Statistics analysis for factor design

- When an experiment has:
- - a single factor with 3 or more levels
- - 2 or more factors
- Statistical test: Analysis of Variance

- The heart of the ANOVA is a comparison of variance estimates between your conditions (groups)

ANOVA

- In the ANOVA, two independent estimates of variance are obtained:
- (1) Between groups variance: based on the variability between the different experimental groups – **how much the means of the different group differ from one another.** Actually, the variance is computed as to how much the individual group means differ from the overall mean of all scores in the experiment.
- (2) Within groups variance: give an estimate of **how much the participants in a group differ from one another** (or the mean of the group)

ANOVA

- Basic idea: are the scores of the different groups or conditions reliable different from each other?
- Null hypothesis: all the participants in the various conditions are drawn from the same population: the experimental variable has no effect.
- Consequence of the null hypothesis on the between and within variance?

ANOVA

- Basic idea: are the scores of the different groups or conditions reliable different from each other?
- Null hypothesis: all the participants in the various conditions are drawn from the same population: the experimental variable has no effect.
- Consequence of the null hypothesis: the between group variance should be the same as the within group variance

ANOVA

- To reject the null hypothesis, the means of the different groups must vary from one another more than the scores vary within the groups
- The greater the variance (differences) between the groups of the experiment, the more likely the independent variable is to have had an effect, especially if the within group variance is low
- The *F* test is simply a ratio of the between groups variance estimate to the within-groups variance estimate

$$F = \frac{\text{Between-groups variance}}{\text{Within-groups variance}}$$

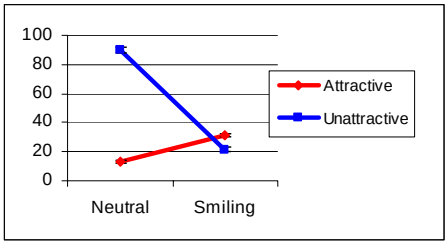
ANOVA

- Under the null hypothesis, the F ratio should be ? 1
- The greater the between groups variance is than the within group variance and consequently, the greater the F ratio is than 1.00, the more confident we can be in rejecting the null hypothesis.

$$F = \frac{\text{Between-groups variance}}{\text{Within-groups variance}}$$

Exercise 1: How guilty is that face

	Beauty			
	Attractive		Unattractive	
	Neutral	Smiling	Neutral	Smiling
S1	15	30	92	22
S2	16	32	88	15
S3	8	36	75	30
S4	10	28	95	28
S5	11	26	89	18
S6	12	32	84	26
S7	16	33	100	24
S8	15	28	92	15
S9	17	34	95	15
S10	16	35	90	22
Mean	13.6	31.4	90	21.5
s.e.m	0.98	1.05	2.17	1.77



In the ANOVA, we want to know:
(1) If there is an effect of the first factor (attractive-unattractive)
(2) If there is an effect of the second factor (neutral-smiling)
(3) If the interaction between the two factors is significant.

How guilty is that face: Two-within factors: A within (or repeated measures) ANOVA - Each subject does all the conditions of the experiment -

Number of subjects -1

Degree of freedom

F is much higher than "1"

Significant if p < . 05

ANOVA Table for guiltiness

		DF	Sum of Squares	Mean Square	F-Value	P-Value
	Subject	9	163.125	18.125		
Factor 1	beauty (Nb condition - 1)	1	11055.625	11055.625	578.072	<.0001
	beauty * Subject	9	172.125	19.125		
Factor 2	Emotion (Nb condition - 1)	1	6426.225	6426.225	129.525	<.0001
	Emotion* Subject	9	446.525	49.614		
Interaction	beauty * Emotion	1	18619.225	18619.225	1558.456	<.0001
	beauty * Emotion* Subject	9	107.525	11.947		

Effect of beauty ? $F(1,9) = 578$, $p < .0001$

Effect of Emotion ? $F(1,9) = 129$, $p < .0001$

Interaction ? $F(1,9) = 1558$, $p < .0001$

How guilty is that face: Two-between factors: A between (or unrepeated measures) ANOVA - Each subject does only 1 condition of the experiment -

Significant if p < . 05

Degree of freedom

ANOVA Table for guiltiness

		DF	Sum of Squares	Mean Square	F-Value	P-Value
Factor 1	beauty	1	11055.625	11055.625	447.546	<.0001
Factor 2	emotion	1	6426.225	6426.225	260.142	<.0001
Interaction	beauty * emotion	1	18619.225	18619.225	753.730	<.0001
	Residual	36	889.300	24.703		

Nb condition - 1 (Factor 1)

Nb condition - 1 (Factor 2)

DF factor 1 * DF factor 2

(Nb measures -1) – df factor 1 – df factor 2 – df interaction

Effect of beauty ? F(1,36) = 447, p <. 0001

Effect of Emotion ? F(1,36) = 260, p <. 0001

Interaction ? F(1,36) = 753, p <. 0001

How guilty is that face: one between – one within factors: A mixte ANOVA - One factor has different groups of subject – within a group, all subjects run the conditions of the second factor

One group saw only neutral emotion (with attractive and unattractive faces)

Another group saw only smiling expression (with attractive and unattractive faces)

ANOVA Table for Beauty

		DF	Sum of Squares	Mean Square	F-Value	P-Value
Emotion		1	6426.225	6426.225	189.735	<.0001
Subject(Group)		18	609.650	33.869		
Category for Beauty	**Factor 2**	1	11055.625	11055.625	711.608	<.0001
Category for Beauty * Emotion	**Interaction**	1	18619.225	18619.225	1198.448	<.0001
Category for Beauty * Subject(Group)		18	279.650	15.536		

Effect of Emotion? F(1,18) = 189, p <. 0001

Effect of beauty ? F(1,18) = 711, p <. 0001

Interaction ? F(1,18) = 1198, p <. 0001

Statistics Test at a glance
One Factor with 2 levels

Chart removed due to copyright reasons.

Statistics Test at a glance
One Factor with more than 2 levels

Chart removed due to copyright reasons.

Statistics Test at a glance
Two Factors with at least 2 levels each

Chart removed due to copyright reasons.