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Tutorial 22: Two Way ANOVA - Analysis of Variance

Description

In this tutorial we will learn how to conduct a Two Way Analysis of Variance (ANOVA). This test is used when we are interested in examining the effects of two independent variables or factors (typically nominal or ordinal) on a single dependent variable (interval or ratio, in Jamovi this means ordinal/integer or continuous). A Two Way ANOVA test three hypotheses at the same time:

1) Effects of Factor A (or Independent Variable A)
   H_0: All μ 's for categories of A are equal
   H_a: At least one μ is not equal
   (note: the alternative hypothesis H_a can also be denoted as H_1)
2) Effects of Factor B (or Independent Variable B)
   H_0: All μ 's for categories of B are equal
   H_a: At least one μ is not equal
3) An interaction effect for Factor A by Factor B (whether mean differences in Factor A depend on mean differences in Factor B)
   H_0: There is no interaction between Factor A and Factor B
   H_a: There is an interaction between Factor A and Factor B

For this tutorial we will examine the question whether the type of apology (No Apology, Half Apology, Full Apology) given by Kathy who perpetrated a discriminatory act toward Maria and whether those who reported English as their native language or not (Eng = Yes, Eng = No) effect the extent to which participants agree that Kathy should be fined for disruption of peace (**k_fine**).

Note: we are using the datafile ARMF2020_wave1andwave2.omv

Thus the first independent variable or Factor A is:
Apology_cond and this variable has 3 levels.

1) NO APOLOGY = 1
2) HALF APOLOGY = 2
3) FULL APOLOGY = 3

The second independent variable or Factor B is:

Eng asked participants "Is English your native or first language?" **and this variable has 2 levels.**

1) Yes (0)
2) No (1)

The dependent variable that we are interested in examining is **k_fine** and corresponds to the participants level of agreement with the consequences that deserves: *Kathy should be fined for disruption of peace using this scale ranging 1 (Strongly Disagree) to 7 (Strongly Agree):*

Data structure (More than 2 Groups of Scores with Each Score a Measurement of the Same Variable)

This data structure therefore describes a between group design where participants in one of six groups defined by two independent variables: 1) apology category conditions and 2) whether English is a participants' native language or not, provide ratings on a continuous (or ordinal-integer in Jamovi) scale. Note. apology_cond has 3 levels and Eng has 2 levels so there are 3 x 2 = 6 total groups, and thus 6 means that are being calculated in addition to the 3 means for just the apology condition, and the 2 means for just the Eng variables.

Subsample of data being tested

Apology_cond	Eng	k_fine
1	0	2
1	0	2
1	1	3
1	1	1
2	0	6
2	0	6
2	1	4
2	1	4
3	0	7
3	0	7
3	1	5
3	1	6

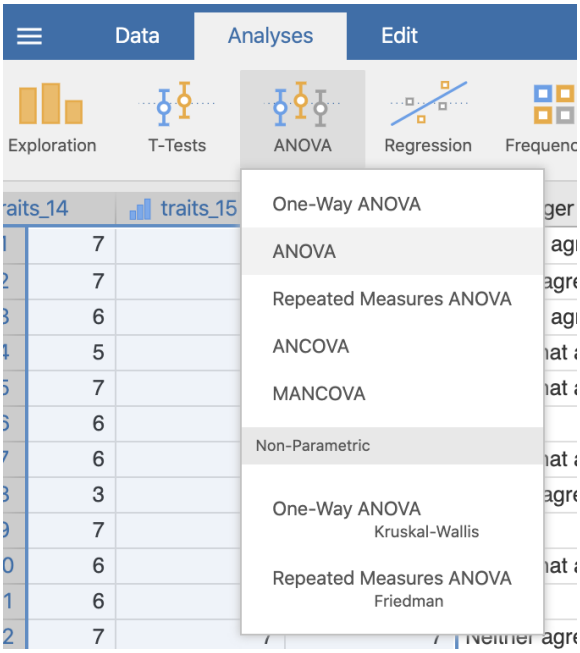
Note. ANOVAs *in Jamovi will only work with ordinal or continuous variables as dependent variables. If your variable is identified as nominal Jamovi will not allow you to select it as a dependent. So before beginning please make sure that the variable you are interested in is ordinal (integer) or continuous.*

