

Example of a Three-Way ANOVA from “Designing
Experiments and Analyzing Data” (Maxwell and
Delaney, 1990) Chapter 8, p. 325

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First we will read the dataset in.

After this is done, we can see the structure of the data.

```
> str(threeway)

'data.frame':      72 obs. of  4 variables:
 $ score  : num  170 175 165 180 160 158 161 173 157 152 ...
 $ biofeed: Factor w/ 2 levels "no","yes": 2 2 2 2 2 2 2 2 2 2 ...
 $ diet   : Factor w/ 2 levels "absent","present": 1 1 1 1 1 1 2 2 2 2 ...
 $ drug   : Factor w/ 3 levels "X","Y","Z": 1 1 1 1 1 1 1 1 1 1 ...
```

```
> with(threeway, table(diet, drug, biofeed))
```

```
, , biofeed = no
```

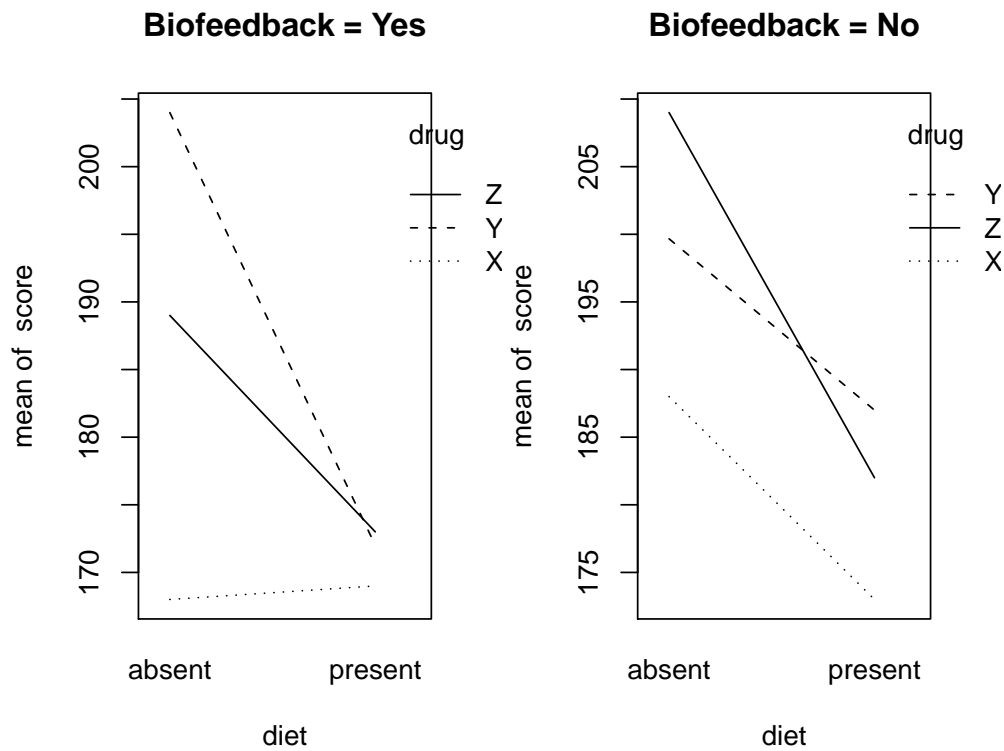
	drug		
diet	X	Y	Z
absent	6	6	6
present	6	6	6

```
, , biofeed = yes
```

