ANOVA(Analysis of Variances)

Submitted By:

Rajan Joshi

ERM I

Date : 7th Jan 2020

What is ANOVA?

- ANOVA is a statistical test that looks for significant differences between means on a particular measure.
- Researchers conduct an ANOVA when they are interested in determining whether two groups differ significantly on a particular measure or test.
- It minimizes the Type 1 error unlike in case of t-test

Decide whether Anova is appropriate or Not?

- A researcher is interested in determining whether there are differences in leg strength between amateur, semi-professional and professional rugby players.
- You compare the reaction times (ms) of three groups that had either coffee, or milk, or nothing for breakfast.
- You want to determine whether the brand of laundry detergent used and the temperature affects the amount of dirt removed from your laundry. To this end, you buy two detergents with the different brand ("Super" and "Best") and choose three different temperature levels ("cold", "warm" and "hot").

Types of ANOVA

1. One - Way ANOVA
2. Two- Way ANOVA

One- Way ANOVA

- A test that allows one to make comparisons between the means of three or more groups of data, where one independent variables are considered .
- It is used to determine whether there are any statistically significant differences between the means of three or more independent groups

One-way ANOVA using SPSS

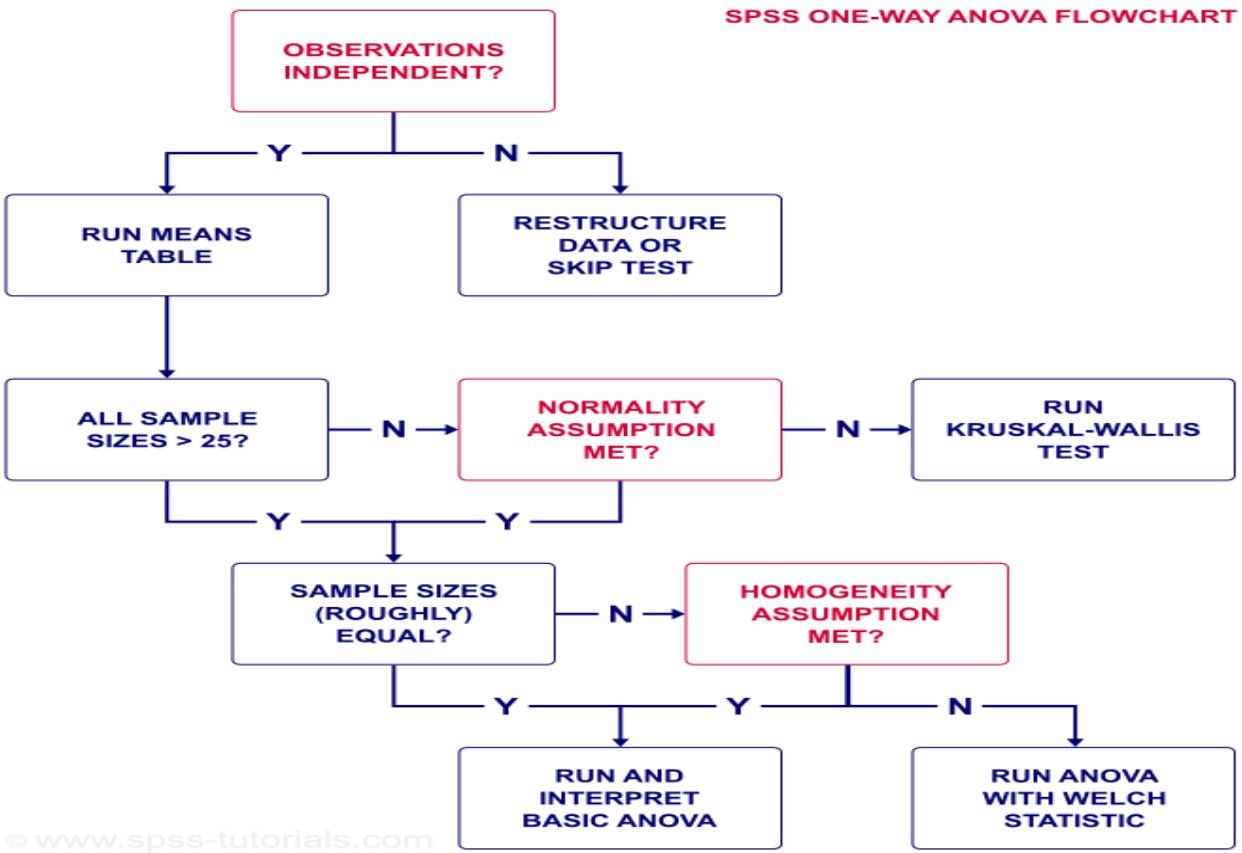
Calculate in SPSS, if there is a difference in total number of remembered adjectives, depending on the experimental condition („bed“).

