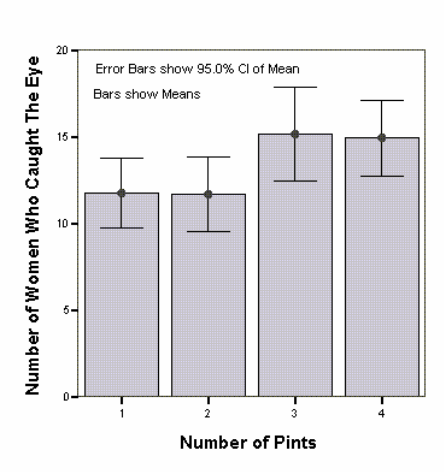
Chapter 11: Answers

Task 1

Imagine I wanted to look at the effect alcohol has on the roving eye. The 'roving eye' effect is the propensity of people in relationships to 'eye-up' members of the opposite sex. I took 20 men and fitted them with incredibly sophisticated glasses that could track their eye movements and record both the movement and the object being observed (this is the point at which it should be apparent that I'm making it up as I go along). Over 4 different nights I plied these poor souls with either 1, 2, 3 or 4 pints of strong lager in a nightclub. Each night I measured how many different women they eyed-up (a women was categorized as having been eyed up if the man's eye moved from her head to toe and back up again). To validate this measure we also collected the amount of dribble on the man's chin while looking at a woman. The data are in the file **RovingEye.sav**, analyse them with a one-way ANOVA.

SPSS Output



This error bar chart of the roving eye data shows the mean number of women that were eyed up after different doses of alcohol. It's clear from this chart that the mean number of women is pretty similar between 1 and 2 pints, and for 3 and 4 pints but there is a jump after 2 pints.

Within-Subjects Factors

Measure: MEASURE_1

ALCOHOL	Dependent Variable
1	PINT1
2	PINT2
3	PINT3
4	PINT4

Descriptive Statistics

	Mean	Std. Deviation	N
1 Pint	11.7500	4.31491	20
2 Pints	11.7000	4.65776	20
3 Pints	15.2000	5.80018	20
4 Pints	14.9500	4.67327	20

These outputs show the initial diagnostics statistics. First, we are told the variables that represent each level of the independent variable. This box is useful to check that the variables were entered in the correct order. The next table provides basic descriptive statistics for the four levels of the independent variable. This table confirms what we saw in the graph.

Mauchly's Test of Sphericity[b]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[a] Greenhouse-Geisser	Epsilon[a] Huynh-Feldt	Epsilon[a] Lower-bound
ALCOHOL	.477	13.122	5	.022	.745	.849	.333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept
Within Subjects Design: ALCOHOL

The next part of the output contains Mauchly's test and we hope to find that it's non-significant if we are to assume that the condition of sphericity has been met. However, the significance value (0.022) is less than the critical value of 0.05, so we accept that the assumption of sphericity has been violated.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
ALCOHOL	Sphericity Assumed	225.100	3	75.033	4.729	.005
	Greenhouse-Geisser	225.100	2.235	100.706	4.729	.011
	Huynh-Feldt	225.100	2.547	88.370	4.729	.008
	Lower-bound	225.100	1.000	225.100	4.729	.042
Error(ALCOHOL)	Sphericity Assumed	904.400	57	15.867		
	Greenhouse-Geisser	904.400	42.469	21.296		
	Huynh-Feldt	904.400	48.398	18.687		
	Lower-bound	904.400	19.000	47.600		

This output shows the main result of the ANOVA. The significance of F is 0.005, which is significant because it is less than the criterion value of 0.05. We can, therefore, conclude that alcohol had a significant effect on the average number of women that were eyed up. However, this main test does not tell us which quantities of alcohol made a difference to the number of women eyed up.

This result is all very nice but as of yet we haven't done anything about our violation of the sphericity assumption. This table contains several additional rows giving the corrected values of *F* for the three different types of adjustment (Greenhouse-Geisser, Huynh-Feldt and lower-bound). First we decide which correction to apply and to do this we need to look at the estimates of sphericity in **Error! Reference source not found.**: if the Greenhouse-Geisser and Huynh-Feldt estimates are less than 0.75 we should use Greenhouse-Geisser, and if they are above 0.75 we use Huynh-Feldt. We discovered in the book that based on these criteria we should use Huynh-Feldt here. Using this corrected value we still find a significant result because the observed *p* (0.008) is still less than the criterion of 0.05.

