Consider an experiment for modifying snake phobia:

- Factor A – Degree of Phobia: Mild, Moderate, Severe
- Factor B – Type of Therapy: Desensitization, Implosion, Insight
- Factor C – Sex: Male, Female

- Y = Post-test scores on the Behavioral Avoidance Test (higher scores indicate less phobia)

	Desensitization			Implosion			Insight		
	Mild	*Moderate*	*Severe*	*Mild*	*Moderate*	*Severe*	*Mild*	*Moderate*	*Severe*
Females	10	12	10	15	12	6	13	11	10
	12	9	11	12	10	7	9	7	6
	13	10	9	14	11	5	11	8	8
Males	16	11	12	17	14	10	16	10	11
	14	13	11	18	13	9	12	12	10
	17	15	13	16	12	11	14	14	9

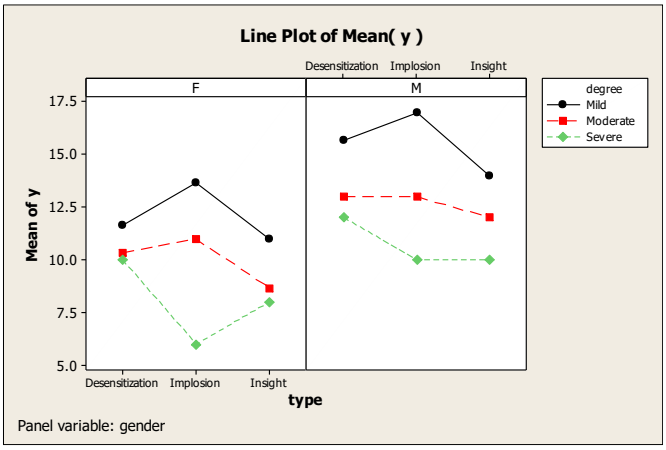
General Linear Model: y versus sex, type, degree

```
Factor  Type   Levels  Values
sex     fixed       2  F, M
type    fixed       3  Desensitization, Implosion, Insight
degree  fixed       3  Mild, Moderate, Severe


Analysis of Variance for y, using Adjusted SS for Tests

Source              DF   Seq SS   Adj SS   Adj MS      F      P
Sex                  1  115.574  115.574  115.574  49.93  0.000
type                 2   22.333   22.333   11.167   4.82  0.014
degree               2  183.000  183.000   91.500  39.53  0.000
sex*type             2    0.259    0.259    0.130   0.06  0.946
sex*degree           2    1.815    1.815    0.907   0.39  0.679
type*degree          4   39.333   39.333    9.833   4.25  0.006
sex*type*degree      4    5.852    5.852    1.463   0.63  0.643
Error               36   83.333   83.333    2.315
Total               53  451.500

S = 1.52145   R-Sq = 81.54%   R-Sq(adj) = 72.83%
```



We have a type by degree interaction.

We have a main effect of sex.

We also have main effects for type and for degree, …
… but we should refrain from interpreting them because of the higher order interaction

We may interpret main effect: sex b/c sex is not involved in any higher order interactions

• Let's start with the main effect of sex.

```
Variable  sex    N    Mean
y         F     27  10.037
          M     27  12.963

Tukey 95.0% Simultaneous Confidence Intervals
Response Variable y
All Pairwise Comparisons among Levels of sex
sex = F  subtracted from:

sex     Lower  Center  Upper  --------+---------+---------+--------
M       2.086   2.926  3.766  (----------------*---------------)
                              --------+---------+---------+--------
                                    2.50      3.00      3.50
```

This analysis reveals the effect of sex averaging across type and degree.
This analysis tells us that men show less post-test phobia than women, …
… *averaging across type and degree*.

NOTE:: Because this test has only 1 df [sex has 2 levels], no M/C was necessary.

