

ANSWERS TO ODD-NUMBERED PROBLEMS

CHAPTER 1

Multiple-Choice Questions _____

1. 2 3. 1 5. 4 7. 3 9. 3
11. 1 13. 4 15. 1 17. 2 19. 1

Short-Answer Questions _____

1.
 - a. A descriptive statistic is an index number that is in some way characteristic of or informative about a large group of numbers. Inferential statistics is a method of drawing conclusions about populations from samples taken from populations.
 - b. A population contains all of the scores that exist for a given group. A sample is a subset of scores drawn from that group.
 - c. Different numbers on an *interval scale* have the following relationships: different numbers stand for different things (or amounts); larger numbers mean more of the thing than smaller numbers; and the differences between numbers on the scale are all the same. *Ordinal scales* have only the first and second characteristics named here.

Problems _____

- 1A.
 - a. room color
 - b. 3; red, blue, and white
 - c. mood survey scores
 - d. all worked the same logic problems, amount of time in the room
 - e. room color
 - f. mood survey; ordinal
 - g. The mood of participants working difficult problems was affected by the color of the room. A red room led to participants being more agitated than working in a white room. Participants working in a blue room reported being calmest of all.

- 1B.
 - a. parenting style
 - b. 3; authoritarian, authoritative, permissive

- c. GPA
- d. age of the participants
- e. parenting style
- f. GPA; interval is a good answer; ordinal is acceptable
- g. Khiela's study did not show that parenting style has an effect on college grade point average.

3. What are the lower and upper limits of the following numbers?

- a. 1.25 – 1.35
- b. 7.5 – 8.5
- c. 22.5-23.5°F
- d. \$45.495 - \$45.505
- e. 9.995-10.005 grams

5. Identify the kind of scale that each set of values comes from.

- a. nominal
- b. nominal
- c. ratio
- d. interval
- e. nominal
- f. ordinal
- g. ratio

7. Identify each measurement below as being based on a quantitative or qualitative variable. For quantitative variables identify the lower and upper limits of the measurement.

- a. Quantitative: 413.5-414.5
- b. Quantitative: 15.5 – 16.5
- c. Qualitative
- d. Quantitative: 2.95-3.05
- e. Quantitative: 101.85-101.95
- f. Quantitative: 23.945-23.955
- g. Quantitative: 4 minutes, 14.5 seconds - 4 minutes, 15.5 seconds
- h. Quantitative: 0.865-0.875

9. The independent variable is deprivation with levels of thirst, hunger and sex. The dependent variable is the amount of electrical shock the rat tolerated. Age, gender, and experience of the rat should have been controlled (Other answers can be correct here.)

CHAPTER 2

Multiple Choice _____

1. 4 3. 4 5. 4 7. 3 9. 1
11. 4 13. 2 15. 4

Short-Answer Questions _____

1. A frequency polygon consists of dots connected by lines and is used to present one or more sets of quantitative data. A histogram, which consists of touching bars, is used to present one set of quantitative data. A bar graph has space between the bars and is used to present qualitative data. A line graph shows the relationship between two variables.

Problems _____

1. a.

X	f
11	1
10	3
9	6
Σ	10

This distribution is positively skewed.

b.

X	f
6	1
5	4
4	2
3	1
2	4
1	1
Σ	13

This distribution is bimodal.

3.

X	f
4	6
3	3
2	5
1	3
0	23
Σ	40

Most people drive to work. The distribution is positively skewed.

5.

GRE scores Class Interval	<i>f</i>
237-245	1
228-236	1
219-227	0
210-218	2
201-209	0
192-200	2
183-191	3
174-182	5
165-173	6
156-164	4
147-155	4
138-146	1
129-137	3
120-128	2
111-119	1
<hr/>	
$\Sigma = 35$	

Chapter 3

Multiple-Choice Questions _____

1. 3 3. 2 5. 2 7. 1 9. 3
11. 3 13. 3 15. 3 17. 3 19. 1

Short-Answer Questions _____

1. The median should be used if a class interval is open ended, the observations are nominal or ordinal data, or if the distribution is severely skewed.
3. The median would be smaller. The mean is pulled toward the higher scores when a distribution is skewed, as this one is. The median, unaffected by skewness, remains in the center of the distribution.

