PSY 216: Elementary Statistics
Exam 4

This exam consists of 25 multiple-choice questions and 5 essay / problem questions. For each multiple-choice question, circle the one letter that corresponds to the correct answer. Each multiple-choice question is worth 2 points. If you do not show your work in the essay / problem questions, you cannot receive partial credit. Each of the essay / problem questions is worth 10 points. You have until 1:50 PM to finish the exam. Budget your time wisely.

1. What is the difference between $\alpha_{\text{comparison wise}}$ and $\alpha_{\text{family wise}}$?
   A. $\alpha_{\text{comparison wise}}$ is the probability of making a Type-I error in a single comparison while $\alpha_{\text{family wise}}$ is the probability of making at least one Type-I error across all the comparisons performed.
   B. $\alpha_{\text{comparison wise}}$ is the probability of making at least one Type-I error across all the comparisons performed while $\alpha_{\text{family wise}}$ is the probability of making a Type-I error in a single comparison.
   C. $\alpha_{\text{comparison wise}}$ is the probability of making at least one Type-II error across all the comparisons performed while $\alpha_{\text{family wise}}$ is the probability of making a Type-II error in a single comparison.
   D. There is no difference -- they are synonyms.

2. Which of the following are appropriate hypotheses for ANOVA?
   A. $H_0$: $\mu_1 = \mu_2 = \mu_3 = \mu_4$
      $H_1$: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4$
   B. $H_0$: $\mu_1 = \mu_2 = \mu_3 = \mu_4$
      $H_1$: not $H_0$
   C. $H_0$: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4$
      $H_1$: $\mu_1 = \mu_2 = \mu_3 = \mu_4$
   D. $H_0$: $\mu_1 = \mu_2 \neq \mu_3 = \mu_4$
      $H_1$: $\mu_1 \neq \mu_2 = \mu_3 \neq \mu_4$

3. Which of the following statements about within-groups variance is / are correct?
   A. Within-groups variance is a measure of error and the effect that the independent variable had on the dependent variable.
   B. If you want to reject $H_0$, you want within-groups variance to be as large as possible.
   C. Within-groups variance is at least partially caused by factors that we did not control in the experiment.
   D. All of the above.
4. Of the three sets of distributions shown above, which has the largest within-groups variance?
   A. A
   B. B
   C. C
   D. The within-groups variances are approximately equal in the three sets of distributions.

5. Which of the following statements about between-groups variance is / are correct?
   A. Between-groups variance at least partially measures the effect of the independent variable on the dependent variable.
   B. Between-groups variance at least partially measures sampling error.
   C. If you want to reject H0, then you want between-groups variance to be as large as possible.
   D. All of the above

6. Of the three sets of distributions shown above question 4, which has the largest between-groups variance?
   A. A
   B. B
   C. C
   D. There is insufficient information to answer this question.

7. What is the definition of Fisher’s F ratio?
   A. \( F = \) between-groups variance / within-groups variance.
   B. \( F = \) within-groups variance / between-groups variance.
   C. \( F = \) error / (effect of the IV on the DV + error)
   D. Both answers B and C
8. What are the expected values of $F$ when $H_0$ is true and when $H_0$ is false?
   A. If $H_0$ is true, the expected value of $F$ is 0. If $H_0$ is false, the expected value of $F$ is $> 0$.
   B. If $H_0$ is true, the expected value of $F$ is $> 0$. If $H_0$ is false, the expected value of $F$ is 0.
   C. If $H_0$ is true, the expected value of $F$ is 1. If $H_0$ is false, the expected value of $F$ is $> 1$.
   D. If $H_0$ is true, the expected value of $F$ is $> 1$. If $H_0$ is false, the expected value of $F$ is 1.

9. ANOVA assumes that
   A. the variance of the distributions is homogeneous.
   B. the observations are independent of each other.
   C. the sampling error is normally distributed centered around the mean of the distribution.
   D. All of the above

10. What is the primary difference between the various multiple comparison tests (e.g. between Tukey’s Honestly Significant Difference and the Chef Bonferroni test)?
    A. Some of the tests are appropriate only for between-subjects designs while others are appropriate only for within-subjects designs.
    B. Some of the tests are appropriate only for single factor designs while others are appropriate only for two factor designs.
    C. The different tests have different statistical power and different amounts of protection from Type-I errors.
    D. Some of the tests are appropriate only for comparing two means at a time while others are appropriate for comparing three or more means at a time.

11. When should multiple comparisons be performed?
    A. They should be performed if the independent variable has more than 2 levels.
    B. They should be performed if the corresponding main effect is statistically significant.
    C. They should be performed if either answer A or answer B is true.
    D. They should be performed only if both answer A and answer B are true.

