Exam #2, Spring 1992

Question 1

A group of researchers from a neurobehavioral institute are interested in the relationships that have been found between the amount of cerebral blood flow (CB FLOW) to the brain and the ability to attend to, and even learn, certain tasks. In particular, these researchers are interested in the amount of cerebral blood flow to the frontal lobes of the brain, and how this relates to performances on specific tasks. A subject's CB FLOW is measured via imaging techniques of the brain immediately following the completion of a particular task: either a task that requires the specific function of the frontal lobe of the brain, a "frontal task," or a task that requires the general, non-localized function of many areas of the brain, a "general task." Each subject is to complete each type of task. Additionally, each subject performs each task under both timed and non-timed conditions. Thus, there are four measures of CBFLOW from each subject. The researchers have also noted in past studies the relationships between the ages of individuals and the amount of CB FLOW to the frontal lobes of the brain. Therefore, they have chosen to examine subjects in their early 20's (ages 20-23), early 30's (ages 30-33), early 40's (ages 40-43), and early 50's (ages 50-53). There are two hypotheses of particular interest: that there is an overall age trend that shows CB FLOW linearly decreasing as one gets older; as well as a tendency for that linear age trend to increase with age (i.e., the age effect gets larger and larger the older you are). There are 9 subjects in each of these age groups.

A. Give the source and df columns of the full source table for the full analysis of variance of these data, defining variables in ways we can understand. (No omnibus tests necessary.) Make sure you identify each source clearly and give its degrees of freedom, and indicate which rows in this full source table test the two hypotheses stated above.

B. In your resulting source table, identify the row that tests each of the following questions:

1. The difference in the linear trend of CB FLOW depends in part on whether any of the tasks are timed or not.

2. The difference in CB FLOW measured after each type of task performed by all subjects depends on whether the tasks are timed or not.

C. Specify models C and A for tests of the following questions. Be sure to indicate the W you would need to use or create for each test. (It does not have to be one of the ones that you would use to generate the full source table that you provided in question A. Also, the W's do not need bo be independent of each other. Finally, some new between subject contrast codes may be necessary as well.)

1. Is it the case that the difference in CB FLOW between subjects in their 50's and subjects in their 20's depends in part on whether any of the tasks are timed or not?

2. Do timed tasks relate to an increased amount of CB FLOW when compared to non-timed tasks?

3. "Frontal tasks" tend to show greater frontal CB FLOW than more "general tasks." Is it the case that the difference in question 2 above is more pronounced for "frontal tasks" than for "general tasks?"

Question 2

Recall the STAT.CITIES dataset that has been previously used in homework assignments. In this dataset, data are available from 174 cities with populations over 100,000 people. In the analyses on the following pages, crime rates in these cities are examined as a function of the size of the city, whether or not the unemployment in the city exceeds the national average, and the number of police employed by the city. CRIME, the dependent variable in all of the reported analyses, is the number of serious crimes per 10,000 residents in a given year.

The size of the city is coded into a three level variable, cities below 300,000, those between 300,000 and 450,000, and those greater than 450,000 residents. To code this three level categorical variable, two contrast coded predictors have been defined as follows:

SIZEL: the linear effect of size (-1 if less than 300,000; +1 if greater than 450,000; 0 otherwise)

SIZEQ: the quadratic effect of size (+2 if between 300,000 and 450,000; -1 otherwise)

HIUNEMP: dichotomous variable with values of -1 if the city's unemployment rate does not exceed the national average and +1 if it does.

UNSIZEL: SIZEL * HIUNEMP

UNSIZEQ: SIZEQ * HIUNEMP

POLICE: continuous variable measuring the number of police officers employed by the city (in hundreds).

Finally, there are the following additional predictor variables made up of products of other predictors:

PSIZEL: POLICE * SIZEL
PSIZEQ: POLICE * SIZEQ
PHIUN: POLICE * HIUNEMP
TRIPLEL: POLICE * UNSIZEL
TRIPLEQ: POLICE * UNSIZEQ

Based on the accompanying output, answer the following questions.