5. σ is the standard deviation of a population. \hat{s} is used to estimate a population standard deviation from a sample and S is used to describe the variability of a sample of data when you have no intention of drawing inferences about the larger population.

Problems

1. Did you estimate a central tendency value before you began the problem? "About 6" is a good estimate.

X	f
6.2	1
6.1	2
5.9	1
5.8	1
Σ	3495

$$\text{Mean} = \bar{X} = \frac{30.1}{5} = 6.02. \text{ Median location} = \frac{N+1}{2} = \frac{5}{2} = 2.5. \text{ The}$$

median is among the two 6.1's. The median is 6.1. The mode is 6.1.

Bonus answer: Avogadro claims 6.02 as his number. (In 1811, the Italian physicist, Avogadro (1776-1856) hypothesized that equal volumes of gas under equal conditions contain equal numbers of molecules. We now know that under a standard condition, that number is 6.02×10^{23} , a quantity referred to as Avogadro's number.)

3. College students: mean = 3.75, median = 4, mode = 4, 5
Older adults: mean = 2.27, median = 2, mode = 1
5. Men: Range: 244-112=132 pounds

Interquartile range: $N = 35$. Thus, $.25 \times 35 = 8.75$. Counting from the top of the distribution to find the 75th percentile, you find 6 frequencies above the interval 183-191 pounds (which has 3 frequencies). The 75th percentile is the midpoint of the interval, 187 pounds. Counting from the bottom of the distribution for the 25th percentile, you find 7 frequencies below the interval

of 147-155 pounds (which has 4 frequencies). The 25th percentile is 151, the midpoint of the interval.

IQR = 187-151 = 36 pounds.

Women: Range: 218-95= 123 pounds

Interquartile range: $N = 35$. Thus, $.25 \times 35 = 8.75$. Counting from the top of the distribution to find the 75th percentile, you find 6 frequencies above the interval 154-162 pounds. The 75th percentile is the midpoint of the interval, 158 pounds. The 8.75th score from the bottom is among the 6 in the interval, 118-126 pounds. The 25th percentile is 122. IQR = 158-122 = 36 pounds.

7.

X	f	$X - \bar{X}$	$(X - \bar{X})^2$	$f(X - \bar{X})^2$
9	1	2	4	4
8	2	1	1	2
7	6	0	0	0
6	2	-1	1	2
5	1	-2	4	4
	$\Sigma = 15$	0		12

$$\sigma = \sqrt{\frac{\sum f(X - \bar{X})^2}{N}} = \sqrt{\frac{12}{15}} = 1.00 \text{ digit};$$

Range = 9-5 = 4; IQR = 8 - 6 = 2 digits.

9.

X	X^2
17	289
14	196
11	121
10	100
8	64
$\Sigma =$	60 770

$$\bar{X} = 12.00$$

$$\sum X = 60$$

$$\sum X^2 = 770$$

$$\sigma = \sqrt{\frac{770 - \frac{60^2}{5}}{5}} = 3.16$$

$$\sigma^2 = 10$$

Chapter 4

Multiple choice _____

1. 3 3. 3 5. 2 7. 1 9. 3
11. 3 13. 4 15. 4 17. 1 19. 4

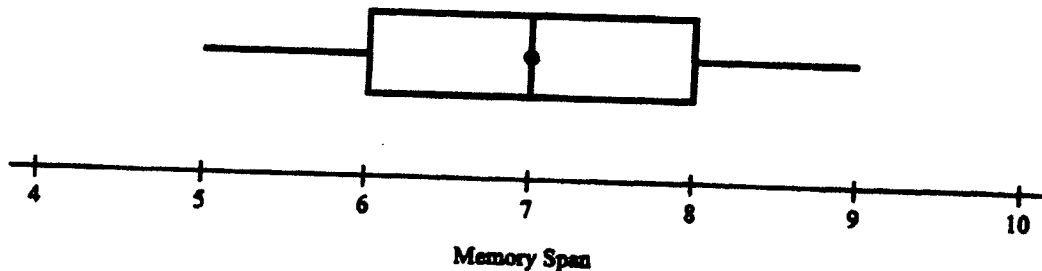
Short-Answer Questions _____

1. A z of 0 is the z score for the mean in a distribution of raw scores.

3. A boxplot shows the mean, median, range and interquartile range. By comparing the positions of the mean and median and by comparing the length of the whiskers, you can determine if the distribution is symmetrical or skewed and the direction of skew.

