Chapter 9: Answers

Task 1

Stalking is a very disruptive and upsetting (for the person being stalked) experience in which someone (the stalker) constantly harasses or obsesses about another person. It can take many forms, from sending intensely disturbing letters threatening to boil your cat if you don't reciprocate the stalkers undeniable love for you, to literally following you around your local area in a desperate attempt to see which CD you buy on a Saturday (as if it would be anything other than Fugazi!). A psychologist, who'd had enough of being stalked by people, decided to try two different therapies on different groups of stalkers (25 stalkers in each group—this variable is called Group). The first group of stalkers he gave what he termed cruel to be kind therapy. This therapy was based on punishment for stalking behaviours; in short every time the stalker followed him around, or sent him a letter, the psychologist attacked them with a cattle prod until they stopped their stalking behaviour. It was hoped that the stalkers would learn an aversive reaction to anything resembling stalking. The second therapy was psychodyshamic therapy, which was a recent development on Freud's psychodynamic therapy that acknowledges what a sham this kind of treatment is (so, you could say it's based on Fraudian theory!). The stalkers were hypnotised and regressed into their childhood, the therapist would also discuss their penis (unless it was a woman in which case they discussed their lack of penis), the penis of their father, their dog's penis, the penis of the cat down the road, and anyone else's penis that sprang to mind. At the end of therapy, the psychologist measured the number of hours in the week that the stalker spent stalking their prey (this variable is called stalk2). Now, the therapist believed that the success of therapy might well depend on how bad the problem was to begin with, so before therapy the therapist measured the number of hours that the patient spent stalking as an indicator of how much of a stalker the person was (this variable is called stalk1). The data are in the file **Stalker.sav**, analyse the effect of therapy on stalking behaviour after therapy, controlling for the amount of stalking behaviour before therapy.

SPSS Output

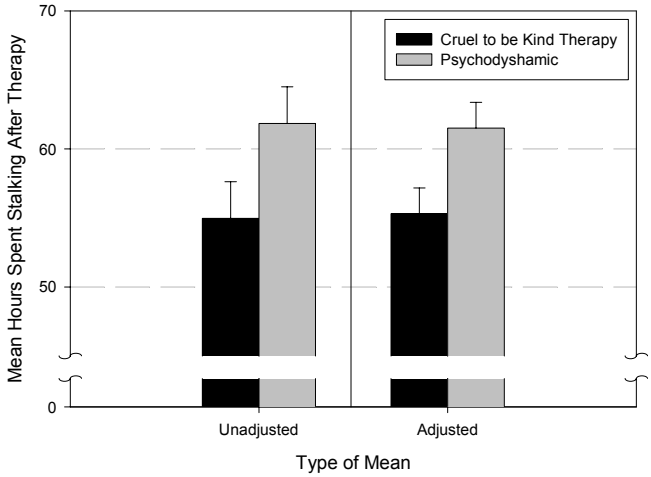
Tests of Between-Subjects Effects

Dependent Variable: Time Spent Stalking After Therapy (hours per week)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	591.680[a]	1	591.680	3.331	.074
Intercept	170528.000	1	170528.000	960.009	.000
THERAPY	591.680	1	591.680	3.331	.074
Error	8526.320	48	177.632		
Total	179646.000	50			
Corrected Total	9118.000	49			

a. R Squared = .065 (Adjusted R Squared = .045)

This output shows the ANOVA table when the covariate is not included. It is clear from the significance value that there is no difference in the hours spent stalking after therapy for the two therapy groups (p is 0.074 which is greater than 0.05). You should note that the total amount of variation to be explained (SS_T) was 9118, of which the experimental manipulation accounted for 591.68 units (SS_M), whilst 8526.32 were unexplained (SS_R).



This bar chart shows the mean number of hours spent stalking after therapy. The normal means are shown as well as the same means when the data are adjusted for the effect of the covariate. In this case the adjusted and unadjusted means are relatively similar.

