UNIVERSITY OF TORONTO MISSISSAUGA

April 2008 Examination
STA442H5S
Professor Jerry Brunner
Duration: 3 hours

Aids allowed: Calculator, Printouts[1].

You may be charged with an academic offence for possessing the following items during the writing of an exam unless otherwise specified: any unauthorized aids, including but not limited to calculators, cell phones, pagers, wristwatch calculators, personal digital assistants (PDAs), iPODS, MP3 players, or any other device. If any of these items are in your possession in the area of your desk, please turn them off and put them with your belongings at the front of the room before the examination begins. A penalty MAY BE imposed if any of these items are kept with you during the writing of your exam.

Please note that students are **not** allowed to petition to RE-WRITE a final examination.

Last Name: _____

Given Name: _____

Student Number: _____

Qn. #	Value	Score		Qn. #	Value	Score
1	10			6	10	
2	10			7	10	
3	10			8	10	
4	10			9	10	
5	10			10	10	
Total = 100 Points						

[1]Computer printouts are supplied. There are 22 pages of printout including the cover page, consisting of

1. Mantids Study (6 pages)
2. Longitudinal IQ Study (10 pages)
3. Cartoon Study (5 pages)

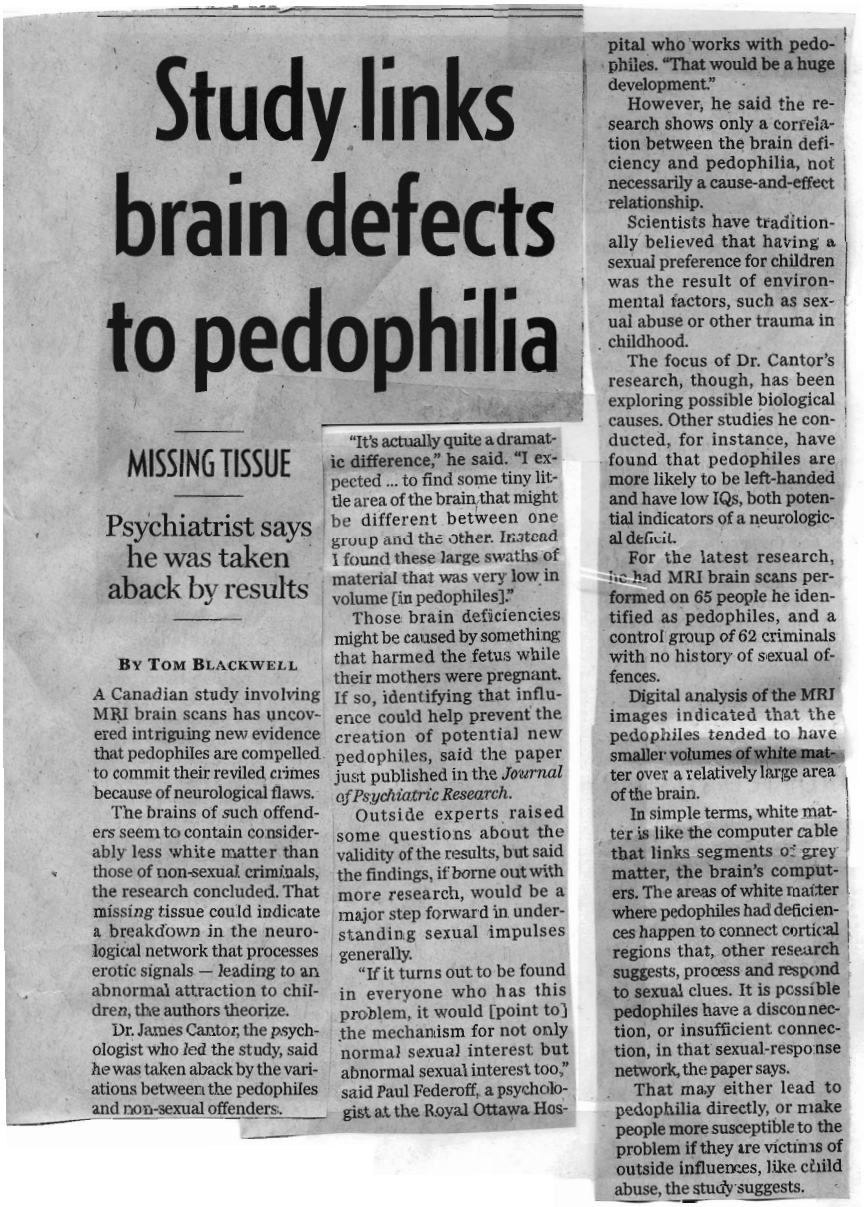
10 points

1. Make up an original study with a single dependent variable; the study should have two categorical independent variables, one with random effects and the other with fixed effects. Values of the random effects variable should be nested within the values of the fixed effects variable. It must be clear from your description of the study why each variable has random or fixed effects.

continued on page 3

10 points

2. Please read the newspaper article below. *In terms of this course*, what is the most important sentence in the article? Underline *just one* sentence. (In case you are unfamiliar with the term "pedophilia," the pedophiles in this study were convicted of sexual crimes against children.)



Study links brain defects to pedophilia

MISSING TISSUE

Psychiatrist says he was taken aback by results

BY TOM BLACKWELL

A Canadian study involving MRI brain scans has uncovered intriguing new evidence that pedophiles are compelled to commit their reviled crimes because of neurological flaws.

The brains of such offenders seem to contain considerably less white matter than those of non-sexual criminals, the research concluded. That missing tissue could indicate a breakdown in the neurological network that processes erotic signals — leading to an abnormal attraction to children, the authors theorize.

Dr. James Cantor, the psychologist who led the study, said he was taken aback by the variations between the pedophiles and non-sexual offenders.

"It's actually quite a dramatic difference," he said. "I expected ... to find some tiny little area of the brain that might be different between one group and the other. Instead I found these large swaths of material that was very low in volume [in pedophiles]."