Problems _____

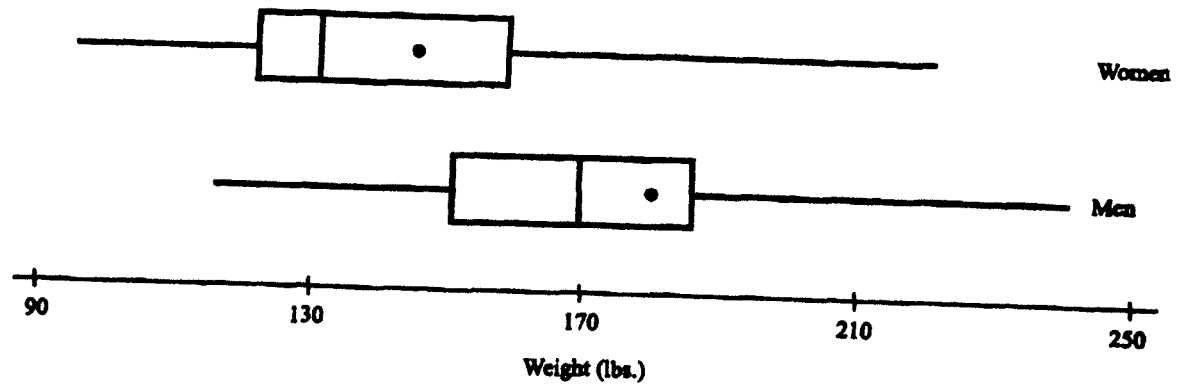
1.



The average number of digits a person can hear and repeat without error is symmetrically distributed about 7. The range is 5 to 9 digits; the IQR is 2

digits; σ is 1.00. (A common way to summarize this universal finding is that human memory span is 7 ± 2 chunks. A digit is an example of a chunk.)

3.



Weights are positively skewed; for men ages 20-29, mean weight is 180 pounds, the median is 169 pounds. For women of the same age, the mean is 145 pounds, the median is 131 pounds. Men weigh more than women; the effect size is 0.88, a value that is considered large. There is, however, some overlap among the middle 50 percent of each population.

5. $d = 0.10$ is a small effect size, suggesting that the difference in cognitive ability between first born children and second born children is not substantial.

7. a. 92 b. 121 c. 141 d. 71

Chapter 5

Multiple-Choice Questions _____

1. 3 3. 1 5. 3 7. 3 9. 4
 11. 1 13. 4 15. 2 17. 2 19. 4

Short-Answer Questions _____

1. The more self-confidence a recruit has, the less likely he or she will be successful.

3. There is some tendency for students scoring higher on the LSAT to earn better grades in the first year of law school than students with relatively low LSAT scores. This tendency, however, is not very strong. The LSAT accounts for only 13% of the variance in grades ($r^2 = .13$) with the other 87% unaccounted for.

Part of the reason for this low correlation is due to truncation of range. In these data, the correlation is computed only on students selected for law school, nearly all of whom had high scores on the LSAT. The range of scores (variability in the scores) is thus restricted. In like manner, grade distributions in law school tend to be restricted to higher grades (mostly A and B). Such restrictions on variability always reduces the size of r .

5. a. The correlation coefficient is based on an N of 100. Each of the 100 items have both a mean score from the nuns and from the child molesters.
b. Nuns and child molesters have the same ideas about social desirability. They agree about what is desirable and what is not.

