ANSWERS TO EXERCISES AND REVIEW QUESTIONS

PART FIVE: STATISTICAL TECHNIQUES TO COMPARE GROUPS

Before attempting these questions read through the introduction to Part Five and Chapters 16-21 of the *SPSS Survival Manual*.

T-tests

5.1 Using the data file survey.sav follow the instructions in Chapter 16 of the *SPSS Survival Manual* to find out if there is a statistically significant difference in the mean score for males and females on the Total Life Satisfaction Scale (tlifesat). Present this information in a brief report.

T-Test

		-			
	sex sex	N	Mean	Std. Deviation	Std. Error Mean
tlifesat total life satisfaction	MALES	185	21.67	6.525	.480
	FEMALES	251	22.90	6.911	.436

Group Statistics

		for Equ	e's Test uality of ances		t-test for Equality of Means							
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference				
tlifesat total life satisfaction	Equal variances assumed	.706	.401	-1.881	434	.061	-1.230	.654	-2.516	.055		
	Equal variances not assumed			-1.897	408.528	.059	-1.230	.648	-2.505	.044		

Independent Samples Test

An independent-samples t-test was conducted to compare total life satisfaction scores for males and females. There was no statistically significant difference between the two groups [t(434) = -1.88, p = .06].

5.2 Using the data file experim.sav apply whichever of the t-test procedures covered in Chapter 16 of the *SPSS Survival Manual* that you think are appropriate to answer the following questions.

(a) Who has the greatest fear of statistics at time 1, males or females?

Group Statistics

	sex	Ν	Mean	Std. Deviation	Std. Error Mean
fost1 fear of stats time1	male	15	41.20	5.685	1.468
	female	15	39.13	4.533	1.171

Independent Samples Test

		Equ	's Test for ality of jances	t-test for Equality of Means							
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference			
fost1 fear of stats time1	Equal variances assumed	2.087	.160	1.101	28	.280	2.067	1.877	-1.779	5.912	
	Equal variances not assumed			1.101	26.679	.281	2.067	1.877	-1.788	5.921	

An independent-samples t-test was conducted to compare fear of statistics scores for males and females. There was no statistically significant difference between the two groups [t(28) = 1.10, p=.28].

(b) Was the intervention effective in increasing students' confidence in their ability to cope with statistics? You will need to use the variables, confidence time1 (conf1) and confidence time2 (conf2). Write your results up in a report.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	confid1 confidence time1	19.00	30	5.369	.980
	confid2 confidence time2	21.87	30	5.594	1.021

Paired Samples Statistics

Paired Samples Test

			Pai	red Differen	ces				
			Std.	Std. Error	Interv	onfidence al of the erence			Sig.
		Mean	Deviation	Mean	Lower	Upper	t	df	(2-tailed)
Pair 1	confid1 confidence time1 - confid2 confidence time2	-2.867	4.754	.868	-4.642	-1.091	-3.303	29	.003

A paired-samples t-test was conducted to assess whether there was a change in students' confidence scores from time 1 (pre-intervention) to time 2 (post-intervention). There was a statistically significant difference between the two sets of scores [t(29) = -3.30, p = .003]. Mean scores increased from 19.0 (SD=5.37) at Time 1 to 21.87(SD=5.59) at Time 2.

(c) What impact did the intervention have on students' levels of depression?

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	depress1 depression time1	42.53	30	4.592	.838
	depress2 depression time2	40.73	30	5.521	1.008

Paired Samples Test

				Paired Dif	ferences				
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower Upper		t	t df	Sig. (2-tailed)
Pair 1	depress1 depression time1 - depress2 depression time2	1.800	2.497	.456	.868	2.732	3.949	29	.000

A paired-samples t-test was conducted to assess whether there was a change in students' depression scores from time 1 (pre-intervention) to time 2 (post-intervention). There was a statistically significant difference between the two sets of scores [t(29) = -3.95, p < .001]. Mean scores decreased from 42.53 (SD=4.59) at Time 1 to 40.73(SD=5.52) at Time 2.

One-way analysis of variance

For exercises 5.3 and 5.4 you will need to open the data file survey.sav.

5.3 Perform a one-way between-groups ANOVA to compare the levels of perceived stress (tpstress) for the five different age groups (agegp5), 18-24yrs, 25-32yrs, 33-40yrs, 41-49yrs and 50+yrs.