12. A factorial design
    A. has all possible combinations of the levels of all the independent variables.
    B. can only tell you about main effects and not interactions.
    C. can only occur for between-subjects designs.
    D. can only occur for within-subjects designs.
13. Which of the following statements is true about main effects?
   A. A main effect occurs when an independent variable influences the dependent variable.
   B. There can be as many main effects in a study as there are independent variables.
   C. Main effects can be determined from both single factor experiments and from factorial design experiments.
   D. All of the above.

14. A researcher was interested in the effects of room color (red vs. blue) and clinical depression (present vs. absent) on aggression. The researcher found that room color did not influence aggression for the people with depression, but red rooms caused more aggressive behaviors than blue rooms for people without depression. Which of the following statements is true about this set of results?
   A. There definitely is an interaction of room color and depression.
   B. There probably is an interaction of room color and depression.
   C. There probably is not an interaction of room color and depression.
   D. There definitely is not an interaction of room color and depression.

15. People who ride buses have a 3 point higher environmental concern rating than people who do not ride buses. People with young children have a 2 point higher environmental concern rating than people who do not have young children. People who do not ride buses and do not have young children have a mean environmental concern rating of 2.5. Which of the following is correct if the effects of riding buses and having young children do not interact?
   A. \( \bar{X}_{\text{ride buses, have young children}} = \bar{X}_{\text{do not ride buses, do not have young children}} + \text{effect of riding buses} = 2.5 + 3 \)
   B. \( \bar{X}_{\text{ride buses, have young children}} = \bar{X}_{\text{do not ride buses, do not have young children}} + \text{effect of having young children} = 2.5 + 2 \)
   C. \( \bar{X}_{\text{ride buses, have young children}} = \bar{X}_{\text{do not ride buses, do not have young children}} + \text{effect of riding buses} + \text{effect of having young children} = 2.5 + 3 + 2 \)
   D. \( \bar{X}_{\text{ride buses, have young children}} = \bar{X}_{\text{do not ride buses, do not have young children}} + \text{effect of riding buses} + \text{effect of having young children} = 2.5 - 3 - 2 \)

16. A researcher conducted a study in which she manipulated whether people received a small reward ($1) or a large reward ($20) for making a decision with unpleasant consequences. She also manipulated whether the person made the decision alone, or in a group of other people who all agreed with the decision. The participants then rated how happy they were with the decision. Each participant in the experiment made two decisions -- one by themselves and one in a group. But each participant received only one type of reward -- either $1 or $20, but not both. What type of ANOVA should the researcher use to analyze the results?
   A. A 2 X 2 between-subjects design ANOVA
   B. A 2 X 2 mixed design ANOVA
   C. A 2 X 2 within-subjects design ANOVA
   D. Any of the above would be appropriate
17. A researcher performed a factorial design study with three independent variables. The higher order interaction was statistically significant. What does this imply?
A. The nature of the interaction between the first two independent variables is different from the nature of the interaction between the last two IVs.
B. The nature of the interaction between the first two independent variables is different from the nature of the interaction of the first and last IVs.
C. The nature of the interaction between any two independent variables is different from the nature of the interaction of any other pair of IVs.
D. The nature of the interaction between two of the independent variables is different depending on the level of the third IV.

18. What is the difference between parametric and non-parametric statistics?
A. Parametric statistics make assumptions about how the data are distributed; non-parametric statistics do not.
B. Parametric statistics are one-tailed while non-parametric statistics are two-tailed.
C. Non-parametric statistics make assumption about how the data are distributed; parametric statistics do not.
D. Non-parametric statistics are one-tailed while parametric statistics are two-tailed.

19. Why are non-parametric statistics less desirable than their parametric counterparts?
A. Non-parametric statistics can be used only with nominally scaled data while parametric statistics can be used with any level of measure.
B. Non-parametric statistics have less statistical power than their parametric counterparts.
C. Non-parametric statistics make more assumptions than their parametric counterparts.
D. All of the above.

20. When would you use the $\chi^2$ one-variable test?
A. You have a nominally scaled DV that has only two categories.
B. You have a nominally scaled DV that has more than two categories.
C. You have a nominally scaled DV and the expected frequencies are unknown.
D. You have an ordinally scaled DV, a between-subjects IV with two levels and the participants are not matched across conditions.

