Gravetter & Wallnau
Chapter 15, Problem 25

	No Drug	Small Dose	Large Dose
Males	1	7	3
	6	7	1
	1	11	1
	1	4	6
	1	6	4
Females	0	0	0
	3	0	2
	7	0	0
	5	5	0
	5	0	3

Enter Data

- Load from class web site http://academic.udayton.edu/gregelvers/psy216/spss/Ch15P25.sav

  or

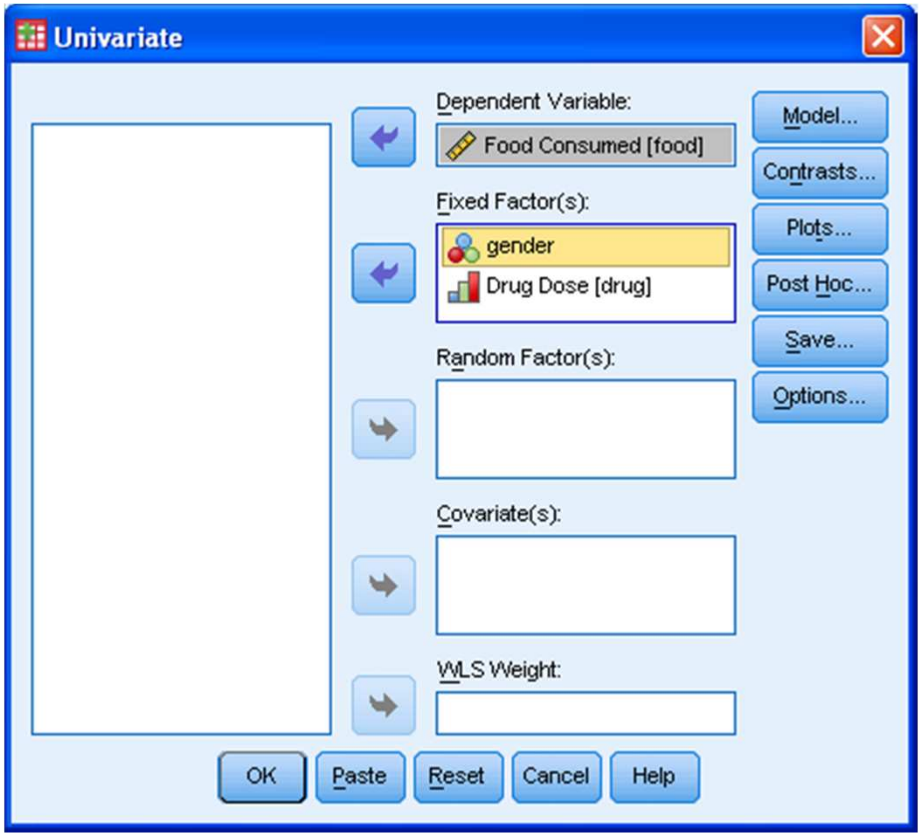
- Variable view
- Create three variables
  - Name: Gender, Value Labels: 1=Males, 2=Females, Measure: Nominal
  - Name: Drug, Label: Drug Dose, Value Labels: 1=No Drug, 2=Small Dose, 3=Large Dose, Measure: Ordinal
  - Name: Food, Label: Food Consumed, Measure: Scale
- Enter the data
  - First row: 1 (males), 1 (no drug), 1 (food consumed)

Step 1:

- H_0: $\mu_{\text{No Drug}} = \mu_{\text{Small Dose}} = \mu_{\text{Large Dose}}$
  H_1: not H_0
- H_0: $\mu_{\text{Males}} = \mu_{\text{Females}}$
  H_1: not H_0
- H_0: there is no interaction
  H_1: there is an interaction
- $\alpha = .05$