Descriptives

tpstress	total perceived	stress								
		Ν	Mean	Std. Deviation	Std. Error	95% Cor Interval f Lower Bound		Minimum	Maximum	Between- Componen t Variance
18-24		93	28.60	6.094	.632	27.35	29.86	12	46	
25-32		86	25.65	4.920	.531	24.60	26.71	14	39	
33-40		82	26.77	5.918	.654	25.47	28.07	13	40	
41-49		95	26.62	5.706	.585	25.46	27.78	12	42	
50+		77	25.75	6.178	.704	24.35	27.16	13	42	
Total		433	26.73	5.848	.281	26.18	27.28	12	46	
Model	Fixed Effects			5.774	.277	26.18	27.27			
	Random Effects				.539	25.23	28.22			1.062

.007 .005

Test of Homogeneity of Variances

tpstress total perceived stress									
Levene Statistic	df1	df2	Sig.						
1.340	4	428	.254						

ANOVA

tpstress total perceived stress										
		Sum of Squares	df	Mean Square	F	Sig.				
	Between Groups	500.761	4	125.190	3.755	.005				
	Within Groups	14271.082	428	33.344						
	Total	14771.843	432							

Robust Tests of Equality of Means

tpstress total perceived stress							
	Statistic ^a	df1	df2	Sig			
Welch	3.651	4	211.303				
Brown-Forsythe	3.744	4	411.700				

a. Asymptotically F distributed.



The results of the one way ANOVA indicate that there is a difference in the perceived stress levels amongst the age groups [F(4, 428)=3.76, p=.005]. Inspection of the means plot suggests that the younger age group (18 to 24yrs) has higher stress levels than the other age groups.

5.4 Perform post-hoc tests to compare the Self esteem scores for people across the three different age groups (use the agegp3 variable).

tslfest to	tal self esteem									
						95% Co Interval f				Between-
				Std.	Std.	Lower	Upper			Componen
		N	Mean	Deviation	Error	Bound	Bound	Minimum	Maximum	t Variance
18-29		149	32.60	5.589	.458	31.69	33.50	18	40	
30-44		152	33.59	5.288	.429	32.74	34.43	18	40	
45+		135	34.50	5.151	.443	33.63	35.38	20	40	
Total		436	33.53	5.395	.258	33.02	34.04	18	40	
Model	Fixed Effects			5.352	.256	33.03	34.04			
	Random Effects				.545	31.19	35.88			.692

Descriptives

tslfest total self esteem

			Subset for	alpha = .05
	agegp3 age 3 groups	Ν	1	2
Tukey HSD ^{a,b}	18-29	149	32.60	
	30-44	152	33.59	33.59
	45+	135		34.50
	Sig.		.259	.311
Tukey B ^{a,b}	18-29	149	32.60	
	30-44	152	33.59	33.59
	45+	135		34.50
	Sig.			

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 144.943.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Post-hoc comparisons using the Tukey Honestly Significant Difference test indicated that the mean score for Group 1 (M=32.6, SD=5.59) was significantly different from Group 3 (M=34.5, SD=5.15). Group 2 (M=33.59, SD=5.29) did not differ significantly from either Group 1 or 3.

For the following exercise you will need to open the data file experim.sav.

5.5 Use one-way repeated measures ANOVA to compare the Fear of Statistics scores for the three time periods (time1, time2 and time3). Inspect the means plots and describe the impact of the intervention and the subsequent follow-up three months later.

General Linear Model

Within-Subjects Factors



time	Dependent Variable
1	fost1
2	fost2
3	fost3

Descriptive Statistics

	Mean	Std. Deviation	Ν
fost1 fear of stats time1	40.17	5.160	30
fost2 fear of stats time2	37.50	5.151	30
fost3 fear of stats time3	35.23	6.015	30

Multivariate Tests b

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
time	Pillai's Trace	.635	24.356 ^a	2.000	28.000	.000	.635
	Wilks' Lambda	.365	24.356 ^a	2.000	28.000	.000	.635
	Hotelling's Trace	1.740	24.356 ^a	2.000	28.000	.000	.635
	Roy's Largest Root	1.740	24.356 ^a	2.000	28.000	.000	.635

a. Exact statistic

b.