A. Ignoring the role of POLICE for the moment, is there evidence in these data that whether or not the unemployment rate in the city exceeds the national average is related to the amount of crime in the city? (Provide values of F*, N-pa, pa-pc, and PRE).

B. Ignoring POLICE again, is there evidence that crime rates increase as cities get larger? (Provide values of F*, N-pa, pa-pc, and PRE).

C. Again, ignoring POLICE for the moment, is there evidence in these data that HIUNEMP affects levels of crime in cities with populations less than 300,000 residents? (Again provide values of F*, N-pa, pa-pc, and PRE).

D. Interpret the coefficient for SIZEL in the model that adds POLICE as a predictor in addition to the five contrast coded predictors that represent size and unemployment level. (i.e., 31.58). Make clear why this coefficient differs from the SIZEL coefficient in the model that does not include POLICE. (Three sentences at most).

E. What is the value of adjusted CRIME mean for cities less than 300,000 and with an unemployment level that exceeds the national average, from the ANCOVA model?

F. Is it reasonable to assume, in these data, that the relationship between POLICE and CRIME is the same in all the cities in the dataset regardless of their values on the trichotomous size variable and on the HIUNEMP variable? (Provide F*, N-pa, pa-pc, and PRE for your answer).

G. Provide a short interpretation of the coefficient for SIZEL (i.e., -3.29) in the model that includes the contrast coded predictors, POLICE, and five variables that are products of POLICE and the contrast coded predictors. (One sentence.)

H. Based on the fact that the coefficient for PSIZEL is reliable in the model that includes the five contrast coded predictors, POLICE, and the five variables that are products of POLICE and the contrast coded predictors, an additional model is estimated in which only this product variable involving POLICE is included rather than the full set of POLICE product predictors (i.e., the last model on the accompanying output). Provide an interpretation of the coefficient for PSIZEL in this last model even though it is now only marginally reliable. (One sentence.)

I. Based on this last model, and assuming the reliability of the PSIZEL coefficient, what is the expected "simple" slope between POLICE and CRIME in cities with populations greater than 450,000?

J. Bothering to interpret only single degree of freedom effects that are reliable at $p < .05$, summarize the results of the analyses reported on the accompanying output. What are the bottom line conclusions? (Four sentences maximum.)

The SAS System
Correlation Analysis

5 'VAR' Variables: SIZE POV UNEMP POLICE CRIME

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
SIZE	174	38.4241	15.5792	6686	10.2951	87.5348
POV	174	22.5441	5.1040	3923	9.5090	39.9295
UNEMP	174	14.5331	4.4208	2529	4.8899	24.3932
POLICE	174	34.4456	14.5766	5994	0.2963	76.5688
CRIME	174	118.3288	49.4884	20589	15.9127	240.6681

Pearson Correlation Coefficients / Prob > |R| under Ho: Rho=0 / N = 174

	SIZE	POV	UNEMP	POLICE	CRIME
SIZE	1.00000	0.21909	0.15805	0.69853	0.45036
	0.0	0.0037	0.0373	0.0001	0.0001
POV	0.21909	1.00000	0.35093	0.25808	0.41931
	0.0037	0.0	0.0001	0.0006	0.0001
UNEMP	0.15805	0.35093	1.00000	0.18893	0.18925
	0.0373	0.0001	0.0	0.0125	0.0124
POLICE	0.69853	0.25808	0.18893	1.00000	0.24685
	0.0001	0.0006	0.0125	0.0	0.0010
CRIME	0.45036	0.41931	0.18925	0.24685	1.00000
	0.0001	0.0001	0.0124	0.0010	0.0

The SAS System

Model: MODEL1
Dependent Variable: CRIME

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	4	140900.07669	35225.01917	21.051	0.0001
Error	169	282795.29565	1673.34494		
C Total	173	423695.37233			

