Two-way ANOVA

Introduction

The two-way ANOVA compares the mean differences between groups that have been split on two independent variables (called factors). The primary purpose of a two-way ANOVA is to understand if there is an interaction between the two independent variables on the dependent variable. For example, you could use a two-way ANOVA to understand whether there is an interaction between gender and educational level on test anxiety amongst university students, where gender (males/females) and education level (undergraduate/postgraduate) are your independent variables, and test anxiety is your dependent variable. Alternately, you may want to determine whether there is an interaction between physical activity level and gender on blood cholesterol concentration in children, where physical activity (low/moderate/high) and gender (male/female) are your independent variables, and cholesterol concentration is your dependent variable.

The interaction term in a two-way ANOVA informs you whether the effect of one of your independent variables on the dependent variable is the same for all values of your other independent variable (and vice versa). For example, is the effect of gender (male/female) on test anxiety influenced by educational level (undergraduate/postgraduate)? Additionally, if a statistically significant interaction is found, you need to determine whether there are any "simple main effects", and if there are, what these effects are (we discuss this later in our guide).

**Note:** If you have three independent variables rather than two, you need a three-way ANOVA

You need to understand the different assumptions that your data must meet in order for a two-way ANOVA to give you a valid result. We discuss these assumptions next.

Assumptions

When you choose to analyze your data using a two-way ANOVA, part of the process involves checking to make sure that the data you want to analyze can actually be analyzed using a two-way ANOVA. You need to do this because it is only appropriate to use a two-way ANOVA if your data "passes" six assumptions that are required for a two-way ANOVA to give you a valid result.

First, let’s take a look at these six assumptions:

* **Assumption #1:** Your **dependent variable** should be measured at the **continuous** level (i.e., they are **interval** or **ratio** variables). Examples of **continuous variables** include revision time (measured in hours), intelligence (measured using IQ score), exam performance (measured from 0 to 100), weight (measured in kg), and so forth. You can learn more about interval and ratio variables in our article: [Types of Variable](https://statistics.laerd.com/statistical-guides/types-of-variable.php).
* **Assumption #2:** Your **two independent variables** should each consist of **two or more categorical**, **independent groups**. Example independent variables that meet this criterion include gender (2 groups: male or female), ethnicity (3 groups: Caucasian, African American and Hispanic), profession (5 groups: surgeon, doctor, nurse, dentist, therapist), and so forth.
* **Assumption #3:** You should have **independence of observations**, which means that there is no relationship between the observations in each group or between the groups themselves. For example, there must be different participants in each group with no participant being in more than one group. This is more of a study design issue than something you would test for, but it is an important assumption of the two-way ANOVA. If your study fails this assumption, you will need to use another statistical test instead of the two-way ANOVA (e.g., a repeated measures design). If you are unsure whether your study meets this assumption, you can use our [Statistical Test Selector](https://statistics.laerd.com/features-selecting-tests.php), which is part of our enhanced guides.
* **Assumption #4:** There should be **no significant outliers**. Outliers are data points within your data that do not follow the usual pattern (e.g., in a study of 100 students' IQ scores, where the mean score was 108 with only a small variation between students, one student had a score of 156, which is very unusual, and may even put her in the top 1% of IQ scores globally). The problem with outliers is that they can have a negative effect on the two-way ANOVA, reducing the accuracy of your results. Fortunately, when using SPSS Statistics to run a two-way ANOVA on your data, you can easily detect possible outliers. In our enhanced two-way ANOVA guide, we: (a) show you how to detect outliers using SPSS Statistics; and (b) discuss some of the options you have in order to deal with outliers.
* **Assumption #5:** Your **dependent variable** should be **approximately normally distributed for each combination of the groups of the two independent variables**. Whilst this sounds a little tricky, it is easily tested for using SPSS Statistics. Also, when we talk about the two-way ANOVA only requiring approximately normal data, this is because it is quite "robust" to violations of normality, meaning the assumption can be a little violated and still provide valid results. You can test for normality using the Shapiro-Wilk test for normality, which is easily tested for using SPSS Statistics. In addition to showing you how to do this in our enhanced two-way ANOVA guide, we also explain what you can do if your data fails this assumption (i.e., if it fails it more than a little bit).
* **Assumption #6:** There needs to be **homogeneity of variances for each combination of the groups of the two independent variables**. Again, whilst this sounds a little tricky, you can easily test this assumption in SPSS Statistics using Levene’s test for homogeneity of variances. In our enhanced two-way ANOVA guide, we (a) show you how to perform Levene’s test for homogeneity of variances in SPSS Statistics, (b) explain some of the things you will need to consider when interpreting your data, and (c) present possible ways to continue with your analysis if your data fails to meet this assumption.

Reporting the results of a two-way ANOVA

You should emphasize the results from the interaction first before you mention the main effects. For example, you might report the result as:

* General

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.

If you had a statistically significant interaction term and carried out the procedure for simple main effects in SPSS Statistics, you would also report these results. Briefly, you might report these as:

* General

Simple main effects analysis showed that males were significantly more interested in politics than females when educated to university level (*p* = .002), but there were no differences between gender when educated to school (*p* = .465) or college level (*p* = .793).