Design: Intercept

Within Subjects Design: time

Mauchly's Test of Sphericity ^b

Measure: MEASURE_1

						Epsilon ^a	
		Approx.			Greenhouse-		
Within Subjects Effect	Mauchly's W	Chi-Square	df	Sig.	Geisser	Huynh-Feldt	Lower-bound
time	.342	30.071	2	.000	.603	.615	.500

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: time

Tests of Within-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
time	Sphericity Assumed	365.867	2	182.933	41.424	.000	.588
	Greenhouse-Geisser	365.867	1.206	303.368	41.424	.000	.588
	Huynh-Feldt	365.867	1.230	297.506	41.424	.000	.588
	Lower-bound	365.867	1.000	365.867	41.424	.000	.588
Error(time)	Sphericity Assumed	256.133	58	4.416			
	Greenhouse-Geisser	256.133	34.974	7.323			
	Huynh-Feldt	256.133	35.664	7.182			
	Lower-bound	256.133	29.000	8.832			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	time	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
time	Linear	365.067	1	365.067	46.652	.000	.617
	Quadratic	.800	1	.800	.795	.380	.027
Error(time)	Linear	226.933	29	7.825			
	Quadratic	29.200	29	1.007			

Tests of Between-Subjects Effects

Measure: MEASURE_1 Transformed Variable: Average

		0				
	Type III Sum					Partial Eta
Source	of Squares	df	Mean Square	F	Sig.	Squared
Intercept	127464.100	1	127464.100	1583.134	.000	.982
Error	2334.900	29	80.514			

Estimated Marginal Means of MEASURE_1



A one way repeated measures ANOVA was conducted to compare scores on the Fear of Statistics Test scores at Time 1(prior to the intervention), Time 2 (following the intervention) and Time 3 (three month follow-up). There was a significant effect for time [Wilks' Lambda= .365, F(2,28)=24.36, p<.0005, multivariate partial eta squared=.64. Inspection of the plot of mean values indicate a steady decrease in fear scores following the intervention, and at the three month follow-up.

Two-way between-groups ANOVA

5.6 For this exercise you will need to open the data file survey.sav. Follow the instructions in Chapter 18 of the *SPSS Survival Manual* to conduct a two-way ANOVA to explore the impact of sex and age group on levels of perceived stress. The three variables you will need are sex, agegp5 and tpstress.

(a) Interpret the results. Is there a significant interaction effect? Are the two main effects significant?

	Between-Subjects Factors						
		Value Label	Ν				
sex sex	1	MALES	184				
	2	FEMALES	249				
agegp5	1	18-24	93				
age 5	2	25-32	86				
groups	3	33-40	82				
	4	41-49	95				
	5	50+	77				

Univariate Analysis of Variance

Descriptive Statistics

Dependent Variable: tpstress total perceived stress

sex sex	agegp5 age 5 groups	Mean	Std. Deviation	N
MALES	18-24	28.18	5.619	39
	25-32	25.26	4.774	38
	33-40	25.50	5.177	38
	41-49	25.06	4.802	35
	50+	24.71	6.157	34
	Total	25.79	5.414	184
FEMALES	18-24	28.91	6.449	54
	25-32	25.96	5.061	48
	33-40	27.86	6.345	44
	41-49	27.53	6.024	60
	50+	26.58	6.138	43
	Total	27.42	6.066	249
Total	18-24	28.60	6.094	93
	25-32	25.65	4.920	86
	33-40	26.77	5.918	82
	41-49	26.62	5.706	95
	50+	25.75	6.178	77
	Total	26.73	5.848	433

Levene's Test of Equality of Error Variances ^a

Dependent Variable: tpstress total perceived stress

F	df1	df2	Sig.			
1.026	9	423	.418			
- · · · · · · · · · · · · · · · · · · ·						

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

a. Design: Intercept+sex+agegp5+sex * agegp5

Tests of Between-Subjects Effects

Dependent Variable	Dependent Variable: tpstress total perceived stress											
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared						
		-		-	, i i i i i i i i i i i i i i i i i i i							
Corrected Model	839.252 ^a	9	93.250	2.831	.003	.057						
Intercept	295968.489	1	295968.489	8985.743	.000	.955						
sex	277.994	1	277.994	8.440	.004	.020						
agegp5	503.367	4	125.842	3.821	.005	.035						
sex * agegp5	64.874	4	16.219	.492	.741	.005						
Error	13932.591	423	32.938									
Total	324089.000	433										
Corrected Total	14771.843	432										

a. R Squared = .057 (Adjusted R Squared = .037)