Content

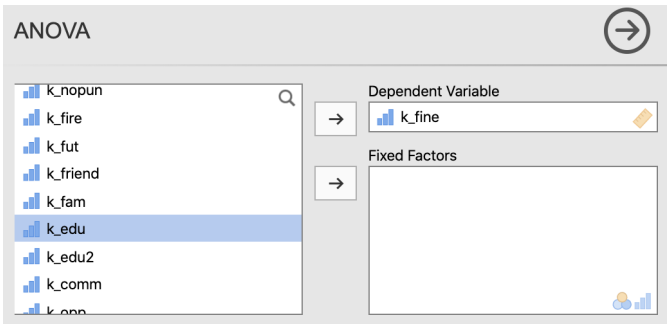
1. **Selecting the test and variables**
2. **Selecting the statistics and model**
3. **Interpreting the results**
4. **APA Format describing the findings**

STEPS

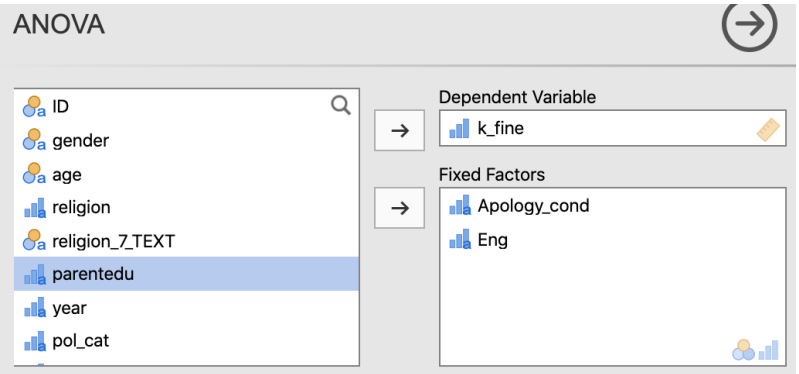
1. **Selecting the test and variables**
    c. Open Jamovi datafile for this dataset.
    d. Go to the 'Analyses' tab.
    e. Click on ANOVA and select 'ANOVA'.



    f. Select the variable 'k_fine' and move it into the 'Dependent variable' window.



    g. Select the variables 'Apology_cond' and 'Eng' move them into the 'Fixed Factors' window:



2. Selecting the statistics and model

c. Below the variable windows you may specify the statistics you would like Jamovi to carry out.

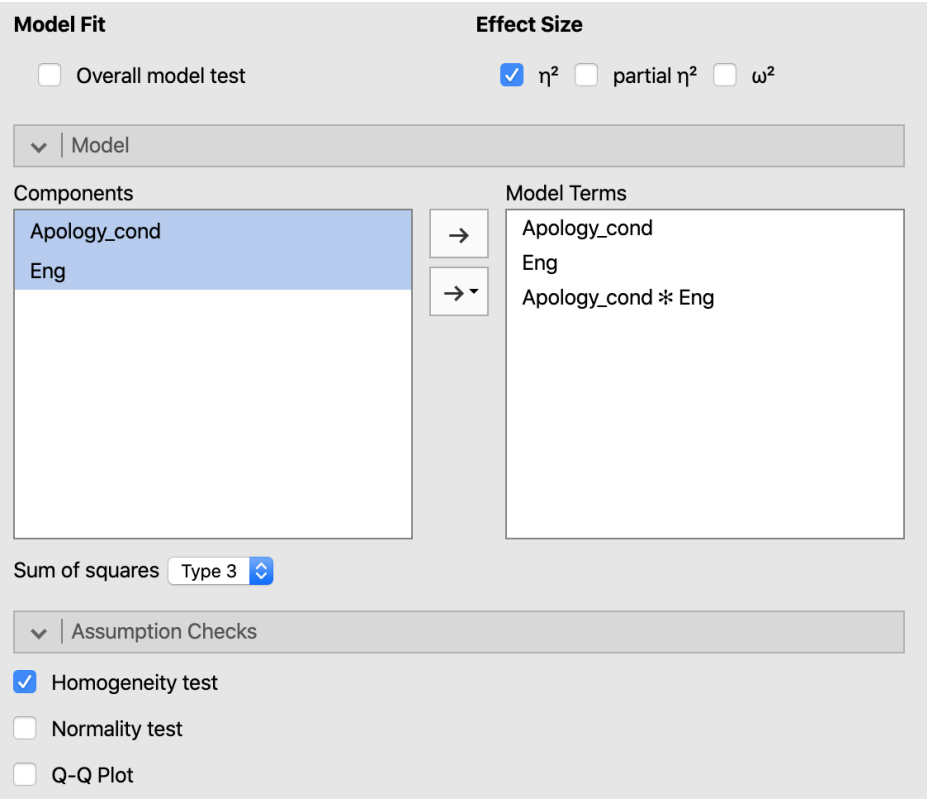
d. First select the **effect size** by clicking on the check box next to η^2

e. Then define your model by opening the Model section (click on the arrow next to word 'Model'):

   i. Select the two factors from the components window and move them into the 'Model Terms' window.

f. Then open the 'Assumption Checks' section by clicking on the arrow next to the word 'Assumption Checks'.

   i. Select "Homogeneity test', this tests whether the variance of the six groups are similar or not.



