

12.6: Higher Factorial ANOVA

We've seen 1-way ANOVA and 2-way ANOVA but it doesn't have to stop there. We can have any number of factors, or independent variables. We can have 3-way ANOVA, 4-way ANOVA, etc. In general we can have an m -way ANOVA. An m -way ANOVA will have m IVs (m factors) but still only one DV.

12.8.1 3-way ANOVA

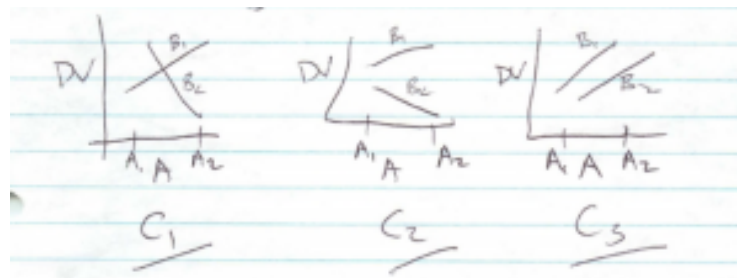
A 3-way ANOVA will have 3 factors (IVs): A , B , and C with a , b and c levels respectively. A 3-way ANOVA will test 7 hypotheses (all of which are one-way ANOVAs) :

1. Main effect of A (collapse across B and C).
2. Main effect of B (collapse across A and C).
3. Main effect of C (collapse across A and B).
4. 2-way interaction $A \times B$ (collapse across C).
5. 2-way interaction $A \times C$ (collapse across B).
6. 2-way interaction $B \times C$ (collapse across A).
7. 3-way interaction $A \times B \times C$.

So there will be 7 test statistics to consider:

$$F_A, F_B, F_C, F_{A \times B}, F_{A \times C}, F_{B \times C}, F_{A \times B \times C} \quad (12.6.1)$$

The profile plots for a 3-way ANOVA are intrinsically 4-dimensional and so can be difficult to draw. One approach is to make c 2-way style ANOVA plots :



The interpretation of a 3-way interaction can be tough and there will be many post-hoc pairwise comparisons of cells that may be meaningful. For these reasons it is best to be more reductionist in your experiment designs so that you never have to use a 3-way ANOVA. A design that uses preplanned *contrasts* is usually better than one that requires a 3 (or higher) way ANOVA.

For an m -way ANOVA, there will be

$$\binom{m}{1} \binom{m}{2} \dots + \binom{m}{m} = \sum_{i=1}^m \binom{m}{i} \quad (12.6.2)$$

hypotheses to test, each with an associated F test statistic. The number of profile plots to consider will be large and will necessarily involve collapsing factors because the data exist in an $m + 1$ dimensional space (number of IVs plus DV). Interpretation will be a nightmare. An m -dimensional ANOVA for $m \geq 3$ is more of a mathematical curiosity than a useful scientific tool.

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