

# Analysis of Variance Designs

## Prerequisites

### [Introduction to ANOVA](#)

There are types of experimental designs that can be analyzed by ANOVA. This section discusses many of these designs and defines many key terms used.

## Factors and Levels

The section on variables defined an independent variable as a [variable](#) manipulated by the experimenter. In the case study [Smiles and Leniency](#), the effect of different types of smiles on the leniency showed to a person was investigated. Four different types of smiles (neutral, false, felt, miserable, on leniency) were investigated. In this experiment, "Type of Smile" is the independent variable. In describing an ANOVA design, the term *factor* is used as a synonym of independent variable. Therefore, "Type of Smile" is the factor in this experiment. Since four types of smiles were compared, the factor "Type of Smile" has four *levels*.

An ANOVA conducted on a design in which there is only one factor is called a *one-way ANOVA*. If an experiment has two factors, then the ANOVA is called a *two-way ANOVA*. For example, suppose an experiment on the effects of age and gender on reading speed were conducted using three age groups (10 yr, 15 yr, and 20 yr) and the two genders (males and females). The factors would be age and gender. Age would have three levels and gender would have two levels.

## Between- and Within-Subject Factors

In the [Smiles and Leniency](#) study, the four levels of the factor "Type of Smile" were represented by four separate groups of subjects. When different subjects are used for the levels of the factor, the factor is called a *between-subjects factor* or a *between-subjects variable*. The term "between subjects" reflects the fact that comparisons are between different groups of subjects.

In the [ADHD Treatment Study](#), every subject was tested with **each** of four dosage levels (0, 0.15, 0.30, 0.60 mg/kg) of a drug. Therefore there was only one group of subjects and comparisons were not between different groups of subjects but between conditions within the same subjects. When the same subjects are used for the levels of the factor, the factor is called a *within-subjects factor* or *within-subjects variable*. Within-subjects variables are sometimes referred to as *repeated-measures variables* since there are repeated measurements of the same subjects.

## Multi-Factor Designs

It is common for designs to have more than one factor. For example, consider a hypothetical study of the effects of age and gender on reading speed in which males and females from the age levels of 8 years, 10 years, and 12 years were tested. There would be a total of six different groups as shown in Table 1.

Table 1. Gender x Age Design

Group	Gender	Age
1	Female	8
2	Female	10
3	Female	12
4	Male	8
5	Male	10
6	Male	12

This design has two factors: age and gender. Age has three levels and gender has two levels. When all combinations of the levels are included (as they are here) the design is called a *factorial design*. A concise way of describing this design is as a Gender (2) x Age(3) factorial design where the numbers in parentheses indicate the number of levels. Complex designs frequently have more than two factors and may have combinations of between- and within-subject factors.