Pairwise Comparisons

Measure: MEASURE_1

(I) ALCOHOL	(J) ALCOHOL	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	95% Confidence Interval for Difference[a] Upper Bound
1	2	5.000E-02	.742	1.000	-2.133	2.233
	3	-3.450	1.391	.136	-7.544	.644
	4	-3.200	1.454	.242	-7.480	1.080
2	1	-5.000E-02	.742	1.000	-2.233	2.133
	3	-3.500*	1.139	.038	-6.853	-.147
	4	-3.250	1.420	.202	-7.429	.929
3	1	3.450	1.391	.136	-.644	7.544
	2	3.500*	1.139	.038	.147	6.853
	4	.250	1.269	1.000	-3.485	3.985
4	1	3.200	1.454	.242	-1.080	7.480
	2	3.250	1.420	.202	-.929	7.429
	3	-.250	1.269	1.000	-3.985	3.485

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

The main effect of alcohol doesn't tell us anything about which doses of alcohol produced different results to other doses. So, we might do some post hoc tests as well. The output above shows the table from SPSS that contains these tests. We read down the column labelled Sig. and look for values less than 0.05. By looking at the significance values we can see that the only difference between condition means is between 2 and 3 pints of alcohol.

Interpreting and Writing the Result

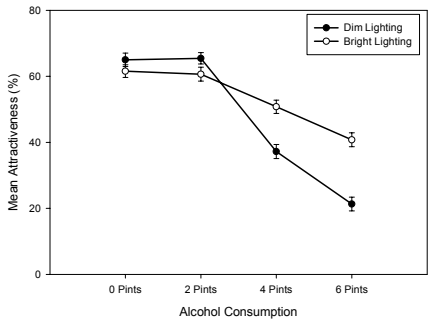
We could report the main finding as:

- ✓ Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2(5) = 13.12$, $p < .05$), therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .85$). The results show that the number of women eyed up was significantly affected by the amount of alcohol drunk, $F(2.55, 48.40) = 4.73$, $p < .05$, $r = .40$). Bonferroni post hoc tests revealed a significant difference in the number of women eyed up only between 2 and 3 pints ($CI_{.95}$ = –6.85 (lower) –.15 (upper), $p < .05$). No other comparisons were significant (all *p*s > .05).'

Task 2

In the previous chapter we came across the beer-goggles effect: a severe perceptual distortion after imbibing vast quantities of alcohol. The specific visual distortion is that previously unattractive people, suddenly become the hottest thing since Spicy Gonzalez' extra hot Tabasco-marinated chilies. In short, one minute you're standing in a zoo admiring the Orangutans, and the next you're wondering why someone would put Gail Porter (or whatever her surname is now) into a cage. Anyway, in that chapter, a blatantly fabricated data set demonstrated that the beer-goggles effect was much stronger for men than women, and took effect only after two pints. Imagine we wanted to follow this finding up to look at what factors mediate the beer goggles effect. Specifically, we thought that the beer goggles effect might be made worse by the fact that it usually occurs in clubs, which have dim lighting. We took a sample of 26 men (because the effect is stronger in men) and gave them various doses of alcohol over four different weeks (0 pints, 2 pints, 4 pints and 6 pints of lager). This is our first independent variable, which we'll call alcohol consumption, and it has four levels. Each week (and, therefore, in each state of drunkenness) participants were asked to select a mate in a normal club (that had dim lighting) and then select a second mate in a specially designed club that had bright lighting. As such, the second independent variable was whether the club had dim or bright lighting. The outcome measure was the attractiveness of each mate as assessed by a panel of independent judges. To recap, all participants took part in all levels of the alcohol consumption variable, and selected mates in both brightly- and dimly-lit clubs. The data are in the file **BeerGogglesLighting.sav**, analyse them with a two-way repeated-measures ANOVA.

