Overview of ANOVA and ANCOVA

Aims and Objectives

Over the past 2-3 months we have looked at various different experimental designs and their corresponding analyses of variance. This has been a lot to take in, and in your exam, your research projects next year, and if you conduct research at any other point, you will need to be able to identify the correct analysis for your data. For many types of research (especially experiments) some form of ANOVA or ANCOVA will be used. The purpose of this session is

- ✓ To practice deciding which ANOVA or ANCOVA analysis needs to be done for a specific set of data.
- ✓ To practice analysing real data from published research papers.
- ✓ To revise the key concepts in ANOVA and ANCOVA from the past 2-3 months.
- ✓ To practice interpreting the SPSS output from ANOVA and ANCOVA

During the session you can work alone or in small groups to analyse each of the problems, your tutors will then go through some of the answers.

Task 1

A researcher was interested in the effects on people's mental health of participating in Big brother. The researcher hypothesised that that they start off with personality disorders that are exacerbated by being forced to live with people as attention-seeking as themselves☺ To test this hypothesis, she gave 8 contestants a questionnaire measuring personality disorders before they entered the house, and again when they left the house. A second group of 8 people acted as a waiting list control. These were people short-listed to go into the house, but who never actually made it. They too were given the questionnaire at the same points in time as the contestants. The data are below.

Group	Personality Disorder Time 1	Personality Disorder Time 2
BB Contestants	65	50
	74	47
	60	52
	63	57
	66	51
	84	82
	49	47
	63	72
Waiting list	35	63
	61	74
	92	107
	47	41
	72	84
	71	103
	46	53
	77	59

- ✓ Enter the data into SPSS.
- ✓ Save the data onto a disk in a file called **BigBrother.sav**
- ✓ Draw an error-bar chart (or charts) of the data.
- ✓ Carry out the appropriate analysis to test the hypotheses that big brother contestants start off with personality disorders that are exacerbated by being forced to live with people as attention-seeking as themselves.

What are the independent and dependent variables?

Your Answer:

What analysis have you carried out? [I.e. an *A* (IV1: level 1, level 2 etc.) × *B* (IV2: level 1, level 2, etc.) × etc. independent/repeated measures/mixed ANOVA/ANCOVA].

Your Answer:

Have the assumptions of this analysis been met? (Report relevant statistics in APA format).

Your Answer:

Write a short results section (in APA format) based on this analysis? Have the hypotheses been confirmed.

Your Answer:

Task 2

- ✓ Using the same data as in the previous task, think of an alternative way to analyse these data! (Yes, there are two perfectly reasonable ways to analyse this data set and I'm doing this to demonstrate that contrary to popular belief there isn't one, and only one, 'correct' way to analyse a set of data!).
- ✓ Use the questions from the previous task as a guide to what's required for the answer of this question too.

Real Research Example: Graham Davey

This example contains data from:

Davey, G. C. L., Startup, H. M, Zara, A., MacDonald, C. B., & Field, A. P. (2003). Perseveration of checking thoughts and mood-as-input hypothesis. *Journal of Behavior Therapy & Experimental Psychiatry*, *34*, 141–160.

[Available from the course bulletin board].

Davey, Startup, Zara, MacDonald & Field (2003) looked at the processes underlying Obsessive Compulsive Disorder by inducing a negative, positive or no mood in different people and then asking them to imagine they were going on holiday and to generate as many things as they could that they should check before they went away. Within each mood group, half of the participants were instructed to generate as many items as they could (known as an 'As many as can' stop rule), whereas the remainder were asked to generate items for as long as they felt like continuing the task (known as a 'feel like continuing' stop rule). The data are below.