Post Hoc Tests agegp5 age 5 groups

Multiple Comparisons

Dependent Variable: tpstress total perceived stress

Tukey HSD

		Mean			95% Confidence Interval	
(I) age 5 groups	(J) age 5 groups	Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
18-24	18-24			-		
	25-32	2.95*	.859	.006	.60	5.30
	33-40	1.83	.869	.218	55	4.22
	41-49	1.98	.837	.127	31	4.27
	50+	2.85*	.884	.012	.43	5.27
25-32	18-24	-2.95*	.859	.006	-5.30	60
	25-32					
	33-40	-1.12	.886	.715	-3.54	1.31
	41-49	97	.854	.788	-3.31	1.37
	50+	10	.900	1.000	-2.57	2.36
33-40	18-24	-1.83	.869	.218	-4.22	.55
	25-32	1.12	.886	.715	-1.31	3.54
	33-40					
	41-49	.15	.865	1.000	-2.22	2.52
	50+	1.02	.911	.799	-1.48	3.51
41-49	18-24	-1.98	.837	.127	-4.27	.31
	25-32	.97	.854	.788	-1.37	3.31
	33-40	15	.865	1.000	-2.52	2.22
	41-49					
	50+	.87	.880	.862	-1.54	3.28
50+	18-24	-2.85*	.884	.012	-5.27	43
	25-32	.10	.900	1.000	-2.36	2.57
	33-40	-1.02	.911	.799	-3.51	1.48
	41-49	87	.880	.862	-3.28	1.54
	50+					

Based on observed means.

 $^{\star \cdot}$ The mean difference is significant at the .05 level.

Homogeneous Subsets

tpstress total perceived stress

Tukey HSD a,b,c

		Subset		
age 5 groups	N	1	2	
25-32	86	25.65		
50+	77	25.75		
41-49	95	26.62	26.62	
33-40	82	26.77	26.77	
18-24	93		28.60	
Sig.		.706	.159	

Means for groups in homogeneous subsets are displayed. Based on Type III Sum of Squares

The error term is Mean Square(Error) = 32.938.

- a. Uses Harmonic Mean Sample Size = 86.075.
- b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

^{C.} Alpha = .05.



Estimated Marginal Means of total perceived stress

The interaction effect (sex*agep5) did not reach statistical significance[F(4, 423)=.492, p=.741), however there was a significant main effect for sex [F(1,423)=8.44,p=.004) and age group [F(4,423)=3.82, p=.005). Inspection of the mean scores and the plot suggest that overall males have lower levels of perceived stress at all age levels. Overall younger people (18 to 24 yrs) reported higher levels of stress than the other age groups. The results of this analysis shows that although the means plot suggests the possibility of an interaction between age and gender, it did not reach statistical significance.

(b) Write up this analysis and the results in a report. (Don't forget to report the means and standard deviations for each group.)

A two-way between groups analysis of variance was conducted to explore the impact of sex and age on levels of perceived stress, as measured by the Perceived Stress Scale. Subjects were divided into five groups according to their age (Group 1: 18 to 24years; Group 2: 25 to 32yrs; Group 3: 33 to 40yrs; Group 4: 41 to 49yrs; Group 5: 50yrs and above). There was no significant interaction effect between age and sex [F(4,423)=.49, p=.74]. The main effect for both sex [F(1,423)=8.44, p=.004, partial eta squared=.02] and age [F(4,423)=3.82, p=.005, partial eta squared=.035] was statistically significant. Post hoc tests using Tukey's Honestly Significance Difference test revealed that the 18 to 24yr age group differed significantly from the 25 to 32yr age group and the 50+ age group. All other group comparisons did not reach statistical significance. Table XX below shows the mean scores for males and females for each of the age groups.

Table XX

		Males		Females			
	п	Mean	SD	п	Mean	SD	
18-24yrs	39	28.18	5.62	54	28.91	6.45	
25-32yrs	38	25.26	4.77	48	25.96	5.06	
33-40yrs	38	25.50	5.18	44	27.86	6.35	
41-49yrs	35	25.06	6.16	60	27.53	6.02	
50+	34	24.70	6.16	43	26.58	6.14	

Mean and Standard Deviations for Males and Females across Age Groups

Mixed between-within subjects analysis of variance

5.7 In Chapter 19 of the *SPSS Survival Manual* we explored the impact of two different intervention programs (maths skills/confidence building) on participants' fear of statistics. We found that both interventions were equally effective in reducing participants' fear—that is, we found no differences between groups—but a significant difference across the three time periods. Repeat these analyses, but this time use confidence scores as the dependent variable.

Open the file experim.sav. You will need to use the following variables: group, conf1, conf2 and conf3.

General Linear Model

Within-Subjects Factors

Measure: MEASURE_1

time	Dependent Variable	
1	confid1	
2	confid2	
3	confid3	

Between-Subjects Factors

		Value Label	N
group type	1	maths skills	15
of class	2	confidence building	15

Descriptive Statistics

î				
	group type of class	Mean	Std. Deviation	Ν
confid1 confidence time1	maths skills	18.87	5.527	15
	confidence building	19.13	5.397	15
	Total	19.00	5.369	30
confid2 confidence time2	maths skills	20.00	4.660	15
	confidence building	23.73	5.970	15
	Total	21.87	5.594	30
confid3 confidence time3	maths skills	24.07	4.543	15
	confidence building	26.00	5.782	15
	Total	25.03	5.203	30

Box's Test of Equality of Covariance Matrices ^a

Box's M	8.522	
F	1.254	
df1	6	
df2	5680.302	
Sig.	.275	

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups. a.

