

There are two questions on this exam. Each sub-question is worth 3 points.

### Question A

There is a treatment-outcome design that has become so popular in the clinical program here that it is worth developing a prototypical analysis strategy for this design. This problem is based (somewhat loosely) on a grant proposal recently submitted by Arnica Buckner, who was a student in this class last year. The research concerns the treatment of eating disorders in college-aged women. There are three treatment groups to which women seeking treatment are randomly assigned:

**CONTROL** A wait-list control. Women seeking treatment are told, truthfully, that there aren't enough therapists available for everyone to begin treatment at the same time and that they have been randomly assigned to a group that will begin treatment at a later date. But these women complete the same questionnaires at the same time as those in the treatment group.

**CBT** A popular treatment for eating disorders is cognitive behavior therapy (CBT).

**CBT/AA** Researchers at the University of Colorado believe that the standard CBT approach errs by training people to do extensive food monitoring, which most people, especially those with eating disorders, find aversive. Instead, these researchers believe it would be better to use the basics of CBT but instead to train people to be better at reading their veridical appetite cue ("appetite awareness" or AA).

To help you plan your coding of the between-subject variable TREATMENT, there are two key questions:

- (a) Is CBT, regardless of which version, better than the CONTROL condition, and
- (b) is CBT/AA better than the traditional CBT?

A key dependent variable of interest is the number of binge/purge events in the past week. This dependent variable is measured at three times:

**BASELINE** measured for the week just prior to treatment

**POST** measured for the week just following the 8-week treatment program

**FOLLOWUP** measured two months after the end of treatment

To help you plan your coding of the within-subject variable TIME, there are two questions of interest that are not orthogonal: (a) Are binge/purge counts at POST lower than at BASELINE and (b) are binge/purge counts at FOLLOWUP lower than at BASELINE? Note that we have no interest in the between-subjects analysis of W0.

In some analyses a variable of interest is an eating disorder attitude measure, measured via an attitude questionnaire administered at baseline:

BATT            a scale measuring eating disorder attitudes, with higher scores indicating more problematic attitudes

1. For the moment ignoring the attitude measure, specify the precise coding of the variables and then the two SAS PROC REG MODEL statements you would use to generate the necessary test statistics to answer the above questions.
2. Specify which one-degree-of-freedom (1-df) test of a coefficient in which of your two models would test whether, on average, binge/purge episodes declined from baseline to post-treatment.
3. Specify which 1-df test of a coefficient in which of your two models would test whether binge/purge episodes declined from baseline to post-treatment more for those receiving either kind of treatment compared to control.
4. Specify which 1-df test of a coefficient in which of your two models would test whether the revised CBT (i.e., CBT/AA) was better than the traditional CBT in reducing binge/purge episodes from baseline to post-treatment?
5. Specify which 1-df test of a coefficient in which of your two models would test whether on average the treatment benefits (assuming there were some) relative to baseline were maintained at follow-up regardless of the type of treatment (CBT or CB/AA) received.
6. Specify which one-degree of freedom test of a coefficient in which of your two models would test whether the treatment benefits (assuming there were some) relative to baseline were maintained at follow-up more the CBT/AA than for CBT.
7. In the preamble to this question, it was stated that the two questions about the within-subject TIME variable were not orthogonal. Mathematically demonstrate that your two within-subject codes for TIME are not orthogonal.
8. A particular methodological problem with treatment-outcome studies like this one is that people are more likely to volunteer when their symptoms are the worst. Those in the control group may therefore improve even without formal treatment through two mechanisms: (a) due to the cyclical nature of these problems the symptoms (in this case number of binge/purge episodes) are likely to have subsided somewhat because of regression toward the mean and (b) those motivated enough to volunteer to be in a treatment-outcome study may be sufficiently motivated to see other forms of self-help treatment even when supposedly they are in the control group. Specify an alternative coding of the between-subjects treatment variable and a corresponding PROC REG MODEL statement that would allow the most powerful test of whether binge/purge episodes declined for the control group from baseline to post-treatment. Specify the key coefficient to be tested. [Note: This is a

fairly difficult question but quite doable. Hint: It does NOT involve using BATT scores in any way.]

9. Now consider the eating disorder attitude measure BATT. Specify the MODEL A/C comparison you would use to answer whether there was an unlucky random assignment that produced significant BATT differences across the treatment groups.
10. An hypothesis of particular interest is that the superiority of CBT/AA or CBT in the baseline versus post-treatment comparison will be even greater for those with more disordered attitudes (higher BATT scores). Specify a MODEL A/C comparison to answer that question.

### Question B

A human perception and performance psychologist believes people are able to throw more accurately with their dominant hand (defined as the hand with which they normally write) than their non-dominant hand. She has 18 participants throw six darts each at a dart board. To control for order effects, half of the participants are randomly selected to throw three darts with their dominant hand first followed by three darts with their non-dominant hand. The other participants throw three darts with their non-dominant hand first and their dominant hand second. For each dart thrown, a score is recorded based on the dart's proximity to the "bull's eye" of the dartboard: 3 = bull's eye or inner circle, 2 = middle circle, 1 = outer circle, 0 = off of the dartboard. [N.B.: These are *real* data!]

The following variables are included in the SAS code presented on the next page.