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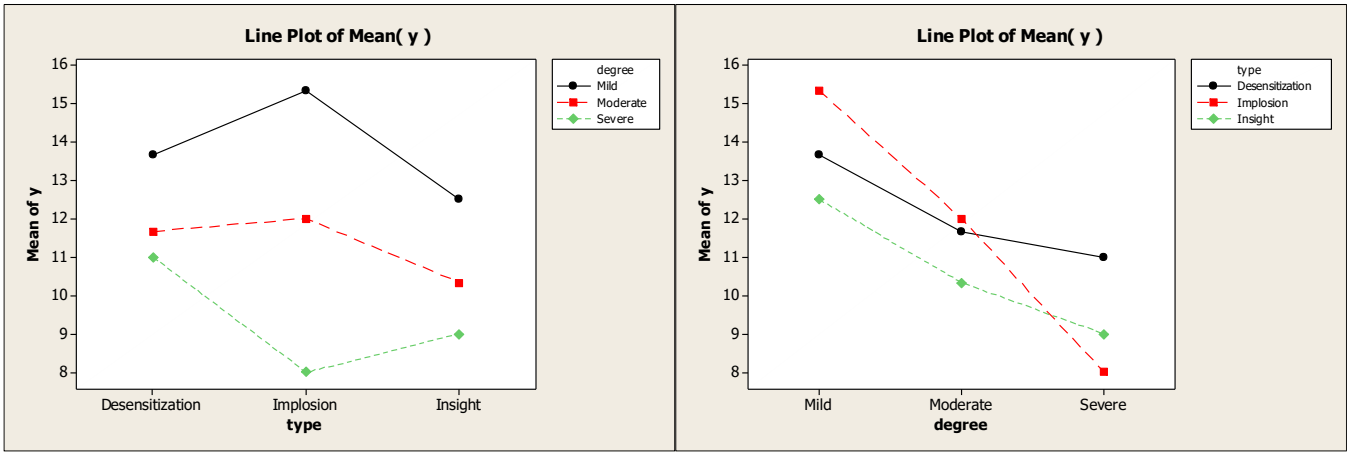
Now, let's turn to the type by degree interaction.



Using the CICCHETTI 1972 modification for Tukey gives 3(3C2) + 3(3C2) = 18 comparisons of interest giving an adjusted # of trts = 7 --- Tukey's LSD = 4.414 sqrt(2.315/6) = 2.74

Tukey Values = http://academic.udayton.edu/gregelvers/psy216/tables/qtab.htm

Degree within Type

Desensitization	Mild 13.67	Moderate 11.667	Severe 11.000
Implosion	Mild 15.333	Moderate 12.00	Severe 8.000
Insight	Mild 12.5	Moderate 10.33	Severe 9.000

For Desensitization – no difference among the degrees …

For Implosion – all pairwise comparisons significant –
mild phobic responded better than moderate phobic who responded better than severe phobic …

For Insight – mild phobic responded better than severe phobic …

Type within Degree

Mild	Implosion 15.333	Desensitization 13.67	Insight 12.5
Moderate	Implosion 12.00	Desensitization 11.667	Insight 10.33
Severe	Desensitization 11.00	Insight 9.000	Implosion 8.000

For Mild – implosion responded better than insight …

For Moderate – no difference among the types …

For Severe – desensitization performed better than implosion …

Higher-Order ANOVA

The logic we developed for two- and three-factor ANOVA can be easily extended …
… to four-factor, five-factor and even higher order ANOVAs.

Interpretation of a three-factor ANOVA is tricky enough.
Things get very hairy for higher order ANOVAs.

For example, a significant four-way interaction (A*B*C*D) indicates that …
… the three way A*B*C interaction is not the same at each level of D …
… or that the three way A*B*D interaction is not the same at each level of C or . . .

We saw that to graph a three-way 2*2*2 interaction, …
… we had to graph two separate two-way interactions.
To graph a four-way 2*2*2*2 interaction, …
… we would have to graph four separate two-way interactions!
To graph a five-way 2*2*2*2*2 interaction, …
… we would have to graph eight separate two-way interactions!

Remember when you design a study, you will need to be able to analyze, understand, and present the results. It is rare that a person can clearly present a four-way interaction in a manner that the audience can understand. Beware of conducting designs that are too complex!

As the number of factors increases, the number of tests increases rapidly.
Because the convention is to use $\alpha = .05$ for each omnibus test, …
… the probability of making a type one error is high for a multi-factor ANOVA.

Number of Factors	Number of Main Effects	Two-way Interactions	Three-way Interactions	Four-way Interactions	Five-way Interactions	Total Number of tests
2	2	1				3
3	3	3	1			7
4	4	6	4	1		15
5	5	10	10	5	1	31