SPSS Output



This chart displays the mean attractiveness of the partner selected (with error bars) in dim and brightly lit clubs after the different doses of alcohol. The chart shows that in both dim and brightly lit clubs there is a tendency for men to select less attractive mates as they consume more and more alcohol.

Descriptive Statistics

	Mean	Std. Deviation	N
0 Pints (Dim Lighting)	65.0000	10.30728	26
2 Pints (Dim Lighting)	65.4615	8.76005	26
4 Pints (Dim Lighting)	37.2308	10.86391	26
6 Pints (Dim Lighting)	21.3077	10.67247	26
0 Pints (Bright Lighting)	61.5769	9.70432	26
2 Pints (Bright Lighting)	60.6538	10.65060	26
4 Pints (Bright Lighting)	50.7692	10.34334	26
6 Pints (Bright Lighting)	40.7692	10.77519	26

This shows the means for all conditions in a table. These means correspond to those plotted in the graph.

Mauchly's Test of Sphericity[b]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[a] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
LIGHTING	1.000	.000	0	.	1.000	1.000	1.000
ALCOHOL	.820	4.700	5	.454	.873	.984	.333
LIGHTING * ALCOHOL	.898	2.557	5	.768	.936	1.000	.333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept
Within Subjects Design: LIGHTING+ALCOHOL+LIGHTING*ALCOHOL

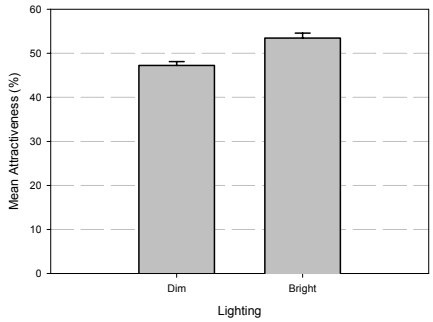
The variable lighting had only two levels (dim or bright) and so the assumption of sphericity doesn't apply and SPSS doesn't produce a significance value. However, for the effects of alcohol consumption and the interaction of alcohol consumption and lighting, we do have to look at Mauchly's test. The significance values are both above 0.05 (they are 0.454 and 0.768 respectively) and so we know that the assumption of sphericity has been met for both alcohol consumption, and the interaction of alcohol consumption and lighting.

Tests of Within-Subjects Effects

Measure: MEASURE_1

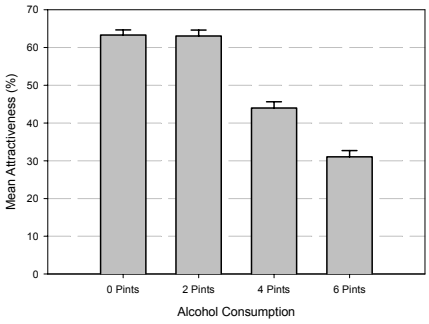
Source		Type III Sum of Squares	df	Mean Square	F	Sig.
LIGHTING	Sphericity Assumed	1993.923	1	1993.923	23.421	.000
	Greenhouse-Geisser	1993.923	1.000	1993.923	23.421	.000
	Huynh-Feldt	1993.923	1.000	1993.923	23.421	.000
	Lower-bound	1993.923	1.000	1993.923	23.421	.000
Error(LIGHTING)	Sphericity Assumed	2128.327	25	85.133		
	Greenhouse-Geisser	2128.327	25.000	85.133		
	Huynh-Feldt	2128.327	25.000	85.133		
	Lower-bound	2128.327	25.000	85.133		
ALCOHOL	Sphericity Assumed	38591.654	3	12863.885	104.385	.000
	Greenhouse-Geisser	38591.654	2.619	14736.844	104.385	.000
	Huynh-Feldt	38591.654	2.953	13069.660	104.385	.000
	Lower-bound	38591.654	1.000	38591.654	104.385	.000
Error(ALCOHOL)	Sphericity Assumed	9242.596	75	123.235		
	Greenhouse-Geisser	9242.596	65.468	141.177		
	Huynh-Feldt	9242.596	73.819	125.206		
	Lower-bound	9242.596	25.000	369.704		
LIGHTING * ALCOHOL	Sphericity Assumed	5765.423	3	1921.808	22.218	.000
	Greenhouse-Geisser	5765.423	2.809	2052.286	22.218	.000
	Huynh-Feldt	5765.423	3.000	1921.808	22.218	.000
	Lower-bound	5765.423	1.000	5765.423	22.218	.000
Error(LIGHTING*ALCOHOL)	Sphericity Assumed	6487.327	75	86.498		
	Greenhouse-Geisser	6487.327	70.232	92.370		
	Huynh-Feldt	6487.327	75.000	86.498		
	Lower-bound	6487.327	25.000	259.493		