Data set: https://tinyurl.com/r69244q

Solution

- Independent variable: Bed
- Dependent variable: Gesamtzahl erinnerter Adjektive.

Flowchart of one-way ANOVA



Source: https://www.spss-tutorials.com/spss-one-way-anova/#anova-assumptions

Assumption for the example

- Our Example seem to be independent observations
- Our means table shows that each $n \geq 25$ so we don't need to meet normality.
- Since our sample sizes are equal, we don't need the homogeneity assumption either.
- So by assuming the above three points we will run and interpret basic anova.

Output

ANOVA

Gesamtzahl erinnerter Adjektive

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	645.213	2	322.607	21.586	.000
Within Groups	2196.980	147	14.945		
Total	2842.193	149			

"The mean are significantly different F(2,147)=21.586, p=.000."

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Gesamtzahl erinnerter Adjektive

Tukey HSD

(I) Verarbeitungsbedingung	(J) Verarbeitungsbedingung	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
strukturell	bildhaft	-3.800*	.773	.000	-5.63	-1.97
	emotional	-4.820*	.773	.000	-6.65	-2.99
bildhaft	strukturell	3.800*	.773	.000	1.97	5.63
	emotional	-1.020	.773	.387	-2.85	.81
emotional	strukturell	4.820*	.773	.000	2.99	6.65
	bildhaft	1.020	.773	.387	-.81	2.85

*. The mean difference is significant at the 0.05 level.

In post hoc test each group is compared with the other two group, If $p<0.05$ than the respective group is significantly different than the other group.

APA Reporting

There was a significant difference among the "bed" condition on the ges, $f(2,147)=21.586$, $P< 0.05, \eta_p^2 = 0.294$

Post hoc comparison to evaluate pair wise difference among group means were conducted with the use of turkey hsd test. Since equal variance were tenable. Test revealed significant pair wise difference between the mean of remember adjectives with condition strukturell with the other two group with $p<0.05$, while there is no significant difference of condition bidhaft and emotion with $p>0.05$.

Two Way ANOVA

- A test that allows one to make comparisons between the means of three or more groups of data, where two independent variables are considered.
- The effect of multiple groups of two independent variables on a dependent variable and on each other.

Assumptions

- The populations from which the samples were obtained must be normally or approximately normally distributed.
- The samples must be independent.
- The variances of the populations must be equal.
- The groups must have the same sample size.

Hypotheses

There are three sets of hypothesis with the two-way ANNOVA. The null hypotheses for each of the sets are given below.

- The population means of the first factor are equal. This is like the one-way ANOVA for the row factor.
- The population means of the second factor are equal. This is like the one-way ANOVA for the column factor.
- There is no interaction between the two factors. This is similar to performing a test for independence with contingency tables.