Negative Mood		Positive Mood		Neutral Mood	
As Many As Can	Feel Like Continuing	As Many As Can	Feel Like Continuing	As Many As Can	Feel Like Continuing
7	3	9	13	8	7
5	8	12	31	5	5
16	8	7	11	11	14
13	5	3	8	9	19
13	9	10	11	11	5
24	14	4	25	10	11
20	9	5	19	11	14
10	15	4	8	10	10
11	7	7	14	7	6
7	14	9	8	5	8

- ✓ Enter these data into SPSS and save them in a file called **Davey2003.sav**
- ✓ Davey et al. hypothesised that people in negative moods, using an as many as can stop rule would generate more items than those using a feel like continuing stop rule. Conversely, people in a positive mood would generate more items when using a feel like continuing stop rule

compared to an as many as can stop rule. Finally, in neutral moods, the stop rule used shouldn't affect the number of items generated.

- ✓ Conduct the appropriate analysis to test Davey et al.'s hypotheses.
- ✓ Use the questions from task 1 as a guide for how to answer this question.
- ✓ If you want to check your answers then consult section 3.2 (pages 148-149) of Davey, et al. (2003).

Real Research Example: Dan Wright

This example contains data from:

Wright, D. B., Mathews, S. A., & Skagerberg, E. M. (2005) Social recognition memory: The effect of other people's responses for previously seen and unseen items. *Journal of Experimental Psychology: Applied, 11*, 200-209.

[Available from http://www.sussex.ac.uk/Users/danw/pdf/socrec2005.pdf].

Wright, Mathews & Skagerberg (2005), Experiment 1, conducted a study in which 24 participants were shown 28 words: there were approximately equal numbers of high frequency words, low frequency words and nonwords. After a filler task, a confederate was introduced to the participant, and both the confederate and the participant were presented with 60 words (some of which they had seen before and some of which they hadn't) and were asked to say whether or not they had seen the word in the first part of the experiment. The confederate always responded first and deliberately gave an incorrect response on about 30% of occasions (e.g. saying they had seen a word that was not in fact presented earlier in the experiment). Wright et al. were interested in whether the confederate's responses affected the participants' responses to 'old' (items from the original 28 word list) and 'new' (items not from the original list) words. To do this, the calculated a metric known as *d'*, which, in this case, is a measure of the effect of the confederate (you don't need to worry about what exactly *d'* is, although if you're interested Dan explains it on his web pages http://www.sussex.ac.uk/Users/danw/ESM/work2dansdt.htm). The data are below.

High Frequency Words		Low Frequency Words		Non-Words	
Old Word	New Word	Old Word	New Word	Old Word	New Word
1.85	2.17	1.85	2.62	2.68	1.32
1.85	1.12	1.93	1.11	-.26	-.17
2.04	1.41	.97	2.62	1.21	1.85
1.64	.89	1.56	1.15	-.57	1.21
1.31	.49	.28	-.36	.99	.16
2.68	1.41	1.93	.32	.38	-.57
1.85	2.17	2.68	1.11	.38	.94
2.68	1.41	1.59	2.62	2.04	1.21
2.68	.89	-.38	2.62	-.26	.99
1.64	1.01	1.93	1.52	1.21	.81
1.85	.68	.97	.47	2.04	1.85
1.21	.49	-.38	.68	1.22	.16

1.64	2.06	2.04	1.78	2.04	.27
1.22	1.44	2.68	2.62	1.85	.37
2.68	2.06	1.85	2.62	1.21	.89
.57	2.17	1.85	1.11	2.04	.27
1.85	1.77	1.85	1.11	1.22	.37
2.04	.89	1.85	1.11	2.04	1.47
2.68	2.17	2.68	1.94	.81	1.32
1.22	.89	1.85	2.62	.57	1.47
.81	2.06	1.22	1.11	1.22	.27
1.85	2.82	2.68	.68	1.22	1.65
1.21	.36	2.04	1.11	2.04	.27
2.04	1.41	1.85	1.94	1.85	1.32

- ✓ Enter these data into SPSS and save them in a file called **Wright et al (2005).sav**
- ✓ Wright et al. hypothesised that the impact of confederates' responses would be greater for 'new' words (i.e. words that participants hadn't seen at the beginning of the experiment).
- ✓ Conduct the appropriate analysis to test Wright et al.'s hypothesis.
- ✓ Use the questions from task 1 as a guide for how to answer this question.
- ✓ If you want to check your answers then consult Experiment 1 (especially the top of Table 2 on page 205) of Wright et al. (2005). Incidentally, although the full analyses are more complicated than this example and possible quite hard for you to follow, this is a gem of a paper for seeing how data and results should be presented.