Design: Intercept+group

Within Subjects Design: time

Multivariate Tests b

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
time	Pillai's Trace	.752	40.897 ^a	2.000	27.000	.000	.752
	Wilks' Lambda	.248	40.897 ^a	2.000	27.000	.000	.752
	Hotelling's Trace	3.029	40.897 ^a	2.000	27.000	.000	.752
	Roy's Largest Root	3.029	40.897 ^a	2.000	27.000	.000	.752
time * group	Pillai's Trace	.207	3.534 ^a	2.000	27.000	.043	.207
	Wilks' Lambda	.793	3.534 ^a	2.000	27.000	.043	.207
	Hotelling's Trace	.262	3.534 ^a	2.000	27.000	.043	.207
	Roy's Largest Root	.262	3.534 ^a	2.000	27.000	.043	.207

a. Exact statistic

b.

Design: Intercept+group Within Subjects Design: time

in oubjects Design. time

Mauchly's Test of Sphericity ^b

Measure: MEASURE_1

						Epsilon ^a	
Within		Approx.			Greenhouse-	Huynh-	
Subjects Effect	Mauchly's W	Chi-Square	df	Sig.	Geisser	Feldt	Lower-bound
time	.573	15.059	2	.001	.701	.753	.500

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+group Within Subjects Design: time

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
time	Sphericity Assumed	546.467	2	273.233	35.383	.000	.558
	Greenhouse-Geisser	546.467	1.401	390.038	35.383	.000	.558
	Huynh-Feldt	546.467	1.505	363.097	35.383	.000	.558
	Lower-bound	546.467	1.000	546.467	35.383	.000	.558
time * group	Sphericity Assumed	45.089	2	22.544	2.919	.062	.094
	Greenhouse-Geisser	45.089	1.401	32.182	2.919	.082	.094
	Huynh-Feldt	45.089	1.505	29.959	2.919	.079	.094
	Lower-bound	45.089	1.000	45.089	2.919	.099	.094
Error(time)	Sphericity Assumed	432.444	56	7.722			
	Greenhouse-Geisser	432.444	39.230	11.023			
	Huynh-Feldt	432.444	42.140	10.262			
	Lower-bound	432.444	28.000	15.444			

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

		Type III Sum					Partial Eta
Source	time	of Squares	df	Mean Square	F	Sig.	Squared
time	Linear	546.017	1	546.017	52.526	.000	.652
	Quadratic	.450	1	.450	.089	.767	.003
time * group	Linear	10.417	1	10.417	1.002	.325	.035
	Quadratic	34.672	1	34.672	6.867	.014	.197
Error(time)	Linear	291.067	28	10.395			
	Quadratic	141.378	28	5.049			

Levene's Test of Equality of Error Variances ^a

	F	df1	df2	Sig.
confid1 confidence time1	.000	1	28	.986
confid2 confidence time2	1.718	1	28	.201
confid3 confidence time3	.873	1	28	.358

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

a.

Design: Intercept+group Within Subjects Design: time

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	43428.100	1	43428.100	619.488	.000	.957
group	88.011	1	88.011	1.255	.272	.043
Error	1962.889	28	70.103			



Estimated Marginal Means of MEASURE_1

(a) Is there a significant interaction effect between type of intervention (group) and time?

The interaction between type of intervention and time is significant (p=.043). An inspection of the plot suggests that the confidence building group showed greater improvement in confidence levels following the intervention than the maths skills group.

(b) Is there a significant main effect for the within-subjects independent variable, time?

The interaction effect for group by time is significant, therefore it is not really appropriate to interpret the main effect. The impact of one variable (eg. Time) is dependent on the level of the other variable (group).

(c) Is there a significant main effect for the between-subjects independent variable, group (maths skills/confidence building)?

The interaction effect for group by time is significant, therefore it is not appropriate to interpret the main effect. The impact of one variable (eg. Time) is dependent on the level of the other variable (group).

Multivariate analysis of variance

5.8 How does MANOVA differ from ANOVA?

Multivariate analysis of variance is an extension of analysis of variance for use when there is more than one dependent variable.

5.9 In Chapter 20 of the *SPSS Survival Manual* it is recommended that you check the Mahalonobis distances before proceeding with MANOVA. What does this allow you to check for?

Mahalonobis distances is a test of multivariate normality.

