Short Answer Examples

1. Define the *distribution of sample means.* How is this distribution used in hypothesis testing?
2. A new drug is found to significantly reduce depression, as compared to a placebo control group ($t(199) = 3.02$, $p < .05$, $d = .01$). Does this drug appear to be a practical means of treating depression? Explain your answer.
3. What is the difference between Type I and Type II error in hypothesis testing? How are the two types of error related?
4. Describe what is measured by the standard error of the mean. Why is this a useful concept for hypothesis testing?
5. Briefly explain an advantage of using a repeated-measures design as opposed to an independent-measures design.

1. *The distribution of sample means is the set of sample means obtained from all the possible random samples of a specified size (n) taken from a particular population. A distribution of sample means allows us to determine if any given sample mean is likely to occur if the null hypothesis is true.*
2. *This drug is significantly different from control, but since the effect size is so low, it probably isn't a practical means of treating depression.*
3. *Type I error is the likelihood of incorrectly rejecting the null hypothesis, whereas type II error is the likelihood of incorrectly failing to reject the null hypothesis. As type I error increases, type II error decreases.*
4. *The standard error of the mean is the standard deviation for the distribution of sample means, and measures the standard distance (or deviation) between a sample mean M and the population mean μ. This is useful for hypothesis testing because we can compare actual to expected deviation between M and μ to decide whether or not to reject the null hypothesis.*
5. *A repeated measures design tends to be more powerful than an independent measures design because it eliminates variability due to individual differences. [Also, a repeated-measure design uses fewer subjects than an independent-measures design and allows you to look at changes over time.]*

Rubric:

- **5 marks = accurate, complete answer that is clearly communicated**
- **4 marks = accurate and mostly complete or complete yet a bit unclear**
- **3 marks = satisfactory answer – not incomplete but mainly accurate and mostly clear**
- **2 marks = unsatisfactory answer – incomplete, unclear but with some accuracy and understanding**
- **1 mark = poor – incomplete, unclear, not totally inaccurate**
- **0 marks = incomplete, inaccurate, unclear**

Computational Section #1

(14 marks) Previous research shops that pet owners are less anxious than are people who don't own pets. A developmental psychologist is studying the effects of pets on anxiety in children. Five children have their anxiety level measured one week before receiving a new pet, and then again six weeks later. The resulting data are presented below. Higher scores mean higher stress.

a) Does pet ownership reduce anxiety in children? Use an alpha level of .05.
b) What is the size of this effect as estimated Cohen's d?

Participant	Before Pets	After Pets
1	27	26
2	32	28
3	31	28
4	30	27
5	23	19
Sum	**143**	**128**
Mean	**28.6**	**25.6**

Participant	Before Pets	After Pets	D	(D-M)	$(D\text{-}M)^2$
1	27	26	1	-2	4
2	32	28	4	1	1
3	31	28	3	0	0
4	30	27	3	0	0
5	23	19	4	1	1
Sum	**143**	**128**	**15**	**0**	**6**
Mean	**28.6**	**25.6**	**$M_D = \sum D/n$ $M_D = 15/5$ $M_D = 3.00$**		

H0: $\mu D \leq 0$ (or $\mu D \geq 0$ if calculated D scores as X2-X1) **[1]**
H1: $\mu D > 0$ (or $\mu D < 0$ if calculated D scores as X2-X1) **[1]**

H0: Pet ownership does not decrease anxiety. **[1]**
H1: Pet ownership does decrease anxiety. **[1]**

$\mu_D = 0$
$M = \Sigma D/n = 15/5 = 3.00$
$s^2 = \sum(D-M)^2/(n-1) = 6/(5-1) = 6/4 = 1.50$

$s_M = sqrt(s^2 / n) = sqrt(1.50/5) = 0.55$
Mean: [0.5] for formula,[0.5] for correct answer
s2: [0.5] for formula,[0.5] for correct answer
est. standard error: [0.5] for formula,[0.5] for correct answer

alpha = .05, one-tailed **[0.5]** df = n-1 = 5-1 = 4 **[0.5]**
t-crit = 2.132 (or -2.132 if subtract as X2 - X1) **[0.5]**
If t > 2.132, reject Ho. **[0.5]** (or If t < -2.132, reject H0. if subtract as X2-X1)

$t = (M_D - \mu)/s_M = (3-0)/.55 = 5.48$
t: [0.5] for formula,[0.5] for correct answer

Reject Ho and conclude that the pets significantly reduced anxiety, $t(4) = 5.48$, $p < .05$.