Real Research Example: Ben Dyson

This example contains data from:

Dyson, B. J., Alain, C. & He, Y. (2005). I've heard it all before: Perceptual invariance represented by early cortical auditory-evoked responses. *Cognitive Brain Research*, *23*, 457-460.

[Available from the course bulletin board].

Dyson, Alain & He (2005) did a study related to whether the brain can passively organise sound. Participants watched a muted, subtitled movie in order to divert their attention while being played complex sounds which varied according to fundamental frequency (200 or 400 Hz) and the harmonicity of the third harmonic (tuned or mistuned). Participants were told to ignore the sounds and no overt responses to the stimuli were required. All participants experienced both fundamental frequencies, and both states of harmonicity.

Brain activity (ERP) was recorded: the outcome for these particular data was the amplitude of a P90 component (a positive deflection generated around 90 msec after stimulus onset). Data were organised according to whether consecutive sounds were the same or different with respect to fundamental frequency or hamonicity.

Consecutive sounds had the same Fundamental frequency		Consecutive sounds had different Fundamental frequencies	
Consecutive sounds had the same Harmonicity	**Consecutive sounds had a different Harmonicity**	**Consecutive sounds had the same Harmonicity**	**Consecutive sounds had a different Harmonicity**
.007	.085	.043	.200
.120	.457	.414	.384
-.069	.143	.005	.089
1.452	1.708	1.983	1.939
.047	.238	.231	.300
.568	.610	.804	.686
.719	.868	.627	.926
.154	.450	.361	.368
.141	.326	.273	.277
.272	.291	.156	.152
.064	.313	.356	.256
.247	.426	.484	.400

- ✓ Enter these data into SPSS and save them in a file called **Dyson et al (2005).sav**
- ✓ Dyson et al. hypothesised that P90 amplitude when fundamental frequency and harmonicity are both the same on consecutive sounds would be smaller than all other situations. (In other words, P90 amplitude would be smallest when acoustic information is identical across presentations).
- ✓ Conduct the appropriate analysis to test Dyson et al.'s hypotheses.
- ✓ Use the questions from task 1 as a guide for how to answer this question.
- ✓ If you want to check your answers then consult page 459 (Table 1 and Panel d of Figure 2 on that page) of Dyson et al. (2005).

Real Research Example: Andy Field

This example contains data from:

Field, A. P., & Lawson, J. (2003). Fear information and the development of fears during childhood: effects on implicit fear responses and behavioural avoidance. *Behaviour Research and Therapy*, *41*, 1277–1293.

[Available from the course bulletin board].

Field & Lawson (2003) did a study in which children were given different kinds of information about different novel animals (a Quoll, a Quokka and a Cuscus). For a particular child, a given animal was associated with positive information, a different animal was associated with negative information, and the final animal was a control animal and so no information was

given about it. Children's fear beliefs were measured both before and after this information using a scale ranging from 0 (no fear beliefs) to 4 (high fear beliefs). The gender of the children was also noted. Their actual data are below.