21. When would you use the binomial test?
A. You have a nominally scaled DV that has only two categories.
B. You have a nominally scaled DV that has more than two categories.
C. You have two nominally scaled DVs and each DV has two or more categories.
D. You have an ordinally scaled DV, a between-subjects IV with two levels and the participants are not matched across conditions.
22. Which of the following are assumptions made by the $\chi^2$ test?
   A. Each observation must be unique; an individual cannot be in more than one category or counted in the same category more than once.
   B. The minimum expected frequency in each category should be sufficiently large.
   C. The data must correspond to frequencies in the categories and not percentages in the categories.
   D. All of the above.

23. In using a one-way analysis of variance, we assume that each score can be represented by the equation: $X_{ij} = \mu + \alpha_j + \epsilon_{ij}$. What does this formula mean?
   A. It states that each score ($X_{ij}$) is composed of three things -- the population mean ($\mu$), the effect of the treatment condition ($\alpha_j$), and a random error ($\epsilon_{ij}$) that is centered around 0.
   B. It states that each score ($X_{ij}$) is composed of three things -- the population mean ($\mu$), the alpha level ($\alpha_j$), and the effect of the treatment condition ($\epsilon_{ij}$).
   C. It states that each score ($X_{ij}$) is composed of three things -- the population mean ($\mu$), the between-groups variance ($\alpha_j$), and the within-groups variance ($\epsilon_{ij}$).
   D. It states that each score ($X_{ij}$) is composed of three things -- the population mean ($\mu$), the alpha level ($\alpha_j$), and the within-groups (error) variance ($\epsilon_{ij}$).

24. $\eta^2$ (eta squared) is a measure of
   A. effect size.
   B. statistical power.
   C. the probability of making a Type-I error.
   D. None of the above.

25. Counterbalancing
   A. is a technique for reducing the degree of carryover effects in a repeated-measures design.
   B. is a technique for reducing the degree of carryover effects in a between-subjects design.
   C. tends to increase the between-groups estimate of variance.
   D. All of the above.
26. Describe and discuss factors that influence the size of the critical F. If you want to reject \( H_0 \), should the critical F be large or small?
27. For each of the following, state whether the main effects and interaction are likely to be present.

A. People who have been friends for five years are more likely to perform an unpleasant task for their friend than are people who have been friends for only one year. This is true for both males and females, but females are more likely to perform an unpleasant task for a friend than are males.

B. The effect of smoking on GPA is to reduce a person’s GPA by 0.4 points. The effect of being on an athletic team on GPA is to reduce a person’s GPA by 0.2 points. The mean GPA of people who do not smoke and are not on an athletic team is 3.2. The mean GPA of people who smoke and are not on an athletic team is 2.6. The mean GPA of people who smoke and are on an athletic team is 3.0. The mean GPA of people who do not smoke and are on an athletic team is known, but I won’t tell you since you don’t need to know it in order to answer the question!
28. Consult the following SPSS ANOVA summary table. Write the results in American Psychological Association style. The two variables in the experiment were the location (LOCATION) of the experiment (in a science lab vs. a run-down office) and the number of dissenters (NUMDIS) present (0 vs. 1 vs. 2).

**Tests of Between-Subjects Effects**

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>110277.778a</td>
<td>5</td>
<td>22055.556</td>
<td>4.460</td>
<td>.001</td>
</tr>
<tr>
<td>Intercept</td>
<td>1293368.1</td>
<td>1</td>
<td>1293368.1</td>
<td>261.563</td>
<td>.000</td>
</tr>
<tr>
<td>LOCATION</td>
<td>16805.556</td>
<td>1</td>
<td>16805.556</td>
<td>3.399</td>
<td>.070</td>
</tr>
<tr>
<td>NUMDIS</td>
<td>87986.111</td>
<td>2</td>
<td>43993.056</td>
<td>8.897</td>
<td>.000</td>
</tr>
<tr>
<td>LOCATION * NUMDIS</td>
<td>5486.111</td>
<td>2</td>
<td>2743.056</td>
<td>.555</td>
<td>.577</td>
</tr>
<tr>
<td>Error</td>
<td>326354.167</td>
<td>66</td>
<td>4944.760</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1730000.0</td>
<td>72</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>436631.944</td>
<td>71</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. R Squared = .253 (Adjusted R Squared = .196)
29. A researcher wants to know if the number of people with 0, 1, 2 or 3 children is equal. In a random sample, there were 10 people with no children, 16 people with one child, 22 people with two children, and 12 people with three children. Answer the researcher’s question. Show all of your work.
A researcher conducted a study in which she factorially manipulated the temperature of a room (either 70° or 85°) and manipulated the humidity of the room (25% relative humidity or 95% relative humidity.) Each participant participated in a single condition. She then presented the participants with 10 opportunities to be aggressive and recorded the number of aggressive acts that each person performed. She wants to know if room temperature has an influence on aggressive behavior, whether relative humidity affects aggressive behavior and whether the two variables interact. Use SPSS to analyze her data. Explicitly answer her questions. Write your name on the SPSS output and turn it in with this sheet.