[1] for "reject Ho", [0.5] for "significantly], [0.5] for reduces (direction), [0.5] for both naming variables in concluding statement (e.g., pets & anxiety)), [0.5] for APA.

b)

$d = M_D/s = 3/1.22 = 2.46$

This is a large effect size.

d: [0.5] for correct value [0.5] for "large effect" (i.e., correct effect size given calculated d)

Make sure d value matches interpretation: d cut-offs are .20, .50 and .80 for small, medium & large

/14

Computational Section #2

(17 marks) A cognitive neuropsychologist is studying the role of the neurotransmitter dopamine in aggression. A group of rats is bred to have abnormally high levels of dopamine receptors. Another group of rats with standard dopamine receptor levels serves as a control group. After reaching maturity, the average number of aggressive responses of each rat is assessed over a one-hour period. The data are presented below.

a. Does expression of dopamine receptors have a significant effect on aggression? Use an alpha level of .05.
b. After hypothesis testing (steps #2-6), write a full APA style conclusion for this example (2-4 sentences).

Standard # Dopamine Receptors	High # Dopamine Receptors
n=4	n=8
M=18	M=14
s^2 = 25.33	s^2 = 23.43

Let the standard dopamine group = 1, let the high dopamine group = 2.

H0: μ1 −μ2 =0 **[1]**
H1: μ1 −μ2 ≠0 **[1]**
Ho: Dopamine receptor expression has no effect on aggression. **[1]**
H1: Dopamine receptor expression has an effect on aggression. **[1]**

μ_{M1}-μ_{M2} = 0

$$s^2_{pooled} = \left(\frac{df_1}{df_{total}}\right)s_1^2 + \left(\frac{df_2}{df_{total}}\right)s_2^2 = \left(\frac{3}{10}\right)25.33 + \left(\frac{7}{10}\right)23.43$$

$$s^2_{pooled} = 7.599 + 16.401 = 24.00$$

$$s^2_{M_1} = \frac{s^2_{pooled}}{n_1} = \frac{24}{4} = 6.00$$

$$s^2_{M_2} = \frac{s^2_{pooled}}{n_2} = \frac{24}{8} = 3.00$$

$$s_{difference} = \sqrt{s^2_{difference}} = \sqrt{s^2_{M_1} + s^2_{M_2}}$$

$$s_{difference} = \sqrt{s^2_{M_1} + s^2_{M_2}} = \sqrt{6+3} = \sqrt{9} = 3.00$$

pooled variance: [0.5] for formula, [0.5] for correct answer
squared standard errors: [0.5] for formula once, [0.5] for both correct
est. standard error of difference: [0.5] for formula, [0.5] for correct answer

alpha = .05, two-tailed **[0.5 for both]**
df = df1+df2 = n1 + n2 - 2 = 4+8-2 = 10 **[0.5]**
t-crit = ±2.228 **[0.5]**
If t < -2.228 or t > +2.228, reject Ho. **[0.5]**

$$t = \frac{(M_1 - M_2) - (\mu_1 - \mu_2)}{s_{difference}} = \frac{(18-14)-0}{3} = 1.33$$

t: [0.5] for formula, [0.5] for correct answer

Do not reject Ho as there is no evidence that dopamine receptor expression has a significant effect on aggression, t(10) = 2.67, *ns.*

[1] for "Do not reject Ho", [0.5] for "no evidence", [0.5] for "significant", [0.5] for naming both variables in conclusion (dopamine receptor/aggression), [0.5] for APA.