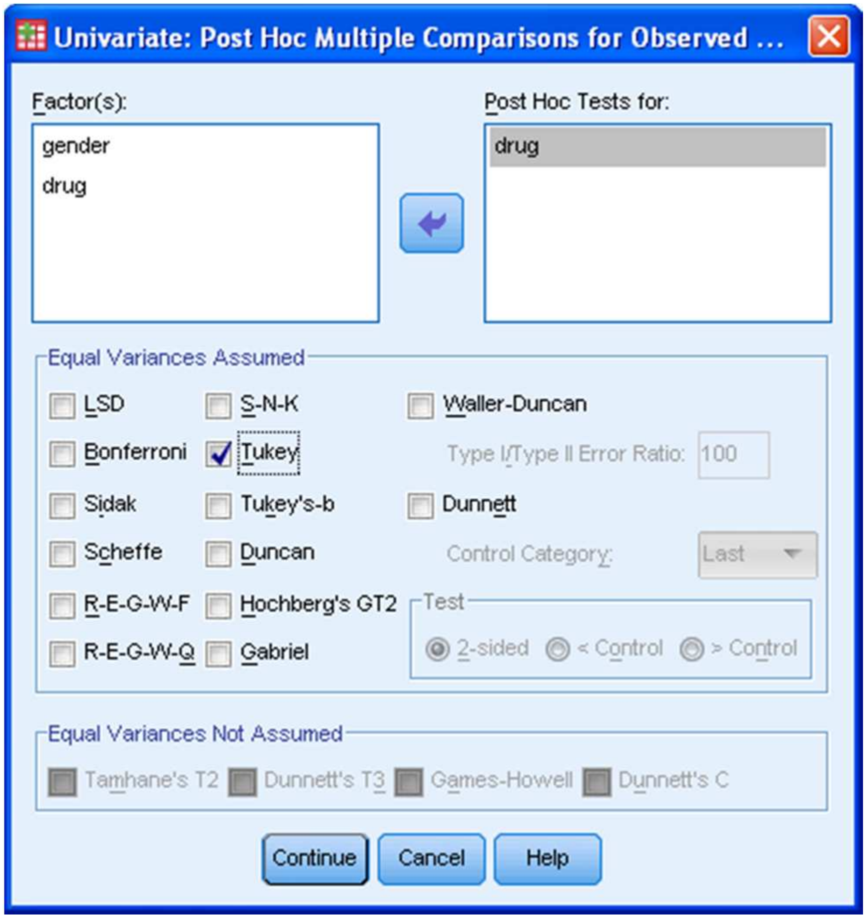
Step 3:

- Analyze | General Linear Model | Univariate
- Move the DV into the Dependent Variable box
- Move the two factors into the Fixed Factor(s) box



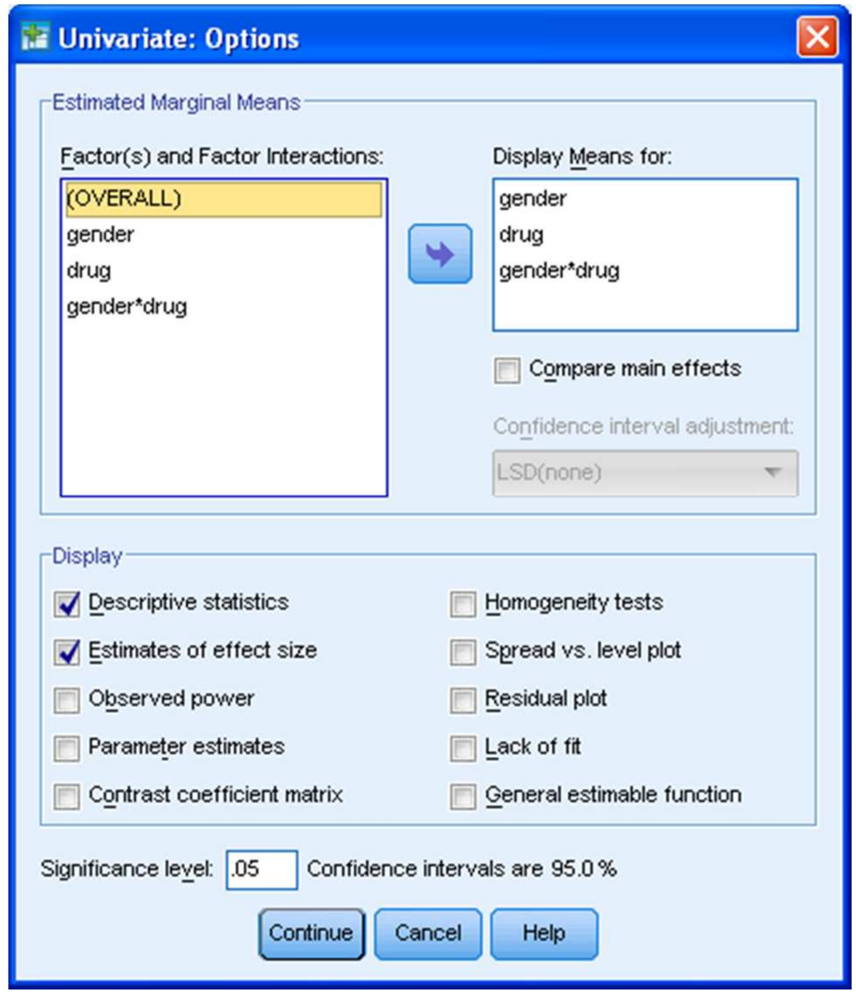
Step 3:

- Post Hoc
- Move factors with more than two levels into the Post Hoc Tests for box
- Select Tukey
- Continue



Step 3:

- Options
- Move the factors and their interaction into the Display Means for box
- Select Descriptive statistics *and* Estimates of effect size
- Continue
- OK



Step 4:

Tests of Between-Subjects Effects

Dependent Variable:Food Consumed

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	130.000[a]	5	26.000	5.200	.002	.520
Intercept	270.000	1	270.000	54.000	.000	.692
gender	30.000	1	30.000	6.000	.022	.200
drug	20.000	2	10.000	2.000	.157	.143
gender * drug	80.000	2	40.000	8.000	.002	.400
Error	120.000	24	5.000			
Total	520.000	30				
Corrected Total	250.000	29				

a. R Squared = .520 (Adjusted R Squared = .420)

- There is a main effect of gender ($p = .022 \leq \alpha = .05$)
- There is not a main effect of drug ($p = .157 > \alpha = .05$)
- There is an interaction of gender and drug ($p = .002 \leq \alpha = .05$)

Tukey

- Should we perform post hoc tests?
  - One of the factors has more than two levels
  - *But* we failed to reject the omnibus H_0 for that factor
  - Therefore, we should *not* perform post hoc tests for that factor

Writing

Tests of Between-Subjects Effects

Dependent Variable:Food Consumed

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	130.000[a]	5	26.000	5.200	.002	.520
Intercept	270.000	1	270.000	54.000	.000	.692
gender	30.000	1	30.000	6.000	.022	.200
drug	20.000	2	10.000	2.000	.157	.143
gender * drug	80.000	2	40.000	8.000	.002	.400
Error	120.000	24	5.000			
Total	520.000	30				
Corrected Total	250.000	29				

a. R Squared = .520 (Adjusted R Squared = .420)

Descriptive Statistics

Dependent Variable:Food Consumed

gender	Drug Dose	Mean	Std. Deviation	N
Males	No Drug	2.0000	2.23607	5
	Small Dose	7.0000	2.54951	5
	Large Dose	3.0000	2.12132	5
	Total	4.0000	3.09377	15
Females	No Drug	4.0000	2.64575	5
	Small Dose	1.0000	2.23607	5
	Large Dose	1.0000	1.41421	5
	Total	2.0000	2.47848	15
Total	No Drug	3.0000	2.53859	10
	Small Dose	4.0000	3.88730	10
	Large Dose	2.0000	2.00000	10
	Total	3.0000	2.93610	30

- Males consumed more (M = 4.00, sd = 3.09) than females (M = 2.00, sd = 2.48). The analysis of variance revealed a significant main effect of gender, $F(1, 24) = 6.00$, $MS_{error} = 5.00$, $p = .022$, $\eta^2 = .200$.

Writing

Tests of Between-Subjects Effects

Dependent Variable:Food Consumed

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	130.000[a]	5	26.000	5.200	.002	.520
Intercept	270.000	1	270.000	54.000	.000	.692
gender	30.000	1	30.000	6.000	.022	.200
drug	20.000	2	10.000	2.000	.157	.143
gender * drug	80.000	2	40.000	8.000	.002	.400
Error	120.000	24	5.000			
Total	520.000	30				
Corrected Total	250.000	29				

a. R Squared = .520 (Adjusted R Squared = .420)

Descriptive Statistics

Dependent Variable:Food Consumed

gender	Drug Dose	Mean	Std. Deviation	N
Males	No Drug	2.0000	2.23607	5
	Small Dose	7.0000	2.54951	5
	Large Dose	3.0000	2.12132	5
	Total	4.0000	3.09377	15
Females	No Drug	4.0000	2.64575	5
	Small Dose	1.0000	2.23607	5
	Large Dose	1.0000	1.41421	5
	Total	2.0000	2.47848	15
Total	No Drug	3.0000	2.53859	10
	Small Dose	4.0000	3.88730	10
	Large Dose	2.0000	2.00000	10
	Total	3.0000	2.93610	30

- The no drug (*M* = 3.00, sd = 2.54), small dose (*M* = 4.00, sd = 3.89) and large dose (*M* = 2.00, sd = 2.00) were not reliably different. The ANOVA failed to reveal a significant main effect of drug dose on amount consumed, $F(2, 24) = 2.00$, $p = .157$, $\eta^2 = .143$.