Root MSE	40.90654	R-square	0.3326
Dep Mean	118.32877	Adj R-sq	0.3168
C.V.	34.57024		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	-0.954604	15.82039153	-0.060	0.9520
SIZE	1	1.635577	0.27947258	5.852	0.0001
POV	1	3.411964	0.66607761	5.122	0.0001
UNEMP	1	0.265317	0.75592495	0.351	0.7260
POLICE	1	-0.706557	0.30225622	-2.338	0.0206

Variable	DF	Type II SS	Squared Partial Corr Type II	Tolerance
INTERCEP	1	6.092533	.	.
SIZE	1	57312	0.16851269	0.51023485
POV	1	43908	0.13439747	0.83687489
UNEMP	1	206.137916	0.00072840	0.86612714
POLICE	1	9143.868956	0.03132115	0.49828110

The SAS System
Model: MODEL2
Dependent Variable: CRIME

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	3	83587.60294	27862.53431	13.927	0.0001
Error	170	340107.76939	2000.63394		
C Total	173	423695.37233			

Root MSE	44.72845	R-square	0.1973
Dep Mean	118.32877	Adj R-sq	0.1831
C.V.	37.80014		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	15.157317	17.03455711	0.890	0.3748
POV	1	3.594346	0.72751182	4.941	0.0001
UNEMP	1	0.355204	0.82638056	0.430	0.6679
POLICE	1	0.492887	0.24291451	2.029	0.0440

Variable	DF	Type II SS	Squared Partial Corr Type II	Tolerance
INTERCEP	1	1583.983347	.	.
POV	1	48835	0.12555734	0.83871085
UNEMP	1	369.627046	0.00108561	0.86648485
POLICE	1	8236.728719	0.02364535	0.92235937

The SAS System

Model: MODEL3
Dependent Variable: POLICE

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	2	2853.97131	1426.98566	7.197	0.0010
Error	171	33904.76355	198.27347		
C Total	173	36758.73486			

Root MSE	14.08096	R-square	0.0776
Dep Mean	34.44565	Adj R-sq	0.0669
C.V.	40.87878		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	14.988342	5.23872642	2.861	0.0047
POV	1	0.624622	0.22399157	2.789	0.0059
UNEMP	1	0.369897	0.25861045	1.430	0.1544

Variable	DF	Type II SS	Squared Partial Corr Type II	Tolerance
INTERCEP	1	1623.006805	.	.
POV	1	1541.827220	0.04349719	0.87685142
UNEMP	1	405.634371	0.01182249	0.87685142

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The SAS System

Model: MODEL4
Dependent Variable: CRIME

Analysis of Variance

                          Sum of          Mean
Source          DF       Squares        Square       F Value       Prob>F

Model            1   25816.81298   25816.81298        11.160       0.0010
Error          172  397878.55935    2313.24744
C Total        173  423695.37233

    Root MSE      48.09623      R-square       0.0609
    Dep Mean     118.32877      Adj R-sq       0.0555
    C.V.          40.64627

Parameter Estimates

                 Parameter      Standard    T for H0:
Variable  DF      Estimate         Error   Parameter=0    Prob > |T|

INTERCEP   1     89.461525    9.37879449         9.539        0.0001
POLICE     1      0.838052    0.25085962         3.341        0.0010

                                 Squared
                                 Partial
Variable  DF    Type II SS  Corr Type II     Tolerance

INTERCEP   1        210475       .             .
POLICE     1         25817    0.06093249    1.00000000
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The SAS System

Model: MODEL5
Dependent Variable: CRIME

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	2	83217.97589	41608.98795	20.898	0.0001
Error	171	340477.39644	1991.09589		
C Total	173	423695.37233			

Root MSE	44.62170	R-square	0.1964
Dep Mean	118.32877	Adj R-sq	0.1870
C.V.	37.70993		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	17.683153	15.95073481	1.109	0.2692
POV	1	3.693942	0.68798006	5.369	0.0001
POLICE	1	0.504239	0.24089801	2.093	0.0378

Variable	DF	Type II SS	Squared Partial Corr Type II	Tolerance
INTERCEP	1	2447.091503	.	.
POV	1	57401	0.14426805	0.93339442
POLICE	1	8723.674750	0.02498181	0.93339442