- throw1st:                'dom' if participant throws with dominant hand first  
                             'non' if participant throws with non-dominant hand first
- dom1, dom2, dom3: accuracy score for each participant's first, second, and third throw, respectively, with their dominant hand
- non1, non2, non3: accuracy score for each participant's first, second, and third throw, respectively, with their non-dominant hand

Using the SAS code and output presented on the following pages, answer the following questions. Provide  $F^*$  and PRE except for #1 and #8.

1. What is the *mean* accuracy score of the average participant?
2. Do accuracy scores depend on which hand participants threw with first?
3. Do participants throw more accurately with their dominant hand than their non-dominant hand?
4. Does the difference in question #3 depend on which hand participants threw with first?

5. Do the accuracy scores of participants improve linearly across each set of three throws, ignoring which hand they used to throw their darts?
6. Does the extent to which there is linear improvement in throwing accuracy (see #5) depend on which hand participants used?
7. Does the strength of the interaction suggested by #6 depend on which hand participants threw with first?
8. What is the predicted difference in throwing accuracy between dominant and non-dominant hands for participant who threw first with their non-dominant hand?

**SAS code**

```

data darts;
input throwlst $ dom1 dom2 dom3 non1 non2 non3;
order = 1*(throwlst = 'dom') - 1*(throwlst = 'non');
sum = dom1 + dom2 + dom3 + non1 + non2 + non3;
domvsnon = (dom1 + dom2 + dom3) - (non1 + non2 + non3);
linear = (dom3 + non3) - (dom1 + non1);
quad = (dom1 + dom3 + non1 + non3) - 2*(dom2 + non2);
linearint = (dom3 - dom1) - (non3 - non1);
quadint = ((dom1 + dom3) - 2*dom2) - ((non1 + non3) - 2*non2);
datalines;
dom 1 2 3 0 2 3
dom 2 0 3 0 3 2
dom 2 2 0 1 0 1
dom 2 3 3 0 0 2
dom 2 0 1 1 2 3
dom 1 1 1 2 2 0
dom 3 0 3 3 1 0
dom 3 2 1 2 3 3
dom 3 3 2 2 2 3
non 2 2 2 1 1 0
non 0 3 3 0 1 2
non 0 1 2 3 3 0
non 2 0 2 0 0 0
non 3 2 3 3 0 3
non 2 3 3 0 0 0
non 2 2 3 0 2 2
non 3 0 3 0 0 3
non 3 2 2 2 0 3
;
proc reg;
model1 sum = order;
model2 domvsnon = order;
model3 linear = order;
model4 quad = order;
model5 linearint = order;
model6 quadint = order;
run;

```

The REG Procedure  
 Model: MODEL1  
 Dependent Variable: sum

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	3.55556	3.55556	0.43	0.5201
Error	16	131.55556	8.22222		
Corrected Total	17	135.11111			

Root MSE	2.86744	R-Square	0.0263
Dependent Mean	9.77778	Adj R-Sq	-0.0345
Coeff Var	29.32611		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	1	9.77778	0.67586	14.47	<.0001
order	1	0.44444	0.67586	0.66	0.5201

The REG Procedure  
 Model: MODEL2  
 Dependent Variable: domvsnon

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	22.22222	22.22222	2.94	0.1056
Error	16	120.88889	7.55556		
Corrected Total	17	143.11111			

Root MSE	2.74874	R-Square	0.1553
Dependent Mean	1.77778	Adj R-Sq	0.1025
Coeff Var	154.61646		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	1	1.77778	0.64788	2.74	0.0144
order	1	-1.11111	0.64788	-1.71	0.1056

The REG Procedure  
 Model: MODEL3  
 Dependent Variable: linear

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	2.00000	2.00000	0.34	0.5700
Error	16	95.11111	5.94444		
Corrected Total	17	97.11111			

Root MSE	2.43812	R-Square	0.0206
Dependent Mean	0.77778	Adj R-Sq	-0.0406
Coeff Var	313.47298		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	1	0.77778	0.57467	1.35	0.1947
order	1	-0.33333	0.57467	-0.58	0.5700

The REG Procedure  
 Model: MODEL4  
 Dependent Variable: quad

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	5.55556	5.55556	0.37	0.5521
Error	16	240.88889	15.05556		
Corrected Total	17	246.44444			

Root MSE	3.88015	R-Square	0.0225
Dependent Mean	1.44444	Adj R-Sq	-0.0385
Coeff Var	268.62569		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	1	1.44444	0.91456	1.58	0.1338
order	1	-0.55556	0.91456	-0.61	0.5521

The REG Procedure  
 Model: MODEL5  
 Dependent Variable: linearint

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	5.55556	5.55556	1.16	0.2969
Error	16	76.44444	4.77778		
Corrected Total	17	82.00000			

Root MSE	2.18581	R-Square	0.0678
Dependent Mean	-0.33333	Adj R-Sq	0.0095
Coeff Var	-655.74385		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	1	-0.33333	0.51520	-0.65	0.5268
order	1	-0.55556	0.51520	-1.08	0.2969

The REG Procedure  
 Model: MODEL6  
 Dependent Variable: quadint

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	5.55556	5.55556	0.40	0.5336
Error	16	219.55556	13.72222		
Corrected Total	17	225.11111			

Root MSE	3.70435	R-Square	0.0247
Dependent Mean	0.77778	Adj R-Sq	-0.0363
Coeff Var	476.27380		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr >  t
Intercept	1	0.77778	0.87312	0.89	0.3862
order	1	0.55556	0.87312	0.64	0.5336