Those brain deficiencies might be caused by something that harmed the fetus while their mothers were pregnant. If so, identifying that influence could help prevent the creation of potential new pedophiles, said the paper just published in the *Journal of Psychiatric Research*.

Outside experts raised some questions about the validity of the results, but said the findings, if borne out with more research, would be a major step forward in understanding sexual impulses generally.

"If it turns out to be found in everyone who has this problem, it would [point to] the mechanism for not only normal sexual interest but abnormal sexual interest too," said Paul Federoff, a psychologist at the Royal Ottawa Hospital who works with pedophiles. "That would be a huge development."

However, he said the research shows only a correlation between the brain deficiency and pedophilia, not necessarily a cause-and-effect relationship.

Scientists have traditionally believed that having a sexual preference for children was the result of environmental factors, such as sexual abuse or other trauma in childhood.

The focus of Dr. Cantor's research, though, has been exploring possible biological causes. Other studies he conducted, for instance, have found that pedophiles are more likely to be left-handed and have low IQs, both potential indicators of a neurological deficit.

For the latest research, he had MRI brain scans performed on 65 people he identified as pedophiles, and a control group of 62 criminals with no history of sexual offences.

Digital analysis of the MRI images indicated that the pedophiles tended to have smaller volumes of white matter over a relatively large area of the brain.

In simple terms, white matter is like the computer cable that links segments of grey matter, the brain's computers. The areas of white matter where pedophiles had deficiences happen to connect cortical regions that, other research suggests, process and respond to sexual clues. It is possible pedophiles have a disconnection, or insufficient connection, in that sexual-response network, the paper says.

That may either lead to pedophilia directly, or make people more susceptible to the problem if they are victims of outside influences, like child abuse, the study suggests.

continued on page 4

10 points

3. Indicate True or False for the statements below. You must get at least nine out of ten right in order to get any marks.

   (a) _____ In an experimental study, a statistically significant relationship between the independent variable and the dependent variable can provide some evidence of a causal relationship.

   (b) _____ We observe $r = -0.70, p = .009$. We do not have sufficient evidence to conclude that the independent variable and the dependent variable are related.

   (c) _____ The p-value is the probability that the null hypothesis is true.

   (d) _____ The greater the p-value, the stronger the evidence that the independent and dependent variable are related.