This output shows the main ANOVA summary table. The main effect of lighting is shown by the *F*-ratio in the row labeled lighting. The significance of this value is 0.000, which is well below



the usual cut-off point of 0.05. We can conclude that average attractiveness ratings were significantly affected by whether mates were selected in a dim or well-lit club. We can easily interpret this result further because there were only two levels: Attractiveness ratings were higher in the well-lit clubs, so we could conclude that when we ignore how much alcohol was consumed, the mates selected in well-lit clubs were significantly more attractive than those chosen in dim clubs.

The main effect of alcohol consumption is shown by the *F*-ratio in the row labeled alcohol. The probability associated with this *F*-ratio is reported as 0.000 (i.e. $p < 0.001$), which is well below the critical value of 0.05. We can conclude that there was a significant main effect of the amount of alcohol consumed on the attractiveness of the mate selected. We know that generally there was an effect, but without further tests (e.g. post hoc comparisons) we can't say exactly which doses of alcohol had the most effect. I've plotted the means for the four doses. This graph shows that when you ignore the lighting in the club, the attractiveness of mates is similar after no alcohol and two pints of lager but starts to rapidly decline at four pints and continues to decline after 6 pints.



Pairwise Comparisons

Measure: MEASURE_1

(I) ALCOHOL	(J) ALCOHOL	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	.231	2.006	1.000	-5.517	5.978
	3	19.288*	2.576	.000	11.909	26.668
	4	32.250*	1.901	.000	26.804	37.696
2	1	-.231	2.006	1.000	-5.978	5.517
	3	19.058*	2.075	.000	13.112	25.003
	4	32.019*	1.963	.000	26.395	37.644
3	1	-19.288*	2.576	.000	-26.668	-11.909
	2	-19.058*	2.075	.000	-25.003	-13.112
	4	12.962*	2.450	.000	5.942	19.981
4	1	-32.250*	1.901	.000	-37.696	-26.804
	2	-32.019*	1.963	.000	-37.644	-26.395
	3	-12.962*	2.450	.000	-19.981	-5.942

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

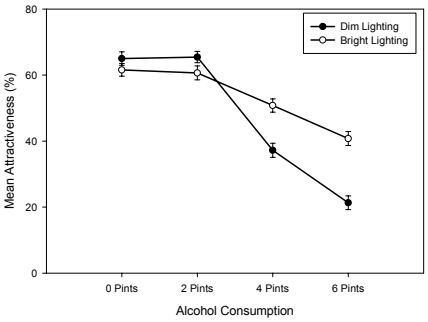
This output shows some post hoc tests for the main effect of alcohol. In this example I've chosen a Bonferroni correction. The main column of interest is the one labelled Sig., but the confidence intervals also tell us the likely difference between means if we were to take other samples. The mean attractiveness was significantly higher after no pints than it was after four pints and six pints (both *p*s are less than 0.001). We can also see that the mean attractiveness after two pints was significantly higher than after four pints and six pints (again, both *p*s are less than 0.001). Finally, the mean attractiveness after four pints was significantly higher than after 6 pints (*p* is less than 0.001). So, we can conclude that the beer goggles effect doesn't kick in until after two pints, and that it has an ever-increasing effect (well, up to six pints at any rate!).

The interaction effect is shown by the *F*-ratio in the row labeled Lightening*Alcohol. The resulting *F*-ratio is 22.22 (1921.81/86.50), which has an associated probability value of 0.000 (i.e. $p < 0.001$). As such, there is a significant interaction between the amount of alcohol consumed and the lighting in the club on the attractiveness of the mate selected.

