Factorial ANOVA

(Note that some aspects of this output have been rearranged for the sake of presentation!)

Descriptives

FactorA	FactorB	N	Mean	SD
1	1	4	2.000	2.449
1	2	4	7.000	2.449
2	1	4	6.000	2.449
2	2	4	5.000	2.449

These descriptive statistics are calculated separately for each group or condition. A level (marginal) mean can be determined by taking the weighted average of the appropriate group means. For example, the marginal mean for Level 1 of Factor A:

$$M_{LEVEL} = \frac{\sum n(M_{GROUP})}{n_{LEVEL}} = \frac{4(2) + 4(7)}{8} = 4.500$$

A grand mean can be determined by taking the weighted average of all of the group means:

$$M_{TOTAL} = \frac{\sum n(M_{GROUP})}{N} = \frac{4(2) + 4(7) + 4(6) + 4(5)}{4 + 4 + 4 + 4} = 5.000$$

ANOVA

	Sum of Squares	df	Mean Square	F	p	η²p
FactorA	4.000	1	4.000	0.667	0.430	0.053
FactorB	16.000	1	16.000	2.667	0.128	0.182
FactorA ✻ FactorB	36.000	1	36.000	6.000	0.031	0.333
Residuals	72.000	12	6.000			

The "$\eta^2 p$" statistic is a ratio of the effect and the effect plus residual variability. For "Factor B":

$$\eta^2 p = \frac{SS_{FACTOR}}{SS_{FACTOR} + SS_{ERROR}}$$

$$\eta^2 p = \frac{16.000}{16.000 + 72.000} = 0.182$$

Thus, 18.2% of the variability among the scores is accounted for by Factor B.

The statistics for the effects of "Factor A" and Factor B" are functions of the level (marginal) means and sample sizes. For "Factor B":

$$SS_{FACTORB} = \sum n(M_{LEVEL} - M_{TOTAL})^2$$
$$SS_{FACTORB} = 8(4.5 - 5)^2 + 8(5.5 - 5)^2$$
$$SS_{FACTORB} = 4.000$$
$$df_{FACTORB} = \#levels - 1 = 2 - 1 = 1$$

The "Factor A * Factor B" (interaction) statistics reflect the between- group variability not accounted for by the factors:

$$SS_{INTERACTION} = SS_{MODEL} - SS_{FACTORA} - SS_{FACTORB}$$
$$SS_{INTERACTION} = 56.000 - 4.000 - 16.000 = 36.000$$
$$df_{INTERACTION} = df_A \times df_B = 1$$

"Mean Squares" are estimates of the variances associated with each source. For "Factor B":

$$MS_{FACTORB} = \frac{SS_{FACTORB}}{df_{FACTORB}} = 16.000$$

The "F" statistic is a ratio of the effect and within group (error) variance estimates. For "Factor B":

$$F_{FACTORB} = \frac{MS_{FACTORB}}{MS_{ERROR}} = \frac{16.0}{6.0} = 2.667$$

An F with 1 and 12 *df* that equals 2.667 has a two-tailed probability of .128, which is not statistically significant.

"Residual" (error) statistics are a function of the within group variabilities. Because SS for each group can be determined (*SS = SD² x df*):

$$SS_{ERROR} = SS_1 + SS_2 + SS_3 + SS_4$$
$$SS_{ERROR} = 18.000 + 18.000 + 18.000 + 18.000 = 72.000$$
$$df_{ERROR} = df_1 + df_2 + df_3 + df_4 = 12$$

Overall, all of the between-group variability is a function of the group means and sample sizes:

$$SS_{MODEL} = \sum n(M_{GROUP} - M_{TOTAL})^2 = 4(2-5)^2 + 4(7-5)^2 + 4(6-5)^2 + 4(5-5)^2 = 56.000$$
$$df_{MODEL} = \#groups - 1 = 3$$