The numbers in the table represent the number of aggressive acts performed.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Relative Humidity</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25%</td>
<td>95%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70°</td>
<td>3</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>85°</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Formulae for Exam 4

1. Normal approximation to the binomial distribution: \( z = \frac{x - NP}{\sqrt{NP(1 - P)}} \), where \( x \) = number of observations in the category, \( N \) = sample size, and \( P \) = probability in question.

2. \( \chi^2 \) - One variable: \( \chi^2 = \sum \left[ \frac{(O_i - E_i)^2}{E_i} \right] \), where \( O_i \) = observed frequency of category \( i \), and \( E_i \) = expected frequency of category \( i \). DF = number of categories - 1

3. \( \chi^2 \) - Test of Independence: \( \chi^2 = \sum \sum \left[ \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \right] \), where \( O_{ij} \) = observed frequency of category in row \( i \), column \( j \), \( E_{ij} \) = expected frequency of category in row \( i \), column \( j \), \( r \) = number of rows, \( c \) = number of columns, and DF = \( (r - 1) \times (c - 1) \)

Critical Values of the \( \chi^2 \) Distribution

<table>
<thead>
<tr>
<th>df</th>
<th>0.1</th>
<th>0.05</th>
<th>0.02</th>
<th>0.01</th>
<th>0.002</th>
<th>0.001</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.706</td>
<td>3.841</td>
<td>5.412</td>
<td>6.635</td>
<td>9.549</td>
<td>10.827</td>
</tr>
<tr>
<td>11</td>
<td>17.275</td>
<td>19.675</td>
<td>22.618</td>
<td>24.725</td>
<td>29.354</td>
<td>31.264</td>
</tr>
<tr>
<td>13</td>
<td>19.812</td>
<td>22.362</td>
<td>25.471</td>
<td>27.688</td>
<td>32.536</td>
<td>34.527</td>
</tr>
<tr>
<td>14</td>
<td>21.064</td>
<td>23.685</td>
<td>26.873</td>
<td>29.141</td>
<td>34.091</td>
<td>36.124</td>
</tr>
<tr>
<td>15</td>
<td>22.307</td>
<td>24.996</td>
<td>28.259</td>
<td>30.578</td>
<td>35.627</td>
<td>37.698</td>
</tr>
<tr>
<td>16</td>
<td>23.542</td>
<td>26.296</td>
<td>29.633</td>
<td>32.000</td>
<td>37.146</td>
<td>39.252</td>
</tr>
<tr>
<td>17</td>
<td>24.769</td>
<td>27.587</td>
<td>30.995</td>
<td>33.409</td>
<td>38.648</td>
<td>40.791</td>
</tr>
<tr>
<td>18</td>
<td>25.989</td>
<td>28.869</td>
<td>32.346</td>
<td>34.805</td>
<td>40.136</td>
<td>42.312</td>
</tr>
<tr>
<td>19</td>
<td>27.204</td>
<td>30.144</td>
<td>33.687</td>
<td>36.191</td>
<td>41.610</td>
<td>43.819</td>
</tr>
<tr>
<td>20</td>
<td>28.412</td>
<td>31.410</td>
<td>35.020</td>
<td>37.566</td>
<td>43.072</td>
<td>45.314</td>
</tr>
<tr>
<td>21</td>
<td>29.615</td>
<td>32.671</td>
<td>36.343</td>
<td>38.932</td>
<td>44.522</td>
<td>46.796</td>
</tr>
<tr>
<td>22</td>
<td>30.813</td>
<td>33.924</td>
<td>37.659</td>
<td>40.289</td>
<td>45.961</td>
<td>48.268</td>
</tr>
<tr>
<td>23</td>
<td>32.007</td>
<td>35.172</td>
<td>38.968</td>
<td>41.638</td>
<td>47.392</td>
<td>49.728</td>
</tr>
<tr>
<td>24</td>
<td>33.196</td>
<td>36.415</td>
<td>40.270</td>
<td>42.980</td>
<td>48.811</td>
<td>51.179</td>
</tr>
<tr>
<td>25</td>
<td>34.382</td>
<td>37.652</td>
<td>41.566</td>
<td>44.314</td>
<td>50.223</td>
<td>52.619</td>
</tr>
</tbody>
</table>