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	LIGHTING	ALCOHOL	Type III Sum of Squares	df	Mean Square	F	Sig.
LIGHTING	Level 1 vs. Level 2		996.962	1	996.962	23.421	.000
Error(LIGHTING)	Level 1 vs. Level 2		1064.163	25	42.567		
ALCOHOL		Level 1 vs. Level 2	1.385	1	1.385	.013	.909
		Level 2 vs. Level 3	9443.087	1	9443.087	84.323	.000
		Level 3 vs. Level 4	4368.038	1	4368.038	27.983	.000
Error(ALCOHOL)		Level 1 vs. Level 2	2616.115	25	104.645		
		Level 2 vs. Level 3	2799.663	25	111.987		
		Level 3 vs. Level 4	3902.462	25	156.098		
LIGHTING * ALCOHOL	Level 1 vs. Level 2	Level 1 vs. Level 2	49.846	1	49.846	.144	.708
		Level 2 vs. Level 3	8751.115	1	8751.115	24.749	.000
		Level 3 vs. Level 4	912.154	1	912.154	2.157	.154
Error(LIGHTING*ALCOHOL)	Level 1 vs. Level 2	Level 1 vs. Level 2	8680.154	25	347.206		
		Level 2 vs. Level 3	8839.885	25	353.595		
		Level 3 vs. Level 4	10569.846	25	422.794		



This output shows the output from a set of contrasts that compare each level of the alcohol variable to the previous level of that variable (this is called a *repeated* contrast in SPSS). So, it compares no pints with two pints (level 1 vs. level 2), two pints with four pints (level 2 vs. level 3) and 4 pints with 6 pints (level 3 vs. level 4). As you can see from the output, if we just look at the main effect of group these contrasts tell us what we already know from the post hoc tests, that is, the attractiveness after no alcohol doesn't differ from the attractiveness after two pints, $F(1, 25) < 1$, the attractiveness after four pints does differ from that after two pints, $F(1, 25) = 84.32$, $p < 0.001$, and the attractiveness after six pints does differ from that after four pints, $F(1, 25) = 27.98$, $p < 0.001$. More interesting is to look at the interaction term in the table. This compares the same levels of the alcohol variable, but for each comparison it is also comparing the difference between the means for the dim and brightly-lit clubs. One way to think of this is to look at the interaction graph and note the vertical differences between the means for dim and bright clubs at each level of alcohol. When nothing was drunk, the distance between the bright and dim means is quite small (it's actually 3.42 units on the attractiveness scale), when two pints of alcohol are drunk the difference between the dim and well-lit club is still quite small (4.81 units to be precise). The first contrast is comparing the difference between dim and bright clubs when nothing was drunk with the difference between dim and bright clubs when two pints were drunk. So, it is asking 'is 3.42 significantly different from 4.81'? The answer is 'no', because the *F*-ratio is nonsignificant—in fact, it's less than 1 ($F(1, 25) < 1$). The second contrast for the interaction is looking at the difference between dim and bright clubs when two pints were drunk (4.81) with the difference between dim and bright clubs when four pints were drunk (this difference is –13.54, note the direction of the difference has changed as indicated by the lines crossing in the graph. This difference is significant ($F(1, 25) = 24.75$, $p < 0.001$). The final contrast for the interaction is looking at the difference between dim and bright clubs when four pints were drunk (–13.54) with the difference between dim and bright clubs when six pints were drunk (this difference is –19.46). This contrast is not significant ($F(1, 25) = 2.16$, *ns*). So, we could conclude that there was a significant interaction between the amount of alcohol drunk and the lighting in the club. Specifically, the effect of alcohol after two pints on the attractiveness of the mate was much more pronounced when the lights were dim.

Writing the Result

We can report the three effects from this analysis as follows:

- ✓ The results show that the attractiveness of the mates selected was significantly lower when the lighting in the club was dim compared to when the lighting was bright, $F(1, 25) = 23.42$, $p < .001$.