Descriptive Statistics

Dependent Variable: Time Spent Stalking After Therapy (hours per week)

Group	Mean	Std. Deviation	N
Cruel to be Kind Therapy	54.9600	16.33116	25
Psychodyshamic Therapy	61.8400	9.41046	25
Total	58.4000	13.64117	50

This table shows the unadjusted means (i.e. the normal means if we ignore the effect of the covariate). These are the same values plotted on the left hand side of the bar chart. These results show that the time spent stalking after therapy was less after cruel to be kind therapy. However, we know from our initial ANOVA that this difference is non-significant. So, what now happens when we consider the effect of the covariate (in this case the extent of the stalker's problem before therapy)?

Levene's Test of Equality of Error Variances[a]

Dependent Variable: Time Spent Stalking After Therapy (hours per week)

F	df1	df2	Sig.
7.189	1	48	.010

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept+STALK1+GROUP

This table shows the results of Levene's test, which is significant because the significance value is 0.01 (less than 0.05). This finding tells us that the variances across groups are different and the assumption has been broken.

Tests of Between-Subjects Effects

Dependent Variable: Time Spent Stalking After Therapy (hours per week)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5006.278[a]	2	2503.139	28.613	.000
Intercept	8.646E-02	1	8.646E-02	.001	.975
HOURS SPENT STALKING BEFORE THERAPY	4414.598	1	4414.598	50.462	.000
THERAPY	480.265	1	480.265	5.490	.023
Error	4111.722	47	87.483		
Total	179646.000	50			
Corrected Total	9118.000	49			

a. R Squared = .549 (Adjusted R Squared = .530)

This table shows the ANCOVA. Looking first at the significance values, it is clear that the covariate significantly predicts the dependent variable, so the hours spent stalking after therapy depends on the extent of the initial problem (i.e. the hours spent stalking before

therapy). More interesting is that when the effect of initial stalking behaviour is removed, the effect of therapy becomes significant (*p* has gone down from 0.074 to 0.023, which is less than 0.05).

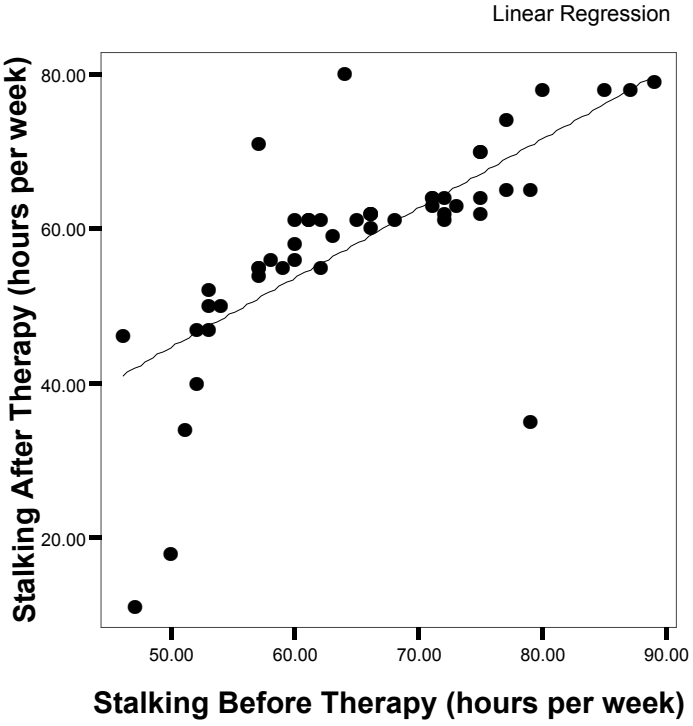
Group

Dependent Variable: Time Spent Stalking After Therapy (hours per week)

			95% Confidence Interval	
Group	Mean	Std. Error	Lower Bound	Upper Bound
Cruel to be Kind Therapy	55.299[a]	1.871	51.534	59.063
Psychodyshamic Therapy	61.501[a]	1.871	57.737	65.266

a. Evaluated at covariates appeared in the model: Time Spent Stalking Before Therapy (hours per week) = 65.2200.