Writing

Tests of Between-Subjects Effects

Dependent Variable:Food Consumed

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	130.000[a]	5	26.000	5.200	.002	.520
Intercept	270.000	1	270.000	54.000	.000	.692
gender	30.000	1	30.000	6.000	.022	.200
drug	20.000	2	10.000	2.000	.157	.143
gender * drug	80.000	2	40.000	8.000	.002	.400
Error	120.000	24	5.000			
Total	520.000	30				
Corrected Total	250.000	29				

a. R Squared = .520 (Adjusted R Squared = .420)

- Table 1 shows the means and standard deviations for each condition. The analysis of variance revealed a significant interaction of gender and drug dose on amount consumed, $F(2, 24) = 8.00$, $p = .002$, $\eta^2 = .400$.

Table 1

Amount of Food Consumed over a 48 Hour Period for Males and Females for Each Drug Dose

	Males		Females		Marginal Means	
	M	*sd*	*M*	*sd*	*M*	*sd*
No Drug	2	2.24	4	2.65	3	2.54
Small Dose	7	2.55	1	2.24	4	3.89
Large Dose	3	2.12	1	1.41	2	2.00
Marginal Means	4	3.09	2	2.48		

Note. You should state what the numbers represent – kilograms of food?

Stuff You Don't Need To Know

- Because we have an interaction, we need to determine the nature of the interaction
- The direction and/or magnitude of the gender difference should be different depending on the dosing levels
- We will perform three one-factor ANOVAs comparing males to females – one for each level of dosing
  – Could have done independent samples t-test instead

Stuff You Don't Need To Know

- Simple main effect of gender at no drug:
  - H_0: $\mu_{male} = \mu_{female}$
    H_1: $\mu_{male} \neq \mu_{female}$
- Simple main effect of gender at small dose:
  - H_0: $\mu_{male} = \mu_{female}$
    H_1: $\mu_{male} \neq \mu_{female}$
- Simple main effect of gender at large dose:
  - H_0: $\mu_{male} = \mu_{female}$
    H_1: $\mu_{male} \neq \mu_{female}$

Stuff You Don’t Need To Know

- Data | Split File
- Compare Groups
- Move the Drug Dose factor into the Groups Based on box
- OK
- Analyze | General Linear Model | Univariate
- Remove the Drug Dose variable from the Fixed Factor(s) box
- OK

Stuff You Don’t Need To Know

Tests of Between-Subjects Effects

Dependent Variable:Food Consumed

Drug Dose	Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
No Drug	Corrected Model	10.000[a]	1	10.000	1.667	.233	.172
	Intercept	90.000	1	90.000	15.000	.005	.652
	gender	10.000	1	10.000	1.667	.233	.172
	Error	48.000	8	6.000			
	Total	148.000	10				
	Corrected Total	58.000	9				
Small Dose	Corrected Model	90.000[b]	1	90.000	15.652	.004	.662
	Intercept	160.000	1	160.000	27.826	.001	.777
	gender	90.000	1	90.000	15.652	.004	.662
	Error	46.000	8	5.750			
	Total	296.000	10				
	Corrected Total	136.000	9				
Large Dose	Corrected Model	10.000[c]	1	10.000	3.077	.117	.278
	Intercept	40.000	1	40.000	12.308	.008	.606
	gender	10.000	1	10.000	3.077	.117	.278
	Error	26.000	8	3.250			
	Total	76.000	10				
	Corrected Total	36.000	9				

a. R Squared = .172 (Adjusted R Squared = .069)

b. R Squared = .662 (Adjusted R Squared = .619)

c. R Squared = .278 (Adjusted R Squared = .188)

No simple main effect of gender at no drug; fail to reject H_0 as $p > \alpha$

Simple main effect of gender at small dose; reject H_0 as $p \leq \alpha$

No simple main effect of gender at large dose; fail to reject H_0 as $p > \alpha$

Different effects of gender at different levels of dosing = interaction!

Stuff You Don't Need To Know

- Follow-up analyses of the simple main effects of gender for each drug dose revealed no simple main effect of gender with no drug, $F(1, 8) = 1.67$, $MSerror = 6.00$, $p = .233$, $\eta^2 = .172$. Also, there was no simple main effect of gender with the large drug, $F(1, 8) = 3.08$, $MSerror = 3.25$, $p = .117$, $\eta^2 = .278$. But there was a simple main effect of gender with the small dose, $F(1, 8) = 15.65$, $MSerror = 5.75$, $p = .004$, $\eta^2 = .662$.