3. Interpreting the results

c. This is the Jamovi output that is produced:

ANOVA

ANOVA - k_fine

	Sum of Squares	df	Mean Square	F	p	η^2
Apology_cond	2.50	2	1.25	0.544	0.581	0.006
Eng	16.41	1	16.41	7.134	0.008	0.038
Apology_cond ✻ Eng	16.73	2	8.37	3.638	0.028	0.039
Residuals	397.83	173	2.30			

[3]

Assumption Checks

Homogeneity of Variances Test (Levene's)

F	df1	df2	p
1.51	5	173	0.188

[3]

d. Interpreting the Two-Way ANOVA

i. Provides a F- statistic under 'F'

ii. Provides the degrees of freedom for each test conducted and the residual df in the df column. The residual df is the df that typically goes in the denominator of the F ratio.

iii. p-value under 'p'

iv. Effect size that we selected which in this case is η^2

v. We can conclude whether the null hypothesis for each test should be rejected or retained:

1. Effects of Factor A or Apology_cond

H_0: All μ 's for the 3 apology conditions (no apology, half apology, full apology) are equal

H_a: At least one μ is not equal

Look at the first row in the ANOVA table that corresponds to Apology_Cond the p-value for that test is = .581 which is greater than .05 so we retain the null hypothesis and conclude that there is no effect of Apology_Cond on whether participants think that Kathy deserves to be fined.

4. Effects of Factor B or Eng

H_0: All μ 's for the 2 Eng categories (yes or no)

H_a: At least one μ is not equal

Look at the 2nd row in the ANOVA table that corresponds to Eng the p-value for that test is p = .008 which is less than .05 so we reject the null hypothesis and conclude that there is an effect of

Eng on whether participants think that Kathy deserves to be fined.

5. An interaction effect for Apology_cond by Eng (whether mean differences in Apology_cond depend on mean differences in Eng)
   H_0: There is no interaction between Apology_cond and Eng
   H_a: There is an interaction between Apology_cond and Eng
   Look at the 3rd row in the ANOVA table that corresponds to Apology_cond*Eng the p-value for that test is .028 which is less than .05 so we reject the null hypothesis and conclude that there is an interaction effect for Apology_cond by Eng on whether participants think that Kathy deserves to be fined. This means that the effect for one factor depends on the levels of the other factor.

c. Interpreting the Homogeneity test
   i. Jamovi conducts a Levene's F test to test whether there is a difference in the variance of each group.
   ii. To interpret this test observe the p-value again if the p-value is less than .05 then we can conclude that the variances are statistically different and therefore are not homogeneous. When p <.05 then homogeneity of variance assumption is violated and the F-statistics calculated are less reliable. However in this p=.188 for this test and

6. APA format describing the findings:

A two-way anova was conducted to examine the effects of the apology type and participants native language on the extent participants agree that Kathy should be fined for her actions. No effect of the type of apology was found.. An effect for one's native language was also found $F(1, 173) = 7.13$, $p<.01$, $\eta^2 = .03$. Additionally, an interaction effect was found, such that $F(2, 173) = 3.64$, $p<.05$, $\eta^2 = .03$.

Notes. The next step would be to understand the interaction effect and examine how one factor changes as a function of the other. For example, is the significant ANOVA driven by one of the factors varying significantly different across levels of the other factor (known as a fan effect) or are the two factors interacting differently across each other (known as a crossover effect).

----------END TUTORIAL----------

This Jamovi tutorial is a companion to a video tutorial and these materials were developed by:

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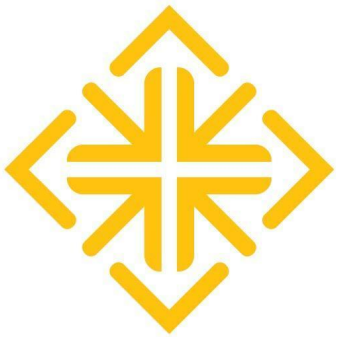

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