To interpret the results of the main effect of therapy we need to look at adjusted means. These adjusted means are shown above. There are only two groups being compared in this example so we can conclude that the therapies had a significantly different effect on stalking behaviour; specifically stalking behaviour was lower after the therapy involving the cattle prod compared to psychodyshamic therapy.



We need to interpret the covariate. The graph above shows the time spent stalking after therapy (dependent variable) and the initial level of stalking (covariate). This graph shows that there is a positive relationship between the two variables, that is, high scores on one variable correspond with high scores on the other, whereas low scores on one variable correspond with low scores on the other.

Calculating the Effect Size

Omega-squared can be calculated for the effect of therapy using the mean squares for the experimental effect (480.27), the mean squares for the error term (87.48), and the sample size per group (25):

$$\omega^2_{Therapy} = \frac{480.27 - 87.48}{480.27 + ((25-1) \times 87.48)}$$
$$= \frac{392.78}{480.27 + 2099.59}$$
$$= 0.15$$
$$\omega_{Therapy} = \sqrt{0.15} = 0.39$$

This represents a medium to large effect. Therefore, the effect of a cattle prod compared to psychodyshamic therapy is a substantive finding.

For the effect of the covariate, the error mean squares is the same, but the effect is much bigger (MS_M is 4414.60 rounded to 2 decimal places). If we place this value in the equation, we get the following:

$$\omega^2_{Covariate} = \frac{4414.60 - 87.48}{4414.60 + ((25-1) \times 87.48)}$$
$$= \frac{4327.12}{4414.60 + 2099.59}$$
$$= 0.66$$
$$\omega_{Covariate} = \sqrt{0.66} = 0.82$$

This represents a very large effect (it is well above the threshold of 0.5, and is close to 1). Therefore, the relationship between initial stalking behaviour and the stalking behaviour after therapy is very strong indeed.

Interpreting and Writing the Result

The correct way to report the main finding would be:

- ✓ Levene's test was significant ($F(1, 48) = 7.19$, $p < .05$) indicating that the assumption of homogeneity of variance had been broken. The main effect of therapy was significant ($F(1, 47) = 5.49$, $p < .05$, $r = .39$) indicating that the time spent stalking was lower after using a cattle prod ($M = 55.30$, $SE = 1.87$) compared to after psychodyshamic therapy ($M = 61.50$, $SE = 1.87$).
- ✓ The covariate was also significant ($F(1, 47) = 50.46$, $p < .001$, $r = .82$) indicating that level of stalking before therapy had a significant effect on level of stalking after therapy (there was a positive relationship between these two variables)All significant values are reported at $p < .05$.There was a significant effect of teaching style on exam marks, $F(2, 27) = 21.01$, $\omega = .82$. Planned contrasts revealed that reward produced significantly better exam grades than punishment and indifference, $t(27) = -5.98$, $r = .75$, and that punishment produced significantly worse exam marks than indifference, $t(27) = -2.51$, $r = .43$.

Task 2

A marketing manager for a certain well-known drinks manufacturer was interested in the therapeutic benefit of certain soft drinks for curing hangovers. He took 15 people out on the town one night and got them drunk. The next morning as they awoke, dehydrated and feeling as though they'd licked a camel's sandy feet clean with their tongue, he gave 5 of them water to drink, 5 of them Lucozade (in case this isn't sold outside of the UK it's a very nice glucose-based drink), and the remaining five a leading brand of cola (this variable is called **drink**). He then measured how well they felt (on a scale from 0 = I feel like death to 10 = I feel really full of beans and healthy) two hours later (this variable is called **well**). He wanted to know which drink produced the greatest level of wellness. However, he realised it was important to control for how drunk the person got the night before, and so he's measured this on a scale of 0 = as sober as a nun to 10 = flapping about like a haddock out of water on the floor in a puddle of their own vomit. The data are in the file **HangoverCure.sav**.