	Negative Information		Positive Information		No Information	
	Before Information	**After Information**	**Before Information**	**After Information**	**Before Information**	**After Information**
Male	1.00	3.86	1.71	.00	.57	1.50
	.14	.57	.43	1.14	.86	2.29
	.67	4.00	.57	.00	.57	.00
	.00	4.00	1.14	.00	.43	1.57
	1.43	3.86	1.43	.14	2.00	1.43
	1.57	2.83	.86	1.14	1.57	1.71
	.86	3.57	1.43	.00	1.86	1.14
	1.14	3.86	1.67	.50	1.29	1.29
	.80	3.29	1.43	.14	2.00	1.00
	.29	3.83	1.57	1.14	1.57	2.14
	.67	4.00	2.14	.17	.00	.67
	.86	1.71	1.57	1.57	1.86	2.17
	1.00	1.43	2.00	1.83	1.43	1.29
	2.14	3.86	.43	.14	.71	.43
	2.71	1.14	2.71	1.43	2.71	1.29
	.71	3.00	.57	.57	.43	.57
	.43	3.50	.43	.00	.57	1.50
	2.14	2.60	1.57	.00	1.86	2.67
	1.86	4.00	1.71	1.14	1.14	1.71
	1.29	-2.71	1.14	.00	1.14	.57
	2.00	4.00	1.86	.00	3.57	1.71
	1.40	3.17	2.17	.83	2.00	.33
	2.14	4.00	1.14	.00	.71	.57
	1.14	2.29	.43	2.29	.86	1.17
	1.57	4.00	1.71	.57	.43	2.14
	2.43	1.71	2.43	2.14	2.57	2.43
	1.57	3.71	1.29	.00	1.14	1.86
	1.29	2.86	1.57	.29	1.86	.83
	1.86	4.00	1.29	.67	1.86	1.00
	.57	3.33	.43	.57	.00	.00
	1.86	2.71	1.86	1.14	.71	1.33
	2.43	2.14	1.43	.57	1.43	1.29
Female	1.00	3.57	1.67	.29	1.57	2.14
	.33	3.57	.43	.00	.57	2.00
	.71	3.43	1.14	.71	.57	.86
	1.14	3.86	1.17	.00	1.00	2.29

	.86	2.14	1.00	.43	.86	2.29
	.29	3.50	.14	.00	1.14	1.29
	1.29	2.00	2.14	1.20	2.00	1.00
	.57	3.33	1.43	.14	1.86	1.43
	1.00	3.40	1.43	.67	1.57	.50
	2.00	3.29	1.14	.00	1.16	2.00
	1.86	1.43	2.14	.57	.33	1.43
	1.71	2.14	2.00	2.00	2.57	2.00
	1.86	3.29	1.29	1.00	1.43	2.86
	2.14	3.00	1.43	1.67	1.83	1.50
	1.29	4.00	.86	.00	.43	1.00
	2.71	3.43	1.43	.00	3.57	3.71
	3.17	3.43	1.86	.00	3.43	3.86
	1.29	3.00	1.29	1.29	1.00	1.00
	2.00	3.71	2.00	.33	1.33	1.33
	1.71	1.43	2.71	1.83	1.57	1.50
	.86	.80	.71	.83	.00	1.83
	.86	2.43	.14	2.60	.00	.86
	1.71	3.86	.86	.57	1.71	1.33
	1.57	3.86	1.67	.00	1.83	2.67
	2.00	3.71	2.50	.17	1.17	1.50
	1.14	2.75	1.14	1.14	.86	1.00
	.86	3.86	.71	.00	.86	.57

- ✓ Enter these data into SPSS and save them in a file called **Field&Lawson2003.sav**
- ✓ Field & Lawson hypothesised that negative information would increase fear beliefs in children, positive information would reduce fear beliefs, and fear beliefs would not change if no information was given. What's more, they believed girls would be more influenced by negative information than boys (anxiety is more common in females).
- ✓ Conduct the appropriate analysis to test Field & Lawson's hypotheses.
- ✓ Use the questions from task 1 as a guide for how to answer this question.
- ✓ If you want to check your answers then consult section 2.1 (pages 1284-1285) of Field et al. (2003).

For help with answering these questions, please consult:

Field, A. P. (2005). *Discovering statistics using SPSS (second edition)*. London: Sage.