Two- Way Anova using SPSS

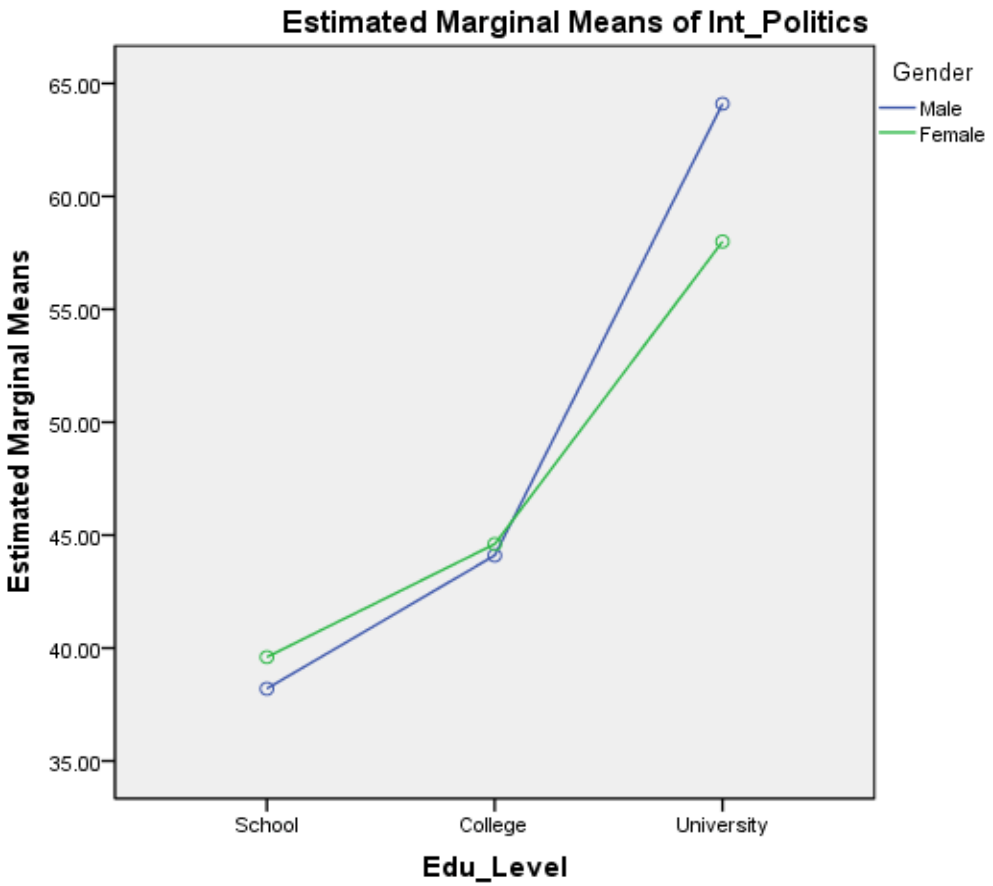
A researcher was interested in whether an individual's interest in politics was influenced by their level of education and gender. They recruited a random sample of participants to their study and asked them about their interest in politics, which they scored from 0 to 100, with higher scores indicating a greater interest in politics. The researcher then divided the participants by gender (Male/Female) and then again by level of education (School/College/University). Therefore, the dependent variable was "interest in politics", and the two independent variables were "gender" and "education".

Variables

- There are two independent variable= Gender and Edu_level
- One dependent Variable =int_politics

SPSS Output Explain

Plot of the results



N.B- An interaction effect can usually be seen as a set of non-parallel lines which might expect there to be a statistically significant interaction, which we can confirm in the next section.

https://statistics.laerd.com/spss-tutorials/two-way-anova-using-spss-statistics-2.php

(Contd.)

Tests of Between-Subjects Effects

Dependent Variable:Int_Politics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5525.200[a]	5	1105.040	61.190	.000
Intercept	138816.600	1	138816.600	7686.727	.000
Gender	29.400	1	29.400	1.628	.207
Edu_Level	5328.100	2	2664.050	147.517	.000
Gender * Edu_Level	167.700	2	83.850	4.643	.014
Error	975.200	54	18.059		
Total	145317.000	60			
Corrected Total	6500.400	59			

a. R Squared = .850 (Adjusted R Squared = .836)

1.From the table we see Gender*Edu_Level has a statistically significant interaction at the $p = .014$ level.

2. We can see from the table above that there was no statistically significant difference in mean interest in politics between males and females ($p = .207$)

3. But there were statistically significant differences between educational levels ($p < .05$)

https://statistics.laerd.com/spss-tutorials/two-way-anova-using-spss-statistics-2.php

(Contd..)

Multiple Comparisons

Int_Politics
Tukey HSD

(I) Edu_Level	(J) Edu_Level	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
School	College	-5.4500*	1.34385	.000	-8.6887	-2.2113
	University	-22.1500*	1.34385	.000	-25.3887	-18.9113
College	School	5.4500*	1.34385	.000	2.2113	8.6887
	University	-16.7000*	1.34385	.000	-19.9387	-13.4613
University	School	22.1500*	1.34385	.000	18.9113	25.3887
	College	16.7000*	1.34385	.000	13.4613	19.9387

Based on observed means.
The error term is Mean Square(Error) = 18.059.