Based on the current results, there was no evidence of a significant difference in aggressive responses between rats with high levels of dopamine receptors (*M* = 14, *SD* = 4.84) and rats with normal levels of dopamine receptors (*M* = 18, *SD* = 5.03), *t*(10) = -2.67, *ns*.

[0.5] for each M & SD (for [2] total)
[1] for APA style statistical conclusion
[1] for naming variables (IV/DV = dopamine levels/aggressive responses)

Computational Section #3

(13 marks) A social psychologist is interested in whether an intervention to reduce littering is successful. Previous research shows that providing social comparison feedback decreases the frequency of behaviours that people think are unpopular. The social psychologist knows that mean weight of litter per location tested before the intervention was $\mu = 25$kg. Based on a sample of 100 locations, after running the littering intervention for one year, the mean amount of litter produced per location was $M = 20$kg with $s = 12$. Using a significance level of .05, what should the researcher conclude about the success of the littering intervention? That is, do people litter less after the intervention than they did before?

H0: The intervention does not decrease littering. **(1)**

H1: The intervention does decrease littering. **(1)**

H0: $\mu \geq 25$**(1)**

H1: $\mu<25$ **(1)**

$\mu M = 0$

$s_M = s/sqrt(n) = 12/sqrt(100) = 1.20$

0.5 for est. standard error formula, 0.5 for correct answer) (can also use formula with SD)

$\alpha = .05$, one-tailed **(1)**

df=n-1=100-1=99 **(0.5)**

t-crit = -1.671 **(0.5)** (NB: incorrect if use t = 1.289 or other values)

If $t < -1.671$, reject Ho. **(1)**

$t = (M-\mu)/s_M = (20-25)/1.20 = -4.17$

(0.5 for t formula, 0.5 for correct answer)

Reject Ho and conclude that the intervention significantly reduced littering, $t(99) = -4.17$, $p < .05$.

(1 for "reject Ho",1 for naming IV and DV in conclusion, 0.5 for "significantly", 0.5 for direction of effect, 1 for APA)

Multiple Choice

1. Which of the following samples will produce the largest value for the estimated standard error?

   a. *n=16 with* s^2 =400

   b. *n=16 with* s^2 =100

   c. *n=25 with* s^2 =400

   d. *n=25 with* s^2 =100

2. For a population with μ = 80 and σ = 20, the distribution of sample means based on *n* = 16 will have an expected value of _____ and a standard error of _____.

   a. 80,5

   b. 20, 20

   c. 5,80

   d. 80, 1.25

3. A researcher uses a hypothesis test to evaluate H0:μ = 80. If the researcher obtains a sample mean of *M* = 88, which combination of factors is most likely to result in rejecting the null hypothesis?

   a. σ=10 and n=25

   b. σ=5 and n=50

   c. σ=5 and n=25

   d. σ=10 and n=50

4. Which set of sample characteristics is most likely to produce a significant value for the independent-samples t statistic?

   a. a small mean difference and small sample variances

   b. a small mean difference and large sample variances

   c. a large mean difference and small sample variances

   d. a large mean difference and large sample variances

5. What additional information is obtained by measuring on an ordinal scale compared to a nominal scale?
   a. whether the measurements are the same or different
   b. the size of the differences
   c. the direction of the differences
   d. none of the above

6. On an exam with a mean of $\mu = 70$, you have a score of $X = 65$. Which of the following values for the standard deviation would give you the highest position within the class?
   a. $\sigma=5$
   b. $\sigma=10$
   c. $\sigma=1$
   d. cannot determine from the information given

7. A normal distribution has $\mu = 80$ and $\sigma = 10$. What is the probability of randomly selecting a score greater than 75 from this distribution?
   a. $p = 0.5000$
   b. $p = 0.3085$
   c. $p = 0.6915$
   d. $p = 0.2500$

1. ANS: A
2. ANS: A
3. ANS: B
4. ANS: C
5. ANS: C
6. ANS: B
7. ANS: C