5.10 Which assumption is Box's M Test used to assess?

Box's M Test is used to assess the homogeneity of variance-covariance matrices.

5.11 Follow the procedure detailed in Chapter 20 of the *SPSS Survival Manual* to perform a MANOVA to explore positive and negative affect scores for the three age groups (18-29yrs, 30-44yrs, 45+yrs). The three variables you will need are tposaff, tnegaff, agegp3. Remember to check your assumptions.

General Linear Model

Between-Subjects Factors

		Value Label	N
agegp3 age	1	18-29	147
3 groups	2	30-44	153
	3	45+	135

	agegp3 age 3 groups	Mean	Std. Deviation	Ν
tposaff total positive affect	18-29	33.33	7.409	147
	30-44	33.59	7.316	153
	45+	34.13	7.017	135
	Total	33.67	7.247	435
tnegaff total negative affect	18-29	20.65	7.346	147
	30-44	19.37	6.616	153
	45+	18.09	7.076	135
	Total	19.40	7.072	435

Descriptive Statistics

Box's Test of Equality of Covariance Matrices ^a

Box's M	2.703
F	.448
df1	6
df2	4335850.466
Sig.	.847

Tests the null hypothesis that the observed covariance

matrices of the dependent variables are equal across groups.

a. Design: Intercept+agegp3

Multivariate Tests ^c

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	.976	8661.453 ^a	2.000	431.000	.000	.976
	Wilks' Lambda	.024	8661.453 ^a	2.000	431.000	.000	.976
	Hotelling's Trace	40.192	8661.453 ^a	2.000	431.000	.000	.976
	Roy's Largest Root	40.192	8661.453 ^a	2.000	431.000	.000	.976
agegp3	Pillai's Trace	.021	2.340	4.000	864.000	.054	.011
	Wilks' Lambda	.979	2.347 ^a	4.000	862.000	.053	.011
	Hotelling's Trace	.022	2.354	4.000	860.000	.052	.011
	Roy's Largest Root	.022	4.709 ^b	2.000	432.000	.009	.021

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

C. Design: Intercept+agegp3

Levene's Test of Equality of Error Variances ^a

	F	df1	df2	Sig.
tposaff total positive affect	.350	2	432	.705
tnegaff total negative affect	.970	2	432	.380

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

a. Design: Intercept+agegp3

Tests of Between-Subjects Effects

0	Devendent Mariable	Type III Sum	-16	Maran Ormana	F	0 in	Partial Eta
Source	Dependent Variable	of Squares	df	Mean Square	F	Sig.	Squared
Corrected Model	tposaff total positive affect	47.346 ^a	2	23.673	.450	.638	.002
	tnegaff total negative affect	463.048 ^b	2	231.524	4.709	.009	.021
Intercept	tposaff total positive affect	492175.882	1	492175.882	9347.172	.000	.956
	tnegaff total negative affect	162755.374	1	162755.374	3310.007	.000	.885
agegp3	tposaff total positive affect	47.346	2	23.673	.450	.638	.002
	tnegaff total negative affect	463.048	2	231.524	4.709	.009	.021
Error	tposaff total positive affect	22746.985	432	52.655			
	tnegaff total negative affect	21241.743	432	49.171			
Total	tposaff total positive affect	515910.000	435				
	tnegaff total negative affect	185499.000	435				
Corrected Total	tposaff total positive affect	22794.331	434				
	tnegaff total negative affect	21704.791	434				

a. R Squared = .002 (Adjusted R Squared = -.003)

b. R Squared = .021 (Adjusted R Squared = .017)

Estimated Marginal Means of total positive affect



Estimated Marginal Means of total negative affect



The results of Box's test of equality of covariance matrices indicate no violation of the assumption (p=.85)

The results of Levene's test of equality of error variances indicate that we have not violated the assumption for either of our dependent variables (p=.71, p=.38).

Inspection of the results shown in Multivariate tests indicate a significant result overall [Wilks' Lambda=.98, F(4, 862)=2.35, p=.05].

The Tests of Between Subjects Effects table indicates a significant result for Total Negative Affect [F(2,432)=4.71, p=.009, partial eta squared=.02], but not for Total Positive Affect [F(2,432)=.45, p=.64, partial eta squared=.002]. Inspection of the mean scores for each age group indicates a steady decrease in levels of negative affect across the three age groups (18-29yrs mean=20.65, SD=7.35; 30-44yrs mean=19.37, SD=6.62; 45+yrs mean=18.09, SD=7.07).

Analysis of covariance

5.12 Under what circumstances would you want to consider using analysis of covariance?

Analysis of covariance is used when you wish to compare groups, while controlling for additional variables that you suspect might be influencing scores on the dependent variable.

