PRACTICE FINAL: Answers

Question 1: Read the following article by Anahad O’Connor and provide the following information about the research described in the article:

1. Is the research an experiment or an observational study?

   OBSERVATIONAL STUDY

2. What are the dependent and independent variables (if any)?

   THREE DEPENDENT VARIABLES: AMOUNT OF CHOCOLATE EATEN, RATE OF SEXUAL AROUSAL, RATE OF SEXUAL DISTRESS

3. What level of measurement are the variables (Nominal, Ordinal, Interval/Ratio)?

   SERVINGS OF CHOCOLATE EATEN PER DAY: INTERVAL/RATIO

   RATE OF SEXUAL AROUSAL: INTERVAL/RATIO (APPROXIMATELY), ORDINAL WOULD ALSO BE AN ACCEPTABLE ANSWER

   RATE OF SEXUAL DISTRESS: INTERVAL/RATIO (APPROXIMATELY), ORDINAL WOULD ALSO BE AN ACCEPTABLE ANSWER

The Claim: Chocolate is an Aphrodisiac (New York Times, 7/18/2006)

The Aztecs may have been the first on record to draw a link between the cocoa bean and sexual desire: the emperor Montezuma was said to consume the bean in copious amounts to fuel his romantic trysts.

Nowadays, scientists ascribe the aphrodisiac qualities of chocolate, if any, to two chemicals it contains. One, tryptophan, is a building block of serotonin, a brain chemical involved in sexual arousal. The other, phenylethylamine, a stimulant related to amphetamine, is released in the brain when people fall in love.

But most researchers believe that the amounts of these substances in chocolate are too small to have any measurable effect on desire. Studies that have looked for a direct link between chocolate consumption and heightened sexual arousal have found none.

The most recent study, published in May in the journal Sexual Medicine, looked specifically at women, who are thought to be more sensitive to the effects of chocolate. The researchers, from Italy, studied a random sample of 163 adult women with an average age of 35 and found no significant differences between reported rates of sexual arousal or distress (both of these were reported on a scale of 1-5, with 1 being lowest) among those who regularly consumed one serving of chocolate a day, those who consumed three or more servings or those who generally consumed none. The study relied on self-reports. But it reflected what many researchers believe: if chocolate has any aphrodisiac qualities, they are probably psychological, not physiological.
You survey everyone in your COGS 14 class to find out how much cash they have on them. You plot your results with a histogram and get the above figure.

(a) How would you describe the distribution of this data (normal, bimodal, positively skewed or negatively skewed)?
POSITIVELY SKEWED

(b) What measure of central tendency would best describe this data (explain your answer)?
MEDIAN (BECAUSE THE MEDIAN IS LESS SENSITIVE TO THE OUTLIERS THAN THE MEAN AND BECAUSE THE MODE IS DIFFICULT TO USE WITH CONTINUOUS DATA)

(c) What measure of dispersion would best describe this data (explain your answer)?
INTERQUARTILE RANGE (BECAUSE THE INTERQUARTILE RANGE IS LESS SENSITIVE TO OUTLIERS THAN STANDARD DEVIATION AND RANGE)
**Question 3:** In your own words, explain what the statement “Our data show that exercise significantly decreases the risk of heart disease at an alpha level of .05” means?

If exercise does not affect one’s risk of heart disease, there is only a 5% chance that we would have gotten results like the ones we did (i.e., results that would have led us to reject the null hypothesis).

**Question 4:** Compute $p$-values for the following sample test statistics. Degrees of freedom are in parenthesis. (2 points each):

a) $t(20)=2.10$ (two-tailed test)
   \[ p<.05 \]

b) $F(3,10)=2.10$
   \[ p>.05 \]

c) $z=2.10$ (upper tailed test)
   \[ p=.0179 \]

**Question 5:** Give the sample size (i.e., number of experimental participants) for the following statistics and tests:

a) $t(20)$, independent samples $t$-test
   \[ 22 \text{ participants} \]

b) $t(20)$, repeated measures $t$-test
   \[ 21 \text{ participants} \]
**Question 6:** Some scientists measure two variables, X and Y, which they think might be related. To find out, they make a scatter plot of these measurements:

Which of the following is the value of $r$, Pearson’s linear correlation coefficient, for these data? *You should be able to answer this without having to actually compute $r$. (4 pts)*:

- a) 0.97
- b) 0.42
- c) 0.02
- d) $-0.02$
- e) -0.42
- f) $-0.97$
**Question 7:** Reaction time (the time it takes for someone to respond to an event) generally has a positively skewed distribution like this:

![Typical Reaction Time Distribution](image)

a) A scientist wants to know if it takes him longer to press a button in response to a light flash with his left or right hand and carries out the following experiment. A light flashes red or green. If it flashes red, he presses the button with his left hand as quickly as possible. If it flashes green, he presses the button with his right hand as quickly as possible. The light flashes 10 times total (5 red and 5 green). What type of hypothesis test should the scientist use to analyze his data (\(z\)-test, one sample \(t\)-test, independent samples \(t\)-test, repeated measures \(t\)-test, binomial/sign test, one factor ANOVA, repeated measures one factor ANOVA, two-factor ANOVA, or “none of these”). **Explain your answer.**

None of these tests would be appropriate, because we want to compare the central tendency of two independent groups of data (i.e., the data are not paired across groups) and the samples do not come from a normal distribution.

b) The scientist repeats the experiment but now the light flashes 500 times (250 red and 250 green). Now, what type of hypothesis test should the scientist use to analyze his data (\(z\)-test, one sample \(t\)-test, independent samples \(t\)-test, repeated measures \(t\)-test, binomial/sign test, one factor ANOVA, repeated measures one factor ANOVA, two-factor ANOVA, or “none of these”). **Explain your answer.**

An independent samples \(t\)-test would be the most appropriate, because we want to compare the central tendency of two independent groups of data (i.e., the data are not paired across groups), the number of samples is relatively large, the number of samples is equal in both groups, and in such situations the independent samples \(t\)-test will be accurate. Even though the samples do not come from a normal distribution, the sample mean will come from an approximately normal distribution because of the relatively large sample size (i.e., due to the Central Limit Theorem), thus the independent samples \(t\)-test assumption that the samples come from a normal distribution is valid. Since there are an equal number of samples in each group, the independent samples \(t\)-test assumption of equal variances across groups should also be valid.
**Question 8:** A classical music radio station wants to know if listening to classical music enhances intelligence more than listening to rock music. The radio station hires a scientist to administer IQ tests to six volunteers. 200 is a perfect score on the test and 0 is the worst possible score. She gets the following IQ scores:

<table>
<thead>
<tr>
<th>Subject</th>
<th>Classical</th>
<th>Rock</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>93</td>
<td>78</td>
</tr>
<tr>
<td>B</td>
<td>115</td>
<td>125</td>
</tr>
<tr>
<td>C</td>
<td>87</td>
<td>75</td>
</tr>
<tr>
<td>D</td>
<td>122</td>
<td>123</td>
</tr>
<tr>
<td>E</td>
<td>99</td>
<td>97</td>
</tr>
<tr>
<td>F</td>
<td>84</td>
<td>71</td>
</tr>
</tbody>
</table>

Choose the most appropriate hypothesis test for this problem and execute it. Assume the data come from populations that are normally distributed unless you have evidence to believe otherwise. In performing the test please fill out the following form:

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>$N(\mu_D=0, \sigma_D=?)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative Hypothesis</td>
<td>$\mu_D&gt;0$</td>
</tr>
<tr>
<td>Tail of Test</td>
<td>Upper tailed</td>
</tr>
<tr>
<td>Type of Test (z-test, one sample t-test, repeated measures t-test, or “none of these”)</td>
<td>repeated measures t-test</td>
</tr>
<tr>
<td>Alpha level</td>
<td>0.05</td>
</tr>
<tr>
<td>Critical Value(s) of Test Statistic</td>
<td>$t(5)=2.015$</td>
</tr>
<tr>
<td>Observed Value of Test Statistic</td>
<td>$t(5)=1.2879$</td>
</tr>
<tr>
<td>Decision</td>
<td>Retain Null Hypothesis</td>
</tr>
<tr>
<td>p-value of Observed Value of Test Statistic</td>
<td>$p&gt;.05$</td>
</tr>
<tr>
<td>Cohen’s $d$ of Observed Difference</td>
<td>.53</td>
</tr>
</tbody>
</table>