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

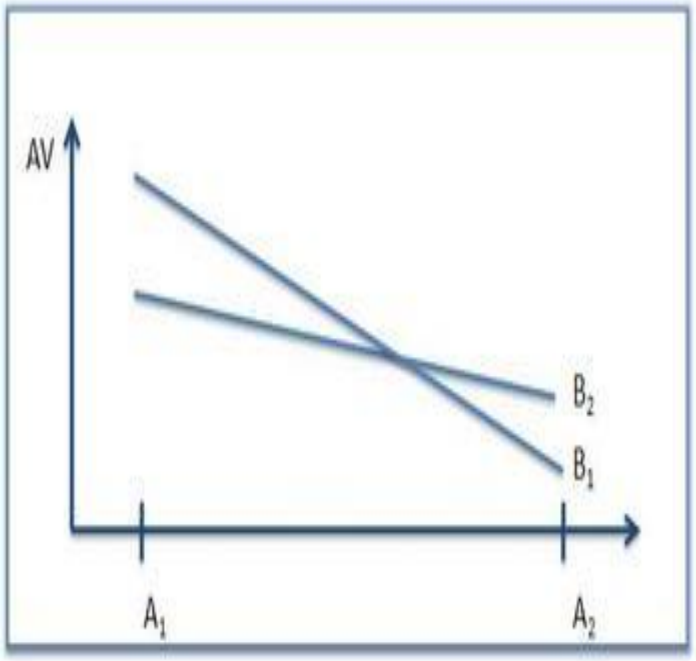
From the results, we can see that there is a statistically significant difference between all three different educational levels ($p < .0005$).

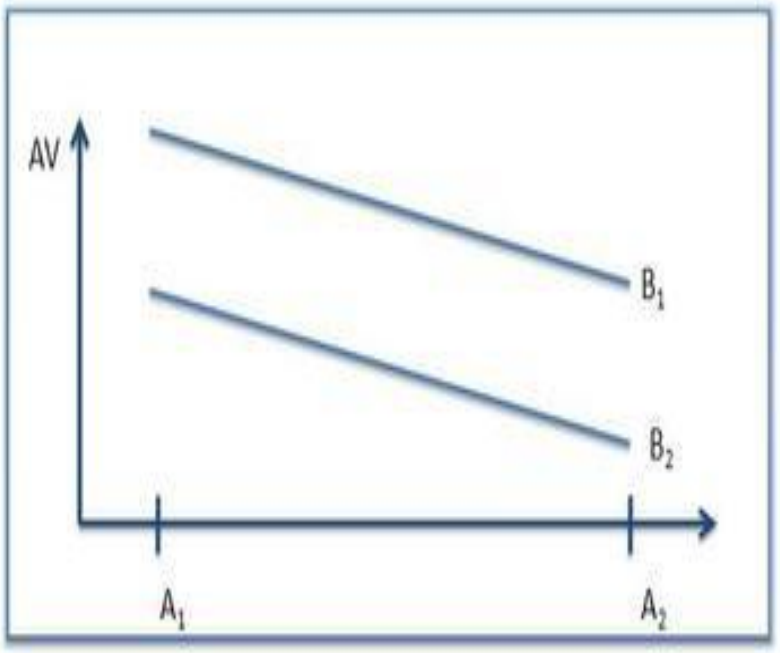
https://statistics.laerd.com/spss-tutorials/two-way-anova-using-spss-statistics-2.php

APA Reporting

A two-way ANOVA was conducted that examined the effect of gender and education level on interest in politics. There was a statistically significant interaction between the effects of gender and education level on interest in politics, F (2, 54) = 4.643, p = .014. Simple main effects analysis showed that males were significantly more interested in politics than females when educated to university level , but there were no differences between gender when educated to school or college level .

Main effect and Interaction effect





Source: TU Dresden

References

- Crossman, Ashley. (2018, December 31). Analysis of Variance (ANOVA): Definition and Examples. Retrieved from https://www.thoughtco.com/analysis-of-variance-anova-3026693
- One-way ANOVA . (n.d.). Retrieved January 2, 2020, from https://statistics.laerd.com/statistical-guides/one-way-anova-statistical-guide-2.php.
- ANOVA Test: Definition, Types, Examples. (n.d.). Retrieved January 2, 2020, from https://www.statisticshowto.datasciencecentral.com/probability-and-statistics/hypothesis-testing/anova/.
- Sajid, M. (2018, August 20). Two way ANOVA calculation By Hand (Analysis Of Variance). Retrieved January 2, 2020, from https://stepupanalytics.com/two-way-anova-calculation-by-hand-analysis-of-variance/.

Thank You!