5.13 What issues do you need to consider when you are selecting possible covariates?

Covariates need to be chosen with a good understanding of background theory and previous research in your research area. The covariates need to be continuous variables, measured reliably and correlate significantly with the dependent variable. The covariate must be measured before the treatment or experimental manipulation is conducted.

5.14 Using the experim.sav data file, perform the appropriate analyses (including assumption testing) to compare the confidence scores for the two groups (maths skills, confidence building) at time 2, while controlling for confidence scores at time 1. The variables you will need are group, conf1, conf2.

Univariate Analysis of Variance

Between-Sub	iects	Factors
Detween-Oub	jeeta	1 401013

		Value Label	N
group type	1	maths skills	15
of class	2	confidence building	15

	Type III Sum				
Source	of Squares	df	Mean Square	F	Sig.
Corrected Model	466.737 ^a	3	155.579	9.178	.000
Intercept	196.989	1	196.989	11.621	.002
group	2.067	1	2.067	.122	.730
confid1	348.104	1	348.104	20.536	.000
group * confid1	17.644	1	17.644	1.041	.317
Error	440.730	26	16.951		
Total	15252.000	30			
Corrected Total	907.467	29			

a. R Squared = .514 (Adjusted R Squared = .458)

The above output is used to assess the assumption of homogeneity of regression slopes. The interaction term (group*confid1) is not significant (p=.317), therefore we have not violated the assumption and can then proceed with the ANCOVA analysis.

Univariate Analysis of Variance

Between-Subjects Factors

		Value Label	Ν
group type	1	maths skills	15
of class	2	confidence building	15

Descriptive Statistics

Dependent Variable: confid2 confidence time2

group type of class	Mean	Std. Deviation	Ν
maths skills	20.00	4.660	15
confidence building	23.73	5.970	15
Total	21.87	5.594	30

Levene's Test of Equality of Error Variances ^a

Dependent Variable: confid2 confidence time2					
F df1 df2 Sig.					
.136	1	28	.715		

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

a. Design: Intercept+confid1+group

Tests of Between-Subjects Effects

Dependent Variable: confid2 confidence time2

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	449.093 ^a	2	224.546	13.227	.000	.495
Intercept	200.700	1	200.700	11.822	.002	.305
confid1	344.560	1	344.560	20.296	.000	.429
group	95.102	1	95.102	5.602	.025	.172
Error	458.374	27	16.977			
Total	15252.000	30				
Corrected Total	907.467	29				

a. R Squared = .495 (Adjusted R Squared = .457)

Estimated Marginal Means

type of class

Dependent Variable: confid2 confidence time2

			95% Confidence Interval	
type of class	Mean	Std. Error	Lower Bound	Upper Bound
maths skills	20.086 ^a	1.064	17.902	22.269
confidence building	23.648 ^a	1.064	21.465	25.831

 Covariates appearing in the model are evaluated at the following values: confid1 confidence time1 = 19.00. Inspection of the table 'Levene's Test of Equality of Error Variances' indicate we have not violated the assumption concerning the equality of variances (p=.715).

The Tests of Between-Subjects Effects table results indicate a significant effect for group (p=.025). There is a significant difference in confidence scores for the confidence building and maths skills groups, after controlling for confidence scores administered prior to the treatment program.

5.15 Perform a two-way analysis of covariance to explore the question: Does gender influence the effectiveness of the two intervention programs designed to increase participants' confidence in being able to cope with statistics training? You will need to assess the impact of sex and type of intervention (group) on confidence at time 2, controlling for confidence scores at time 1.

Univariate Analysis of Variance

Between-Subjects Factors

		Value Label	N
group type	1	maths skills	15
of class	2	confidence building	15
sex	1	male	15
	2	female	15

Descriptive Statistics

Dependent Variable: confid2 confidence time2

group type of class	sex	Mean	Std. Deviation	Ν
maths skills	male	22.25	4.301	8
	female	17.43	3.823	7
	Total	20.00	4.660	15
confidence building	male	21.29	5.880	7
	female	25.88	5.515	8
	Total	23.73	5.970	15
Total	male	21.80	4.931	15
	female	21.93	6.364	15
	Total	21.87	5.594	30