**Question 9:** Provide 95% (upper and lower bound) confidence intervals for your estimate of the mean difference between Classical Music and Rock Music in Question 8 (8 pts total)

$$5.17\pm 2.571*4.012 = 5.17 \pm 10.31$$

lower bound=-5.14, upper bound=15.48
### Question 10:

A researcher wants to know if day-to-day levels of corticotropin-releasing hormone (CRH, a hormone that is released when a person experiences stress) differ across different industrialized nations. To find out, he takes blood samples from 25 people in five different countries (the United States, Germany, France, Italy, and Japan) and measures the amount of CRH in each sample. Circle which of the following hypothesis tests the researcher should use to analyze his data? Assume the data come from a normal distribution unless you have reason to believe otherwise. Circle only one answer. (6 pts)

a) z-test  
b) one sample t-test  
c) repeated measures t-test  
d) independent samples t-test  
e) t-test of Pearson’s r  
f) Mann-Whitney U test  
g) binomial (sign test)  
h) **independent samples one factor ANOVA**  
i) repeated measures one factor ANOVA  
j) independent samples two factor ANOVA
**Question 11:** (2 pts for each part, 20 pts total): A lab conducts a study of the effects of social and physical discomfort on time perception. 16 volunteers are told to walk across campus and to estimate the time of their trip when they arrive at their destination. Each volunteer does this three times: once in normal clothing, once wearing a hat covered in plastic fruit and a t-shirt that says “Weirdus Maximus” (which is socially uncomfortable), and once wearing long underwear under the clothes (which is physically uncomfortable). The lab measures the difference between the actual travel time and the estimated travel time. They use a repeated measures one factor ANOVA to analyze their results (3*16=48 total observations). Complete the lettered squares of their ANOVA table, compute the p-value of the resulting F ratio, and compute the partial eta squared (\(\eta^2_p\)) of the effect of discomfort.

### One Factor Analysis of Variance (Repeated Measures)

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>98</td>
<td>a) 2</td>
<td>f) 49</td>
<td>h) 4.9</td>
</tr>
<tr>
<td>Within</td>
<td>840</td>
<td>b) 45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subjects</td>
<td>540</td>
<td>c) 15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>300</td>
<td>d) 30</td>
<td>g) 10</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>938</td>
<td>e) 47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p-value: p < .05

* partial eta squared (\(\eta^2_p\)): .25
Question 12: Imagine that you read the following statement in a report on the effects of afternoon naps on learning a new language: “Several healthy undergraduates volunteered for the study. A randomly determined half of the volunteers were assigned to take naps in the afternoon and the other participants were not allowed to take naps. In the late afternoon (an hour or two after naptime), the volunteers were trained for an hour on a new foreign language (i.e., Swahili). After two weeks of this procedure, the Swahili knowledge of the participants was tested. The mean test score of the individuals who had taken naps was 85 (out of 100). The mean test score of the napless volunteers was 80. Although the volunteers who had taken naps did better on average (as we expected), a one tailed independent samples \( t \)-test showed that this difference failed to reach significance (\( t(4)=1.12, p>.05, \) Cohen’s \( d=1.6) \).” What can be inferred from these data about the effects of napping on the ability to learn a new language? How certain can we be that napping does or doesn’t help language learning? Be sure to discuss the specific statistics given in the statement. You should be able to answer this question with about three to five sentences. (6 pts)

Not much can be inferred from these data about the effect of napping on the ability to learn a new language. First of all, since the p-value is greater than .05, we cannot reject the null hypothesis that napping has no effect on language learning. In other words, there is not sufficient evidence to prove that napping does help language learning. However, the sample size for the study is quite small (6 participants), the experiment was a between-subjects design, and Cohen’s \( d \) suggests that there is a potentially large effect of napping on language learning. These statistics and the design of the study suggest the analysis is making a Type II Error. If the study was repeated with a larger sample size and with a within-subjects design (which controls for individual variability), it would quite possibly prove that napping helps language learning.