SPSS Output

Tests of Between-Subjects Effects

Dependent Variable: How Well Does The Person Feel?

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2.133[a]	2	1.067	.821	.463
Intercept	459.267	1	459.267	353.282	.000
DRINK	2.133	2	1.067	.821	.463
Error	15.600	12	1.300		
Total	477.000	15			
Corrected Total	17.733	14			

a. R Squared = .120 (Adjusted R Squared = -.026)

This table shows the ANOVA table for these data when the covariate is not included. It is clear from the significance value that there are no differences in how well people feel when they have different drinks.

Levene's Test of Equality of Error Variances[a]

Dependent Variable: How Well Does The Person Feel?

F	df1	df2	Sig.
.220	2	12	.806

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept+DRUNK+DRINK

Tests of Between-Subjects Effects

Dependent Variable: How Well Does The Person Feel?

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	13.320[a]	3	4.440	11.068	.001
Intercept	14.264	1	14.264	35.556	.000
DRUNK	11.187	1	11.187	27.886	.000
DRINK	3.464	2	1.732	4.318	.041
Error	4.413	11	.401		
Total	477.000	15			
Corrected Total	17.733	14			

a. R Squared = .751 (Adjusted R Squared = .683)

These tables show the results of Levene's test and the ANOVA table when drunkenness the previous night is included in the model as a covariate. Levene's test is non-significant, indicating that the group variances are roughly equal (hence the assumption of homogeneity of variance has been met). It is clear that the covariate significantly predicts the dependent variable, so the drunkenness of the person influenced how well they felt the next day. What's more interesting is that when the effect of drunkenness is removed, the effect of drink becomes significant (p is 0.041 which is less than 0.05).

Parameter Estimates

Dependent Variable: How Well Does The Person Feel?

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	7.116	.377	18.861	.000	6.286	7.947
DRUNK	-.548	.104	-5.281	.000	-.777	-.320
[DRINK=1.00]	-.142	.420	-.338	.741	-1.065	.781
[DRINK=2.00]	.987	.442	2.233	.047	.014	1.960
[DRINK=3.00]	0[a]	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

The next table shows the parameter estimates selected in the *options* dialog box. These estimates are calculated using a regression analysis with **drink** split into two dummy coding variables. SPSS codes the two dummy variables such that the last category (the category coded with the highest value in the data editor—in this case the cola group) is the reference category. This reference category (labelled dose=3 in the output) is coded with a zero for both dummy variables. Dose=2, therefore, represents the difference between the group coded as 2 (Lucozade) and the reference category (cola), and dose=1 represents the difference between

the group coded as 1 (water) and the reference category (cola). The β values literally represent the differences between the means of these groups and so the significances of the *t*-tests tell us whether the group means differ significantly. Therefore, from these estimates we could conclude that the cola and water groups have similar means whereas the cola and Lucozade groups have significantly different means.

Contrast Results (K Matrix)

Drink Simple Contrast[a]			Dependent Variable: How Well Does The Person Feel?
Level 2 vs. Level 1	Contrast Estimate		1.129
	Hypothesized Value		0
	Difference (Estimate - Hypothesized)		1.129
	Std. Error		.405
	Sig.		.018
	95% Confidence Interval for Difference	Lower Bound	.237
		Upper Bound	2.021
Level 3 vs. Level 1	Contrast Estimate		.142
	Hypothesized Value		0
	Difference (Estimate - Hypothesized)		.142
	Std. Error		.420
	Sig.		.741
	95% Confidence Interval for Difference	Lower Bound	-.781
		Upper Bound	1.065

a. Reference category = 1

The next output shows the result of a contrast analysis that compares level 2 (Lucozade) against level 1 (water) as a first comparison, and level 3 (cola) against level 1 (water) as a second comparison. These results show that the Lucozade group felt significantly better than the water group (contrast 1), but that the cola group did not differ significantly from the water group (p = 0.741). These results are consistent with the regression parameter estimates (in fact, note that contrast 2 is identical to the regression parameters for dose=1 in the previous section).

