T Test

This test allows you to explore differences in mean values across two groups e.g., between low vs. high-income groups; male vs. female consumers; those who received a reward vs. nothing; those who get a flu jab vs. placebo, country A vs. country B, etc.

Now, we want to assess if there are differences in the Opinion of Leadership (average scores of `q10_op1`, `q10_op2`, `q10_op3`) across gender (`q14_gender`).

As in the previous lab, you need to conduct reliability analysis to find out whether the three items of Opinion Leadership get well together, if yes, then you need to create a composite score by taking the average of the three items (I would suggest that you name the new variable as `Opinion_avg`).

In this lab, you will test following hypothesis:

H0: Opinion leadership of male consumers = Opinion leadership of female consumers.

H1: Opinion leadership of male consumers > Opinion leadership of female consumers.

> **Task**
>
> The above alternative hypothesis is directional. Formulate a non-directional alternative hypothesis instead.

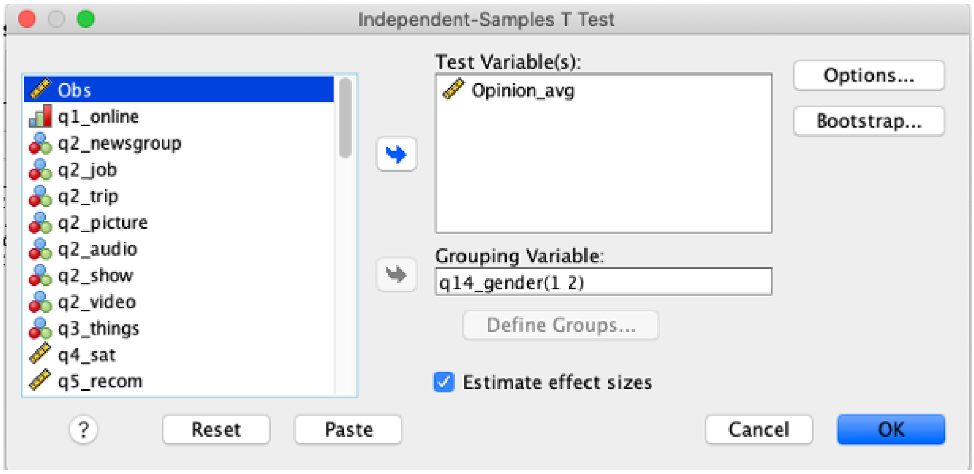
> **Warning**
>
> Note that when using a two independent samples test, the grouping variable (e.g., gender) is a qualitative variable – nominal or ordinal, and the test variable (e.g., amount money spent, scores on opinion leadership) is always a quantitative variable – interval or ratio.

To conduct a T test, use the menu options **Analyze→Compare means→Independent-Samples T test**. The test variables will be `Opinion_avg`. The grouping variable is `gender`. You need to "define groups" this means telling SPSS that gender is measured using the numbers 1 and 2 (you will see from the data view that `loyalty card status` is coded as 1 and 2). By default, 'Estimates effect size' was ticked'.

3.1 Outputs

In the output window you will have three tables, the first giving the "Group Statistics", the second giving the results of the "Independent Samples Test" (The important column is the sig. columns which give the p-values.), and the third gives the estimate of the effect size.

First, we need to look at the descriptive statistics to get a clear picture of the mean score of female vs. male on `Opinion_avg`, and assess the difference between the means.