   (e) _____ The p-value is the probability of failing to replicate significant results in a second independent random sample of the same size.

   (f) _____ When a relationship between the independent variable and the dependent variable is statistically significant, we conclude there is no evidence that the two variables are actually related.

   (g) _____ In simple regression, a negative regression coefficient b_1 implies that high values of X tend to go with low values of Y and low values of X tend to go with high values of Y.

   (h) _____ We seek to predict the dependent variable from the independent variable.

   (i) _____ If $p < 0.05$ we say the results are statistically significant at the 0.05 level.

   (j) _____ Experimental studies are based on random sampling from a well-defined population.

continued on page 5

10 points

4. In a study of alleged discrimination, cases are employees at a bank. Variables are

   Y Starting salary

   X_1 Sex (0=Male, 1=Female)

   X_2 Seniority (time in months since hired)

   X_3 Age when hired, in months

   X_4 Education in years

   X_5 Work experience prior to being hired by bank, in months.

   The primary question is this. Controlling for how long ago the person was hired, age when hired and prior work experience, is there a sex difference in average starting salary?

   (a) Give $E[Y|\mathbf{X}]$ for the full model.

   (b) Give $E[Y|\mathbf{X}]$ for the reduced model.

   (c) Suppose we observe a positive value of b_1 with $p = .0003$. State your conclusion in plain, non-statistical language. If the results are statistically significant at the 0.05 level, begin your answer with "Allowing for ...". If the results are not statistically significant at the 0.05 level, just write "No conclusion."

continued on page 6

10 points

5. In a study of math education in elementary school, equal numbers of boys and girls were randomly assigned to one of three training programs designed to improve spatial reasoning. After five school days of training, the students were given a standardized test of spatial reasoning. Score on this test is the dependent variable.

   (a) The table below shows all six treatment conditions. Make columns indicating the contrasts you would use to test the main effect for Training Program.

Girls, Program 1	
Girls, Program 2	
Girls, Program 3	
Boys, Program 1	
Boys, Program 2	
Boys, Program 3	

   (b) The table below shows all six treatment conditions. Make columns indicating the contrasts you would use to test the Sex by Training Program interaction.

Girls, Program 1	
Girls, Program 2	
Girls, Program 3	
Boys, Program 1	
Boys, Program 2	
Boys, Program 3	

continued on page 7

10 points

6. In Question 5, suppose we include the child's marks (overall GPA last marking period) as a covariate. Call this variable X_1. You will define a regression model for this analysis of covariance. Your model will have an intercept β_0.

   (a) In the table below, show how your dummy variables are defined. *Write the name of each dummy variable at the head of its column.*

Girls, Program 1	
Girls, Program 2	
Girls, Program 3	
Boys, Program 1	
Boys, Program 2	
Boys, Program 3	

   (b) Give $E[Y|\mathbf{X}]$ for the full model.

   (c) Fill in the table below. Make sure that the *symbols* for your dummy variables do not appear.

Treatment Combination	$E[Y\|\mathbf{X}]$
Girls, Program 1	
Girls, Program 2	
Girls, Program 3	
Boys, Program 1	
Boys, Program 2	
Boys, Program 3	

   (d) Suppose you want to test for the main effect of Sex (controlling for marks). Give one or more linear combinations of the β values set equal to zero, to specify the null hypothesis. Of course these restrictions also specify a reduced (restricted) model, but you need not write that model. Just write one or more linear combinations set equal to zero.

continued on page 8

10 points

7. Please refer to the printout for the Mantids study. Consider the two-factor ANOVA in which the dependent variable is frequency of alarm calls when the predator is 18 cm away.