Levene's Test of Equality of Error Variances a

Dependent Variable: confid2 confidence time2

F	df1	df2	Sig.
2.277	3	26	.103

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

a. Design: Intercept+confid1+group+sex+group * sex

Tests of Between-Subjects Effects

	Type III Sum					Partial Eta
Source	of Squares	df	Mean Square	F	Sig.	Squared
Corrected Model	826.891 ^a	4	206.723	64.139	.000	.911
Intercept	55.142	1	55.142	17.109	.000	.406
confid1	556.942	1	556.942	172.800	.000	.874
group	92.813	1	92.813	28.797	.000	.535
sex	.815	1	.815	.253	.620	.010
group * sex	377.226	1	377.226	117.040	.000	.824
Error	80.576	25	3.223			
Total	15252.000	30				
Corrected Total	907.467	29				

a. R Squared = .911 (Adjusted R Squared = .897)

Estimated Marginal Means

1. type of class

Dependent Variable: confid2 confidence time2

			95% Confidence Interval	
type of class	Mean	Std. Error	Lower Bound	Upper Bound
maths skills	19.855 ^a	.465	18.898	20.811
confidence building	23.381 ^a	.465	22.424	24.339

 Covariates appearing in the model are evaluated at the following values: confid1 confidence time1 = 19.00.

2. sex

Dependent Variable: confid2 confidence time2

			95% Confidence Interval		
sex	Mean	Std. Error	Lower Bound	Upper Bound	
male	21.783 ^a	.465	20.826	22.740	
female	21.453 ^a	.465	20.495	22.410	

 Covariates appearing in the model are evaluated at the following values: confid1 confidence time1 = 19.00.

3. type of class * sex

Dependent Variable: confid2 confidence time2

				95% Confidence Interval	
type of class	sex	Mean	Std. Error	Lower Bound	Upper Bound
maths skills	male	23.750 ^a	.645	22.422	25.078
	female	15.959 ^a	.688	14.543	17.375
confidence building	male	19.816 ^a	.688	18.400	21.232
	female	26.947 ^a	.640	25.629	28.265

 Covariates appearing in the model are evaluated at the following values: confid1 confidence time1 = 19.00. **Estimated Marginal Means of confidence time2**



An inspection of the plot of mean scores suggests the possibility of an interaction between gender and type of intervention in terms of confidence scores. Females in the Confidence building group showed higher confidence scores at Time 2, than those who received the Maths skills intervention. Males however who participated in the Maths skills intervention showed higher mean scores than those who were in the Confidence Building group. This is supported by the results in the Tests of Between Subjects Effects table. The group*sex interaction term is statistically significant [F(1,25)=117.04, p<.0005].

Non-parametric statistics

5.16 What is the difference between parametric techniques and non-parametric techniques?

The parametric tests (eg. T-tests, ANOVA) make assumptions about the population the sample has been drawn from. Non-parametric techniques do not have such stringent requirements and do not make assumptions about the underlying population distribution.

5.17 What factors would you consider when choosing whether to use a parametric or a non-parametric technique?

You need to consider the levels of measurement of your data. If you have nominal or ordinal scaled data you should use a suitable non-parametric, rather than parametric technique.

5.18 For each of the following parametric techniques indicate the non-parametric alternative (if one exists).

(a) one-way between-groups ANOVA
(b) Pearson's product-moment correlation
(c) independent samples t-test
(d) multivariate analysis of variance
(e) one-way repeated measures ANOVA
(f) paired samples t-test
(g) partial correlation

Kruskal-Wallis Test Spearman Rank Order Correlation Mann-Whitney Test No equivalent Friedman Test Wilcoxon Signed Rank Test No equivalent

5.19 Choose and perform the appropriate *non-parametric* test to address each of the following research questions.

(a) Using the survey.sav data file find out whether smokers are significantly more stressed than non-smokers. The variables you will need are smoke and total perceived stress (tpstress).

Mann-Whitney Test

(b) Using the survey.sav data file compare the self-esteem scores across the three different age groups (18-29yrs, 30-44yrs, 45+yrs). The variables you will need are tslfest and agegp3.

Kruskal-Wallis Test.

(c) Using the survey.sav data file explore the relationship between optimism and negative affect. The variables you will need are toptim and tnegaff.

Spearman Rank Order Correlation

(d) Using the survey.sav data file explore the association between education level and smoking. The variables you will need are educ2 and smoke. Check the codebook and the questionnaire in the appendix of the *SPSS Survival Manual* for details on these two variables.

Chi square test for independence

(e) Using the experim.sav data file compare the depression scores at time 1 and the depression scores at time 2. Did the intervention result in a significant change in depression scores? The variables you will need are depress1 and depress2.

Wilcoxon Signed Rank Test

(f) Using the experim.sav data file compare the depression scores for the three time periods involved in the study (before the intervention, after the intervention and at the three-month follow up). The variables you will need are depress1, depress2 and depress3.

Friedman Test