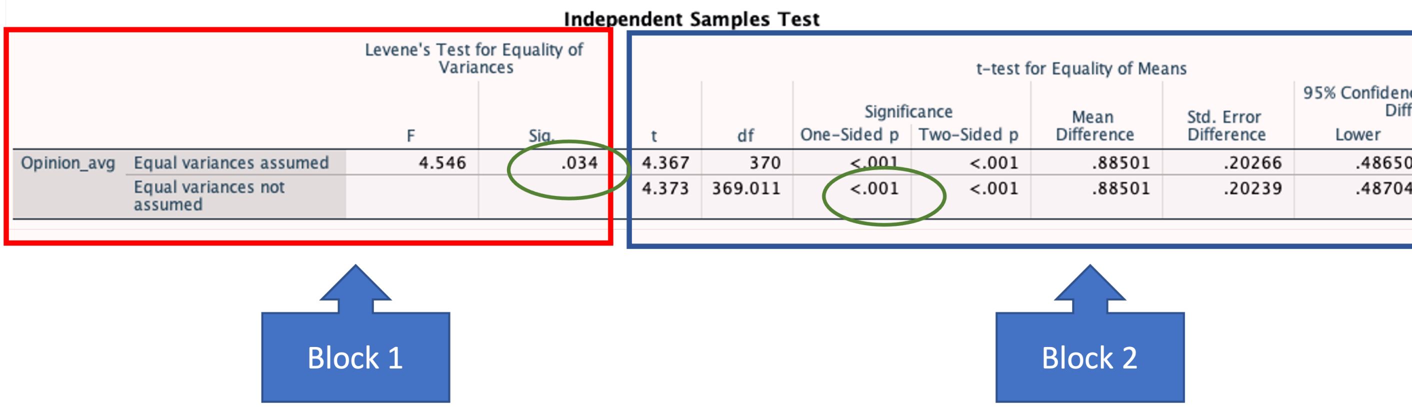
Group Statistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Opinion_avg	Male	183	4.6557	1.86900	.13816
	Female	189	3.7707	2.03320	.14789

The std. deviation is helpful in understanding the Levene's test results reported in the second table.

> **Task**
>
> Look at the descriptive statistic above, say something about the mean scores and their standard deviations.

Now, let us discuss the second table.



Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						95% Confiden Diff
						Significance				
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower
Opinion_avg	Equal variances assumed	4.546	.034	4.367	370	<.001	<.001	.88501	.20266	.48650
	Equal variances not assumed			4.373	369.011	<.001	<.001	.88501	.20239	.48704

The second column in the table gives the significance value for Levene's test (**Block 1**). This tells you if you can assume that the variance for the groups is equal, which cannot be assumed for this example and therefore when interpreting the result of the T-tests you should look at the p-value for "equal variances not assumed" (bottom row of **Block 2**). The p-value associated with the one-sided test was circled because our alternative hypothesis was directional (the males' scores is higher than the females' scores).

> **Task**
>
> The one-sided p-value in the second block is significant (circled in green), what do you conclude?

3.2 Is the Difference Practically Meaningful?

If the mean difference is significant. We should ask if the different is meaningful or not. To answer this question, we need to assess the effect size table.

What is effect size? Imagine that if you took a paracetamol when you had a migraine and the pill reduces the pain slightly but it is not really helping you much – so the effect of the pill is small.

i Guidelines on the effect size of mean difference (Cohen 1988)

d = 0.2 is considered small
0.5 medium
0.8 large
For example, if the difference between two groups' means < 0.2 standard deviations, despite the difference being significant, it is not practically meaningful.

Let us look at the effect size output below:

Independent Samples Effect Sizes

		Standardizer[a]	Point Estimate	95% Confidence Interval	
				Lower	Upper
Opinion_avg	Cohen's d	1.95416	.453	.247	.658
	Hedges' correction	1.95813	.452	.246	.657
	Glass's delta	2.03320	.435	.227	.643

a. The denominator used in estimating the effect sizes.
Cohen's d uses the pooled standard deviation.
Hedges' correction uses the pooled standard deviation, plus a correction factor.
Glass's delta uses the sample standard deviation of the control group.

i Task

Look at the Cohen's d in the above table, what does it tell you?

3.3 Interpretation of the Findings

Looking at the descriptive statistics and statistical results, we can conclude that there are statistically significant differences between male and female consumers on their ratings on opinion leadership. Specifically, male consumers have a higher rating of opinion leadership compared to that of female consumers ($M_{Male} = 4.66$ vs. $M_{Female} = 3.77$, Cohen's d = 0.45). Furthermore in terms of the variability in the opinion leadership across the two groups (male and female consumers), the Levene's test show that there are differences in the spread, that is, the variability in the opinion of leadership is not the same for both groups ($SD_{Male} = 1.87$ vs. $SD_{Female} = 2.03$).

i Task

Why not investigating if there are differences in the satisfaction level between those who are willing to participate in Dell loyalty program and those who are not.

4 Video

One-sample T-test

Two independent samples T-test

Crosstabs

5 Readings

Feick, L. F., & Price, L. L. (1987). The market maven: A diffuser of marketplace information. *Journal of Marketing*, 51(1), 83-97.

Goldsmith, R. E., Flynn, L. R., & Goldsmith, E. B. (2003). Innovative consumers and market mavens. *Journal of Marketing Theory and Practice*, 11(4), 54-65.