   (a) The first question is whether there is a difference among the eight means of this design, in the population.

      i. Give the numerical value of the F statistic. The answer is a number from the printout. _____

      ii. Give the p-value. The answer is a number from the printout. _____

      iii. Are the differences among sample means statistically significant at the 0.05 level? Answer Yes or No. _____

      iv. Is there any difference among the eight population means? Answer Yes, No, or No Conclusion. _____

   (b) Now we would like to know whether the effect of Predator depends upon Sex of Mantid.

      i. Give the numerical value of the F statistic. The answer is a number from the printout. _____

      ii. Give the p-value. The answer is a number from the printout. _____

      iii. Is this test statistically significant at the 0.05 level? Answer Yes or No. _____

      iv. Considered as a Scheffé followup to the test of Question 7a, is this "it depends" test statistically significant at the *joint* 0.05 level? Answer Yes or No. _____

      v. What critical value of F are you using? The answer is a single number from the printout. _____

   (c) Now we want to know whether, averaging over predators, there is a Sex difference in the frequency of alarm calls they elicit.

      i. Give the numerical value of the F statistic. The answer is a number from the printout. _____

      ii. Considered as a Scheffé followup to the test of Question 7a, is this statistically significant at the joint 0.05 level? Answer Yes or No. _____

      iii. What critical value of F are you using? The answer is a single number from the printout. _____

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iv. Give the marginal means for Males and Females. The answer is two numbers from the printout. _____ _____

(d) Now we want to know whether, averaging over males and females, there is a difference among predators in frequency of alarm calls.

i. Give the numerical value of the F statistic. The answer is a number from the printout. _____

ii. Considered as a Scheffé followup to the test of Question 7a, is this statistically significant at the joint 0.05 level? Answer Yes or No. _____

iii. What critical value of F are you using? The answer is a single number from the printout. _____

iv. Considering the pairwise differences between marginal means as Scheffé followups to the test of Question 7a,

A. What difference(s) are statistically significant at the joint 0.05 level?

B. State the findings (if any) in plain, non-statistical language. You have much more room than you need.

continued on page 10

10 points

8. Please refer to the printout for the Longitudinal IQ study.

   (a) Consider a study participant whose birth mother had an IQ of 100, and whose adoptive mother had 16 years of education. Predict this person's IQ at age 13. Base your prediction on the full model, without regard to any significance tests. Your answer is a single number, rounded to a whole number. **Circle your answer**.

   (b) Considering all four dependent variables simultaneously, we want to know whether, controlling for adoptive mother's education, the birth mother's IQ is related to her child's IQ.
      i. Give the numerical value of the F statistic. The answer is a number from the printout. _____
      ii. Give the p-value. The answer is a number from the printout. _____
      iii. Is this test statistically significant at the 0.05 level? Answer Yes or No. _____
      iv. Treating the univariate tests as Bonferroni-corrected follow-ups to the multivariate test, at what age or ages (if any) does the relationship hold? _____

   (c) Considering all four dependent variables simultaneously, we want to know whether, controlling for birth mother's IQ, adoptive mother's education is related to her child's IQ.
      i. Give the numerical value of the F statistic. The answer is a number from the printout. _____
      ii. Give the p-value. The answer is a number from the printout. _____
      iii. Is this test statistically significant at the 0.05 level? Answer Yes or No. _____
      iv. Treating the univariate tests as Bonferroni-corrected follow-ups to the multivariate test, at what age or ages (if any) does the relationship hold? _____

   (d) Which is a more promising predictor of child's IQ, birth mother's IQ or adoptive mother's education?

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10 points

9. Continuing with the printout from the longitudinal IQ study, we will apply an analysis of covariance.

   (a) What are the covariates?

   (b) What is the factor?

   (c) Is the factor between-cases, or within-cases?

   (d) Give the F-statistic for whether, controlling for birth mother's IQ and adoptive mother's education, there is a change over time in the childrens' average IQ. The answer is a number from the printout. _____

   (e) Follow up the test for age with Bonferroni-corrected pairwise comparisons. You are comparing p-values on the printout to what number? The answer is a number between zero and one. _____

   (f) Guided by these significance tests and other numbers on the printout, state the results in simple, non-statistical language. You have more room than you need.

continued on page 12

10 points

10. Finally, please look at the printout from the Cartoon study.

    (a) The printout gives a "Null Model Likelihood Ratio Test." What does this tell us? Any kind of language (statistical or not) is okay here.

    (b) Describe the main results of this analysis in simple, non-statistical language. A good answer could easily be two short sentences, with no numbers.

Total Marks = 100 points