

ANOVA SPSS Example

Below is the output for the SPSS ONEWAY procedure to compare the means of three school types in the hypothetical teacher satisfaction example. This is a pretty small sample size per group and such a small sample is not necessarily recommended. It is certainly legitimate to do an ANOVA with this size sample, but one should be particularly conscious of unequal variances.

Syntax

ONEWAY is available through the menus (Analyze—Compare Means—One-way ANOVA), but below I give the syntax as an alternative that will produce the same results.

```
oneway satisfaction by school.
```

Oneway

Descriptives

satisfaction teacher satisfaction

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1.000 public	5	6.0000	2.00000	.89443	3.5167	8.4833	4.00	8.00
2.000 charter	5	9.0000	1.00000	.44721	7.7583	10.2417	8.00	10.00
3.000 private	5	6.0000	.70711	.31623	5.1220	6.8780	5.00	7.00
Total	15	7.0000	1.92725	.49761	5.9327	8.0673	4.00	10.00

ANOVA

satisfaction teacher satisfaction

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	30.000	2	15.000	8.182	.006
Within Groups	22.000	12	1.833		
Total	52.000	14			

Teacher satisfaction differed significantly among the three groups, $F(2,12) = 8.18$, $p < .01$. Teachers were most satisfied in charter schools ($M = 9.00$) and less satisfied in public and private schools (both $M_s = 6.00$).

It is also possible to do the same one-way ANOVA using several other procedures in SPSS, including the GLM through the menus or GLM, ANOVA, or MANOVA (syntax only) commands. Unequal group sizes, very different variances, and small sample sizes can increase Type I error rates (or sometimes increased Type II error rates; Clinch & Keselman, 1982; Tomarken & Serlin, 1986). If the ratio of variances in different groups is less than 4 to 1 and the group sizes are over 5, there is generally a very minor impact on Type I error rates. If data are very non-normal, variances are very unequal, and/or the group sample sizes are small and unequal, the Welch's robust test is an alternative that will generally have a more accurate Type I error rate.

Post Hoc SPSS Example

The results from the one-way ANOVA do not indicate which of the three groups differ from one another, so, in many cases, it is of interest to follow the analysis with a post hoc test or a planned comparison among particular means. If several comparisons between pairs of means are made, it is a good idea to use a test, such as the Tukey, that controls for alpha inflation.

For the present example, there are not too many possible comparisons to make (just 3), so alpha inflation will not be a tremendous issue. Also, in the case of this artificial example, two of the means are exactly equal and should not require a statistical test. Nevertheless, to illustrate the use of the Tukey post hoc approach in SPSS, I've also included the Games-Howell test, because very small sample sizes may be particularly sensitive to the homogeneity of variance assumption.

Syntax

To obtain the post hoc tests with syntax, the POST HOC subcommand is added.

```
oneway satisfaction by school
  /posthoc=tukey gh.
```

Post Hoc Tests

Multiple Comparisons

Dependent Variable: satisfaction teacher satisfaction

	(I) school		(J) school		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
	school type	school type	school type	school type				Lower Bound	Upper Bound
Tukey HSD	1.000	public	2.000	charter	-3.00000*	.85635	.011	-5.2846	-.7154
			3.000	private	.00000	.85635	1.000	-2.2846	2.2846
	2.000	charter	1.000	public	3.00000*	.85635	.011	.7154	5.2846
			3.000	private	3.00000*	.85635	.011	.7154	5.2846
	3.000	private	1.000	public	.00000	.85635	1.000	-2.2846	2.2846
			2.000	charter	-3.00000*	.85635	.011	-5.2846	-.7154
Games-Howell	1.000	public	2.000	charter	-3.00000	1.00000	.056	-6.0861	.0861
			3.000	private	.00000	.94868	1.000	-3.0903	3.0903
	2.000	charter	1.000	public	3.00000	1.00000	.056	-.0861	6.0861
			3.000	private	3.00000*	.54772	.002	1.3978	4.6022
	3.000	private	1.000	public	.00000	.94868	1.000	-3.0903	3.0903
			2.000	charter	-3.00000*	.54772	.002	-4.6022	-1.3978

*. The mean difference is significant at the .05 level.

Homogeneous Subsets

satisfaction teacher satisfaction

	school	school type	N	Subset for alpha = .05	
				1	2
Tukey HSD ^a	1.000	public	5	6.0000	
	3.000	private	5	6.0000	
	2.000	charter	5		9.0000
		Sig.		1.000	1.000

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.

The Tukey post hoc tests indicated that teacher satisfaction in the charter schools differed significantly from teacher satisfaction in public and private schools ($p < .05$). The Games-Howell test, however, suggested that the difference between public and charter schools was only marginally significant ($p = .056$).