By Hand

	No Drug	Small Dose	Large Dose		
Males	1	7	3		
	6	7	1		
	1	11	1		
	1	4	6		
	1	6	4		
	n = 5	n=5	n=5		
	M=2	M=7	M=3		
	T=10	T=35	T=15	T_{Males} = 60	
	SS=20	SS=26	SS=18		G = 30
					N = 30
Females	0	0	0		$\Sigma X^2 = 520$
	3	0	2		
	7	0	0		
	5	5	0		
	5	0	3		
	n=5	n=5	n=5		
	M=4	M=1	M=1		
	T=20	T=5	T=5	$T_{Females}$ = 30	
	SS=28	SS=20	SS=8		
	$T_{No\ Drug}$ = 30	$T_{Small\ Dose}$ = 40	$T_{Large\ Dose}$ = 20		

Stage 1

$$SS_{total} = \sum X^2 - \frac{G^2}{N}$$

$$= 520 - \frac{90^2}{30}$$

$$= 250$$

$$df_{Total} = N - 1$$

$$= 30 - 1$$

$$= 29$$

$$SS_{Within\ Treatments} = \sum SS_{inside\ each\ treatment}$$

$$= 20 + 26 + 18 + 28 + 20 + 8$$

$$= 120$$

$$df_{Within\ Treatments} = \sum df$$

$$= 4 + 4 + 4 + 4 + 4 + 4$$

$$= 24$$

$$SS_{Between\ Treatments} = \left(\sum \frac{T^2}{n}\right) - \frac{G^2}{N}$$

$$= \frac{10^2}{5} + \frac{35^2}{5} + \frac{15^2}{5} + \frac{20^2}{5} + \frac{5^2}{5} + \frac{5^2}{5} - \frac{90^2}{30}$$

$$= 20 + 245 + 45 + 80 + 5 + 5 - 270$$

$$= 130$$

$$df_{Between\ Treatments} = \text{number of treatments} - 1$$

$$= 6 - 1$$

$$= 5$$

Stage 2

$$SS_{Gender} = \sum \frac{T^2_{Rows}}{n_{Rows}} - \frac{G^2}{N}$$
$$= \frac{60^2}{15} + \frac{30^2}{15} - \frac{90^2}{30}$$
$$= 240 + 60 - 270$$
$$= 30$$

$$df_{Gender} = \text{number of rows} - 1$$
$$= 2 - 1$$
$$= 1$$

$$SS_{Drug} = \sum \frac{T^2_{Cols}}{n_{Cols}} - \frac{G^2}{N}$$
$$= \frac{30^2}{10} + \frac{40^2}{10} + \frac{20^2}{10} - \frac{90^2}{30}$$
$$= 90 + 160 + 40 - 270$$
$$= 20$$

$$df_{Drugs} = \text{number of columns} - 1$$
$$= 3 - 1$$
$$= 2$$

$$SS_{Gender\ X\ Drug} = SS_{Between} - SS_{Gender} - SS_{Drug}$$
$$= 130 - 30 - 20$$
$$= 80$$

$$df_{Gender\ X\ Drugs} = df_{Gender}\ X\ df_{Drugs}$$
$$= 1\ X\ 2$$
$$= 2$$

Stage 2

$$MS_{Gender} = \frac{SS_{Gender}}{df_{Gender}} = \frac{30}{1} = 30$$

$$F_{Gender} = \frac{MS_{Gender}}{MS_{Within\ Treatment}} = \frac{30}{5} = 6$$

$$MS_{Drugs} = \frac{SS_{Drugs}}{df_{Drugs}} = \frac{20}{2} = 10$$

$$MS_{Within\ Treatment} = \frac{SS_{Within\ Treatment}}{df_{Within\ Treatment}} = \frac{120}{24} = 5$$

$$F_{Drugs} = \frac{MS_{Drugs}}{MS_{Within\ Treatment}} = \frac{10}{5} = 2$$

$$MS_{Gender\ X\ Drugs} = \frac{SS_{Gender\ X\ Drugs}}{df_{Gender\ X\ Drugs}} = \frac{80}{2} = 40$$

$$F_{Gender\ X\ Drugs} = \frac{MS_{Gender\ X\ Drugs}}{MS_{Within\ Treatment}} = \frac{40}{5} = 8$$