**Bonus Example: 3x3 Two-Way ANOVA as a Linear Model, Two Approaches**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Means:** | **1** | **2** | **3** |  |
| **A** | \*a1\* | a2 | a3 | **Marginal A** |
| **B** | b1 | b2 | b3 | **Marginal B** |
| **C** | c1 | c2 | c3 | **Marginal C** |
|  | **Marginal 1** | **Marginal 2** | **Marginal 3** | **Grand Mean** |

 **Method 1 Data Coding: Create 2 contrasts for each 3-category predictor (a1 = intercept)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Letter** | **Number** | **AvB** | **AvC** | **1v2** | **1v3** |
| A | 1 | 0 | 0 | 0 | 0 |
| A | 2 | 0 | 0 | 1 | 0 |
| A | 3 | 0 | 0 | 0 | 1 |
| B | 1 | 1 | 0 | 0 | 0 |
| B | 2 | 1 | 0 | 1 | 0 |
| B | 3 | 1 | 0 | 0 | 1 |
| C | 1 | 0 | 1 | 0 | 0 |
| C | 2 | 0 | 1 | 1 | 0 |
| C | 3 | 0 | 1 | 0 | 1 |

Model 1

**Typical two-way ANOVA results for model 1 would include:**

* the marginal DF=2 F-test for letter (averaged over numbers)
* the marginal DF=2 F-test for number (averaged over letters)
* the DF=4 F-test of the interaction
* The marginal main effects are not useful if any part of the interaction is significant, and the DF=4 interaction test is too general to tell you what is really going on… instead we need to create DF=1 simple main effects and their DF=1 simple interaction contrasts as follows…

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Means:** | **1** | **2** | **3** |  |
| **A** |  |  |  |  |
| **B** |  |  |  |  |
| **C** |  |  |  |  |
|  |  |  |  |  |

**Effects of Interest, All Given by Model 1 (1 intercept + 8 slopes recreate all 9 cell means):**

* 9 possible letter simple mean differences (3 per number)
* 9 possible number simple mean differences (3 per letter)
* 9 possible single-df interaction contrasts of simple mean differences:

	+ Does AvB differ from 1 to 2? OR Does 1v2 differ from A to B? 🡪
	+ Does AvC differ from 1 to 2? OR Does 1v2 differ from A to C? 🡪
	+ Does BvC differ from 1 to 2? OR Does 1v2 differ from B to C? 🡪
	+ Does AvB differ from 1 to 3? OR Does 1v3 differ from A to B? 🡪
	+ Does AvC differ from 1 to 3? OR Does 1v3 differ from A to C? 🡪
	+ Does BvC differ from 1 to 3? OR Does 1v3 differ from B to C? 🡪
	+ Does AvB differ from 2 to 3? OR Does 2v3 differ from A to B? 🡪
	+ Does AvC differ from 2 to 3? OR Does 2v3 differ from A to C? 🡪
	+ Does BvC differ from 2 to 3? OR Does 2v3 differ from B to C? 🡪

Sound complicated? It is… here is a simpler approach that can be especially useful in not-fully-crossed designs (when one or more of the cells is missing by design)—create cell-specific dummy coded predictors (=1 if it’s that cell, =0 otherwise) to create cell-specific intercepts and use those instead of a global intercept and differences:

Model 2

**Effects of Interest, All Given by Model 2 (9 cell-specific intercepts recreate all 9 cell means):**

* 9 possible letter simple mean differences (3 per number)
* 9 possible number simple mean differences (3 per letter)
* 9 possible single-df interaction contrasts of simple mean differences:

	+ Does AvB differ from 1 to 2? OR Does 1v2 differ from A to B? 🡪
	+ Does AvC differ from 1 to 2? OR Does 1v2 differ from A to C? 🡪
	+ Does BvC differ from 1 to 2? OR Does 1v2 differ from B to C? 🡪
	+ Does AvB differ from 1 to 3? OR Does 1v3 differ from A to B? 🡪
	+ Does AvC differ from 1 to 3? OR Does 1v3 differ from A to C? 🡪
	+ Does BvC differ from 1 to 3? OR Does 1v3 differ from B to C? 🡪
	+ Does AvB differ from 2 to 3? OR Does 2v3 differ from A to B? 🡪
	+ Does AvC differ from 2 to 3? OR Does 2v3 differ from A to C? 🡪
	+ Does BvC differ from 2 to 3? OR Does 2v3 differ from B to C? 🡪