- ✓ The main effect of alcohol on the attractiveness of mates selected was significant, $F(3, 75) = 104.39$, $p < .001$. This indicated that when the lighting in the club was ignored, the attractiveness of the mates selected differed according to how much alcohol was drunk before the selection was made. Specifically, post hoc test revealed that compared to a baseline of when no alcohol had been consumed, the attractiveness of selected mates was not different after two pints ($p > .05$), but was significantly lower after four and six pints (both ps $< .001$). The mean attractiveness after two pints was also significantly higher than after four pints and six pints (both ps $< .001$), and the mean attractiveness after four pints was significantly higher than after 6 pints ($p < .001$). To sum up, the beer goggles effect seems to take effect after two pints have been consumed and has an increasing impact until six pints are consumed.
- ✓ The lighting $\times$ alcohol interaction was significant, $F(3, 75) = 22.22$, $p < .001$, indicating that the effect of alcohol on the attractiveness of the mates selected differed when lighting was dim compared to when it was bright. Contrasts on this interaction term revealed that when the difference in attractiveness ratings between dim and bright clubs was compared after no alcohol and after two pints had been drunk there was no significant difference, $F(1, 25) < 1$. However, when comparing the difference between dim and bright clubs when two pints were drunk with the difference after four pints were drunk a significant difference emerged, $F(1, 25) = 24.75$, $p < .001$. A final contrast revealed that the difference between dim and bright clubs after four pints were drunk compared to after six pints was not significant, $F(1, 25) = 2.16$, *ns*. To sum up, there was a significant interaction between the amount of alcohol drunk and the lighting in the club: the decline in the attractiveness of the selected mate seen after two pints (compared to after four) was significantly more pronounced when the lights were dim.

Task 3

Change the syntax in **SimpleEffectsAttitude.sps** to look at the effect of drink at different levels of imagery

The correct syntax to use is:

```
MANOVA
  beerpos beerneg beerneut winepos wineneg wineneut waterpos waterneg waterneu
/WSFACTORS  drink(3) imagery(3)
/WSDESIGN = MWITHIN  imagery(1) MWITHIN  imagery(2) MWITHIN  imagery(3)
 /PRINT
        SIGNIF( UNIV MULT AVERF HF GG ).
```

SPSS Output

The main part of the analysis is:

```
* * * * * * A n a l y s i s   o f   V a r i a n c e -- design   1 * * * * * *

Tests involving 'MWITHIN IMAGERY(1)' Within-Subject Effect.

 Tests of Significance for T1 using UNIQUE sums of squares
 Source of Variation          SS      DF        MS         F  Sig of F

 WITHIN+RESIDUAL         1088.40      19     57.28
 MWITHIN IMAGERY(1)     27136.27       1  27136.27    473.71      .000

 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * * * * * A n a l y s i s   o f   V a r i a n c e -- design   1 * * * * * *

Tests involving 'MWITHIN IMAGERY(2)' Within-Subject Effect.

 Tests of Significance for T2 using UNIQUE sums of squares
```

```
 Source of Variation          SS      DF        MS         F  Sig of F

 WITHIN+RESIDUAL         3113.92      19    163.89
 MWITHIN IMAGERY(2)      1870.42       1   1870.42     11.41      .003

 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

* * * * * * A n a l y s i s   o f   V a r i a n c e -- design   1 * * * * * *

Tests involving 'MWITHIN IMAGERY(3)' Within-Subject Effect.

 Tests of Significance for T3 using UNIQUE sums of squares
 Source of Variation          SS      DF        MS         F  Sig of F

 WITHIN+RESIDUAL         1070.67      19     56.35
 MWITHIN IMAGERY(3)      3840.00       1   3840.00     68.14      .000

 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

What this shows is a significant effect of drink at level 1 of imagery. So, the ratings of the three drinks significantly differed when positive imagery was used. Because there are three levels of drink though this isn't that helpful in untangling what's going on. There is also a significant effect of drink at level 2 of imagery. So, the ratings of the three drinks significantly differed when negative imagery was used. Finally, there is also a significant effect of drink at level 3 of imagery. So, the ratings of the three drinks significantly differed when neutral imagery was used.