Drink

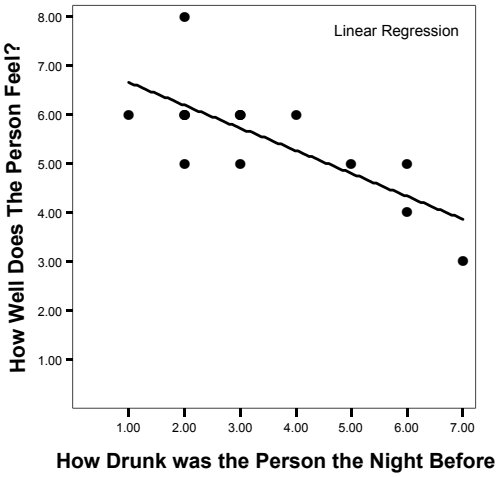
Dependent Variable: How Well Does The Person Feel?

Drink	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Water	5.110[a]	.284	4.485	5.735
Lucozade	6.239[a]	.295	5.589	6.888
Cola	5.252[a]	.302	4.588	5.916

a. Covariates appearing in the model are evaluated at the following values: How Drunk was the Person the Night Before = 4.6000.

This table gives the adjusted values of the group means and it is these values that should be used for interpretation. The adjusted means show that the significant ANCOVA reflects a difference between the water and the Lucozade group. The cola and water groups appear to have fairly similar adjusted means indicating that cola is no better than water at helping your hangover. These conclusions support what we know from the contrasts and regression parameters.

To look at the effect of the covariate we can examine a scatterplot:



This shows that the more drunk a person was the night before, the less well they felt the next day.

Calculating the Effect Size

We can calculate omega squared (ω^2) for the covariate:

$$\omega^2 = \frac{MS_M - MS_R}{MS_M + ((n-1) \times MS_R)}$$

$$\omega^2 = \frac{11.19 - 0.40}{11.19 + ((5-1) \times 0.40)}$$
$$= 0.84$$
$$= 0.92$$

We can also do the same for the main effect of drink:

$$\omega^2 = \frac{1.73 - 0.40}{1.73 + ((5-1) \times 0.40)}$$
$$= 0.40$$
$$= 0.63$$

We've got *t*-statistics for the comparisons between the cola and water group and the cola and Lucozade groups. These *t*-statistics have *N*–2 degrees of freedom, where *N* is the total sample size (in this case 15). Therefore we get:

$$r_{\text{Cola vs. Water}} = \sqrt{\frac{-0.338^2}{-0.338^2 + 13}}$$
$$= 0.09$$

$$r_{\text{Cola vs. Lucozade}} = \sqrt{\frac{2.233^2}{2.233^2 + 13}}$$
$$= 0.53$$

Interpreting and Writing the Result

We could report the main finding as:

- ✓ The covariate, drunkenness, was significantly related to the how ill the person felt the next day, $F(1, 11) = 27.89$, $p < .001$, $\omega^2 = .84$. There was also significant effect of the

type of drink on how well the person felt after controlling for how drunk they were the night before, $F(2, 11) = 4.32$, $p < 0.05$, $\omega^2 = .40$.

We can also report some contrasts:

- ✓ Planned contrasts revealed that having Lucozade significantly improved how well you felt compared to having cola, $t(13) = 2.23$, $p < .05$, $r = .53$, but having cola was no better than having water, $t(13) = -0.34$, *ns*, $r = .09$. We can conclude that cola and water have the same effects on hangovers but that Lucozade seems significantly better at curing hangovers than cola.