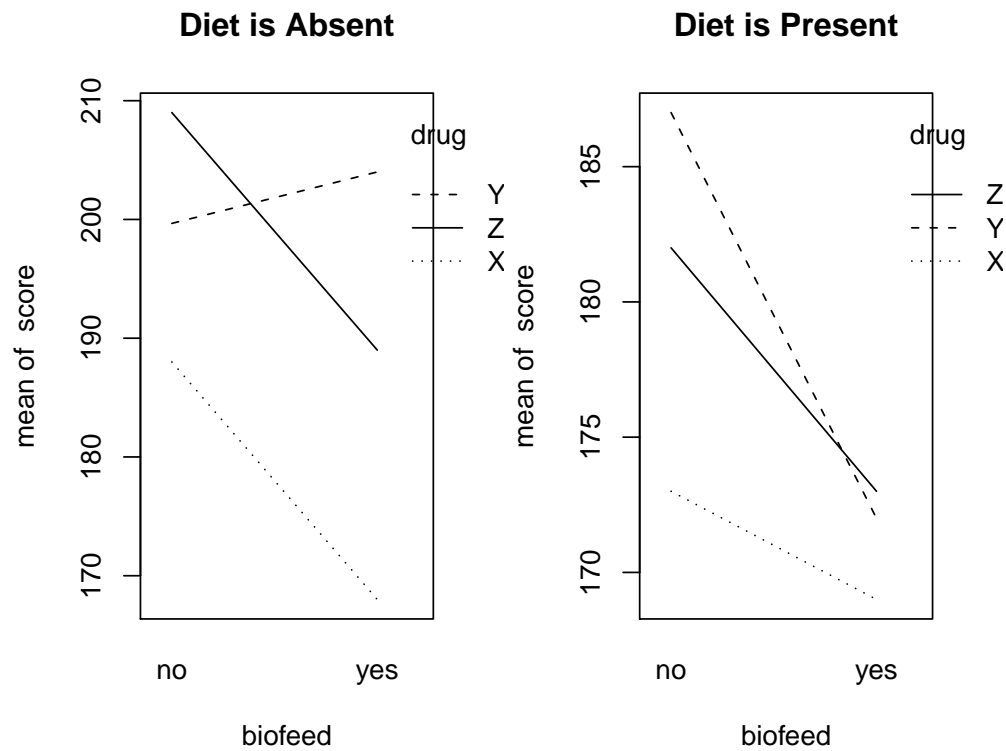
	drug		
diet	X	Y	Z
absent	6	6	6
present	6	6	6

We will then start with some graphical exploration.

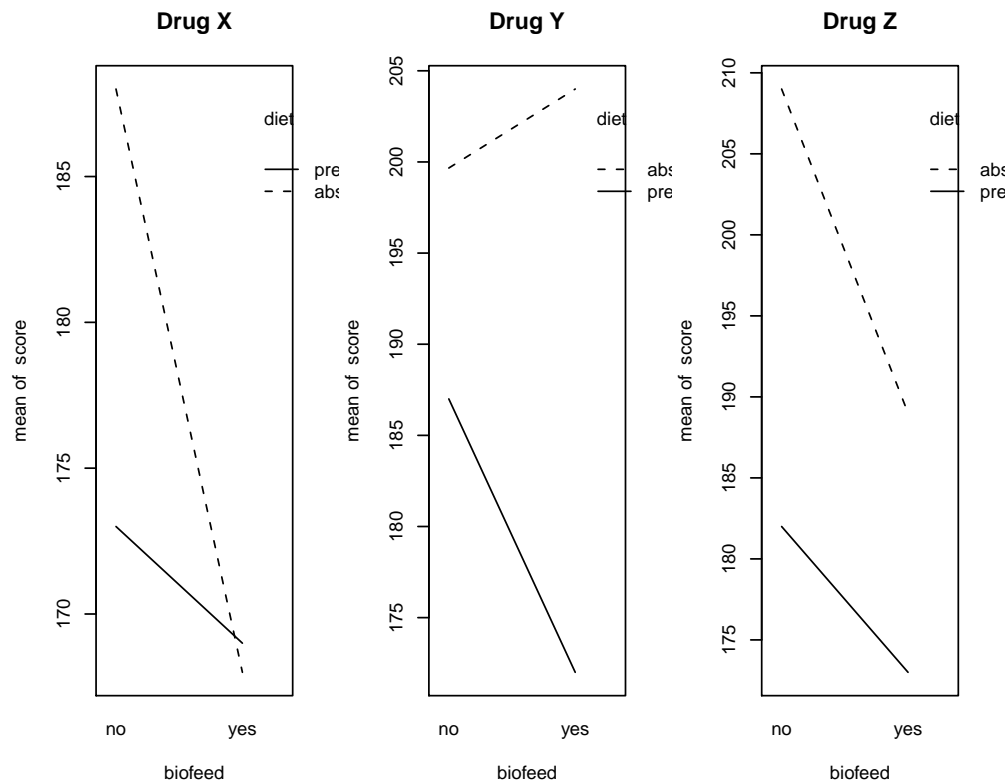
```
> par(mfrow = c(1, 2))
> with(threeway[threeway$biofeed == "yes", ], interaction.plot(diet, drug, score,
+   main = "Biofeedback = Yes"))
> with(threeway[threeway$biofeed == "no", ], interaction.plot(diet, drug, score, main = "Biofeedback = No"))
```



```
> par(mfrow = c(1, 2))
> with(threeway[threeway$diet == "absent", ], interaction.plot(biofeed, drug, score,
+   main = "Diet is Absent"))
> with(threeway[threeway$diet == "present", ], interaction.plot(biofeed, drug, score,
+   main = "Diet is Present"))
```



```
> par(mfrow = c(1, 3))
> with(threeway[threeway$drug == "X", ], interaction.plot(biofeed, diet, score, main =
> with(threeway[threeway$drug == "Y", ], interaction.plot(biofeed, diet, score, main =
> with(threeway[threeway$drug == "Z", ], interaction.plot(biofeed, diet, score, main =
```



