11.E: Tests of Means (Exercises)

General Questions

Q1

The scores of a random sample of 8 students on a physics test are as follows: $60, 62, 67, 69, 70, 72, 75, 78$

a. Test to see if the sample mean is significantly different from 65 at the 0.05 level. Report the t and p values.

b. The researcher realizes that she accidentally recorded the score that should have been 76 as 67. Are these corrected scores significantly different from 65 at the 0.05 level? (relevant section)

Q2

A (hypothetical) experiment is conducted on the effect of alcohol on perceptual motor ability. Ten subjects are each tested twice, once after having two drinks and once after having two glasses of water. The two tests were on two different days to give the alcohol a chance to wear off. Half of the subjects were given alcohol first and half were given water first. The scores of the 10 subjects are shown below. The first number for each subject is their performance in the "water" condition. Higher scores reflect better performance. Test to see if alcohol had a significant effect. Report the t and p values. (relevant section)

water	alcohol
16	13
15	13
11	10
20	18
19	17
14	11
13	10
15	15
14	11
16	16

Q3

The scores on a (hypothetical) vocabulary test of a group of 20 year olds and a group of 60 year olds are shown below.

20 yr olds	60 yr olds
27	26
26	29
21	29
24	29
15	27
18	16
17	20
12	27
13	

a. Test the mean difference for significance using the 0.05 level. (relevant section).

b. List the assumptions made in computing your answer.(relevant section)

Q4

The sampling distribution of a statistic is normally distributed with an estimated standard error of 12, $(df = 20)$.

a. What is the probability that you would have gotten a mean of 107 (or more extreme) if the population parameter were 100? Is this probability significant at the 0.05 level (two-tailed)?

b. What is the probability that you would have gotten a mean of 95 or less (one-tailed)? Is this probability significant at the 0.05 level? You may want to use the t Distribution calculator for this problem. (relevant section)

Q5

How do you decide whether to use an independent groups t test or a correlated t test (test of dependent means)? (relevant section & relevant section)

Q6

An experiment compared the ability of three groups of subjects to remember briefly-presented chess positions. The data are shown below.

Non-players	Beginners	Tournament players
22.1	32.5	40.1
22.3	37.1	45.6
26.2	39.1	51.2
29.6	40.5	56.4
31.7	45.5	58.1
33.5	51.3	71.1
38.9	52.6	74.9
39.7	55.7	75.9
43.2	55.9	80.3
43.2	57.7	85.3

a. Using the Tukey HSD procedure, determine which groups are significantly different from each other at the 0.05 level. (relevant section)

b. Now compare each pair of groups using t-tests. Make sure to control for the familywise error rate (at 0.05) by using the **Bonferroni correction**. Specify the alpha level you used.

Q7

Below are data showing the results of six subjects on a memory test. The three scores per subject are their scores on three trials (a, b, and c) of a memory task. Are the subjects getting better each trial? Test the linear effect of trial for the data.

a	b	c
4	6	7
3	7	8
2	8	5
1	4	7
4	6	9

2	4	2

a. Compute L for each subject using the contrast weights -1, 0, and 1. That is, compute $(-1)(a)+(0)(b)+(1)(c)$ for each subject.
b. Compute a one-sample t-test on this column (with the L values for each subject) you created. (relevant section)

Q8

Participants threw darts at a target. In one condition, they used their preferred hand; in the other condition, they used their other hand. All subjects performed in both conditions (the order of conditions was counterbalanced). Their scores are shown below.

Preferred	Non-preferred
12	7
7	9
11	8
13	10
10	9

a. Which kind of t-test should be used?
b. Calculate the two-tailed t and p values using this t test.
c. Calculate the one-tailed t and p values using this t test.

Q9

Assume the data in the previous problem were collected using two different groups of subjects: One group used their preferred hand and the other group used their non-preferred hand. Analyze the data and compare the results to those for the previous problem (relevant section)

Q10

You have 4 means, and you want to compare each mean to every other mean.

a. How many tests total are you going to compute?
b. What would be the chance of making at least one **Type I** error if the **Type I** error for each test was 0.05 and the tests were independent? (relevant section & relevant section)
c. Are the tests independent and how does independence/non-independence affect the probability in (b).