Next, we will run the full factorial ANOVA

```
> m1 <- aov(score ~ biofeed * diet * drug, threeway)
> summary(m1)
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
biofeed	1	2026.7	2026.7	12.8717	0.0006716 ***
diet	1	5168.1	5168.1	32.8223	3.465e-07 ***
drug	2	3650.1	1825.1	11.5909	5.542e-05 ***
biofeed:diet	1	29.4	29.4	0.1866	0.6672692
biofeed:drug	2	269.4	134.7	0.8556	0.4301392
diet:drug	2	892.1	446.1	2.8329	0.0667361 .
biofeed:diet:drug	2	1096.8	548.4	3.4828	0.0370662 *
Residuals	60	9447.3	157.5		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```
> model.tables(m1, type = "means")
```

Tables of means

Grand mean

184.4722

```

biofeed
biofeed
  no    yes
189.78 179.17

```

```

diet
diet
  absent present
192.94  176.00

```

```

drug
drug
  X      Y      Z
174.50 190.67 188.25

```

```

biofeed:diet
  diet
biofeed absent present
  no  198.89 180.67
  yes 187.00 171.33

```

```

biofeed:drug
  drug
biofeed X      Y      Z
  no  180.50 193.33 195.50
  yes 168.50 188.00 181.00

```

```

diet:drug
  drug
diet    X      Y      Z
  absent 178.00 201.83 199.00
  present 171.00 179.50 177.50

```

```

biofeed:diet:drug
, , drug = X

```

```

  diet
biofeed absent present
  no  188.00 173.00
  yes 168.00 169.00

```

```

, , drug = Y

```

```

  diet
biofeed absent present

```

```
no  199.67 187.00
yes 204.00 172.00
```

```
, , drug = Z
```

```
      diet
biofeed absent present
no      209.00 182.00
yes     189.00 173.00
```

And then we will run the ANOVA with only main effects and three-way interaction

```
> m2 <- aov(score ~ biofeed + diet + drug + biofeed:diet:drug, threeway)
> summary(m2)
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
biofeed	1	2026.7	2026.7	12.8717	0.0006716 ***
diet	1	5168.1	5168.1	32.8223	3.465e-07 ***
drug	2	3650.1	1825.1	11.5909	5.542e-05 ***
biofeed:diet:drug	7	2287.7	326.8	2.0756	0.0600624 .
Residuals	60	9447.3	157.5		

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Notice that the SS_{3way} is equal to the SS for all of the two-way interactions and the 3-way summed up.