Q11

In an experiment, participants were divided into 4 groups. There were 20 participants in each group, so the degrees of freedom (error) for this study was $80-4=76$. Tukey's HSD test was performed on the data.

a. Calculate the p value for each pair based on the Q value given below. You will want to use the Studentized Range Calculator.
b. Which differences are significant at the 0.05 level? (relevant section)

Comparison of Groups	Q
A - B	3.4
A - C	3.8
A - D	4.3
B - C	1.7
B - D	3.9
C - D	3.7

Q12

If you have 5 groups in your study, why shouldn't you just compute a t test of each group mean with each other group mean? (relevant section)

Q13

You are conducting a study to see if students do better when they study all at once or in intervals. One group of 12 participants took a test after studying for one hour continuously. The other group of 12 participants took a test after studying for three twenty minute sessions. The first group had a mean score of 75 and a variance of 120. The second group had a mean score of 86 and a variance of 100.

a. What is the calculated t value? Are the mean test scores of these two groups significantly different at the 0.05 level?
b. What would the t value be if there were only 6 participants in each group? Would the scores be significant at the 0.05 level?

Q14

A new test was designed to have a mean of 80 and a standard deviation of 10. A random sample of 20 students at your school take the test, and the mean score turns out to be 85. Does this score differ significantly from 80? To answer this problem, you may want to use the Normal Distribution Calculator.(relevant section)

Q15

You perform a one-sample t test and calculate a t statistic of 3.0. The mean of your sample was 1.3 and the standard deviation was 2.6. How many participants were used in this study? (relevant section)

Q16

True/false: The contrasts $(-3, 111)$ and $(0, 0, -1, 1)$ are orthogonal. (relevant section)

Q17

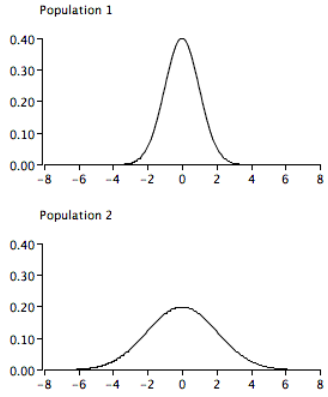
True/false: If you are making 4 comparisons between means, then based on the **Bonferroni correction**, you should use an alpha level of 0.01 for each test. (relevant section)

Q18

True/false: Correlated t tests almost always have greater power than independent t tests. (relevant section)

Q19

True/false:The graph below represents a violation of the homogeneity of variance assumption. (relevant section)



Q20

True/false: When you are conducting a one-sample t test and you know the population standard deviation, you look up the critical t value in the table based on the degrees of freedom. (relevant section)

Questions from Case Studies

The following questions use data from the Angry Moods (AM) case study.

Q21

(AM#17) Do athletes or non-athletes calm down more when angry? Conduct a t test to see if the difference between groups in Control-In scores is statistically significant.

Q22

Do people in general have a higher Anger-Out or Anger-In score? Conduct a t test on the difference between means of these two scores. Are these two means independent or dependent? (relevant section)

The following questions use data from the Smiles and Leniency (SL) case study.

Q23

Compare each mean to the neutral mean. Be sure to control for the familywise error rate. (relevant section)

Q24

Does a "felt smile" lead to more leniency than other types of smiles?

a. Calculate L (the linear combination) using the following contrast weights
$false: -1,\ felt: 2,\ miserable: -1,\ neutral: 0$.
b. Perform a significance test on this value of L. (relevant section)

The following questions are from the Animal Research (AR) case study.

Q25

(AR#8) Conduct an independent samples t test comparing males to females on the belief that animal research is necessary. (relevant section)

Q26

(AR#9) Based on the t test you conducted in the previous problem, are you able to reject the null hypothesis if $alpha = 0.05$? What about if $alpha = 0.1$? (relevant section)

Q27

(AR#10) Is there any evidence that the t test assumption of homogeneity of variance is violated in the t test you computed in #25? (relevant section)

The following questions use data from the ADHD Treatment (AT) case study.

Q28

Compare each dosage with the dosage below it (compare $d0$ and $d15$, $d15$ and $d30$, and $d30$ and $d60$). Remember that the patients completed the task after every dosage.

a. If the familywise error rate is 0.05, what is the alpha level you will use for each comparison when doing the Bonferroni correction?
b. Which differences are significant at this level? (relevant section)

Q29

Does performance increase linearly with dosage?

a. Plot a line graph of this data.
b. Compute L for each patient. To do this, create a new variable where you multiply the following coefficients by their corresponding dosages and then sum up the total: $(-3)d0 + (-1)d15 + (1)d30 + (3)d60$ (see #8). What is the mean of L?
c. Perform a significance test on L. Compute the 95% confidence interval for L. (relevant section)

Select Answers

S1

a. $t(7) = 1.91$

S4

b. 0.035

S7

b. two-tailed $p = 0.0088$

S8

b. $p = 0.1662$

S11

a. $A - B : p = 0.085$

S13

a. $t(22) = 2.57$

S23

$t(76) = 3.04$

S25

a. $p = 0.0745$

S29

c. $p = 0.0006$