Problems

$$\bar{X} = \frac{3500}{50} = 70.00$$

1.
$$\bar{Y} = \frac{115}{50} = 2.30$$

$$S_x = \sqrt{\frac{250,000 - \frac{3500^2}{50}}{50}} = 10.00$$

$$S_y = \sqrt{\frac{289 - \frac{115^2}{50}}{50}} = 0.70$$

$$a. r = \frac{\frac{8084}{50} - (70)(2.30)}{10(.70)} = .097$$

$$r = \frac{(50)(8084) - (3500)(115)}{\sqrt{[(50)(250,000) - 3500^2][50(289) - 115^2]}} = .097$$

$$b. b = (.097) \frac{.70}{10} = 0.0068$$

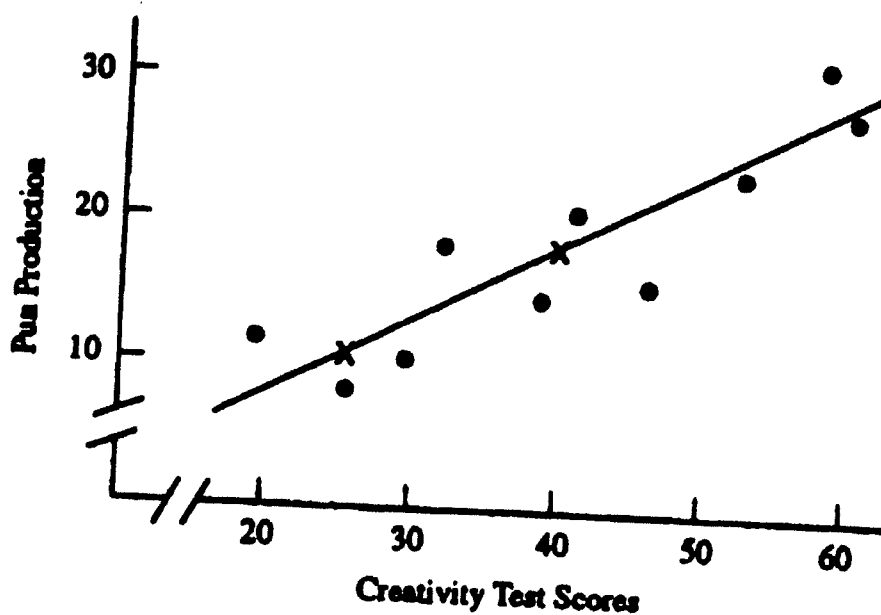
$$a = 2.30 - (0.0068)(70) = 1.825$$

$$Y' = 1.825 + 0.0068X$$

$$c. Y' = 1.825 + (0.0068)(100) = 2.51$$

- d. Because the degree of relationship between sensory ability and GPA is so slight (the r is only .09), not much faith can be put in any regression equation prediction. That is, a wide range of GPA's around 2.51 would be expected for those students whose sensory score was 100.

3.



Student	x	Y	X ²	Y ²	XY
1	60	28	3600	784	1680
2	57	32	3249	1024	1824
3	52	24	2704	576	1248
4	46	16	2116	256	736
5	41	21	1681	441	861
6	38	14	1444	196	532
7	32	18	1024	324	576
8	29	11	841	121	319
9	25	9	625	81	225
10	19	12	361	144	228
$\Sigma=$	399	185	17,645	3947	8229

$$\bar{X} = \frac{399}{10} = 39.9$$

$$\bar{Y} = \frac{185}{10} = 18.5$$

$$S_x = \sqrt{\frac{17,645 - \frac{399^2}{10}}{10}}$$

$$S_y = \sqrt{\frac{3947 - \frac{185^2}{10}}{10}}$$

$$= 13.1335$$

$$= 7.2422$$

$$r = \frac{\frac{8229}{10} - (39.9)(18.5)}{(13.1335)(7.24422)} = \frac{84.75}{95.1154} = .89$$

$$r = \frac{(10)(8229) - (399)(185)}{\sqrt{[(10)(17,645) - (399^2)][(10)(3947) - (185^2)]}}$$

$$= \frac{8475}{\sqrt{(17,249)(5245)}} = \frac{8475}{9511.6247} = .89$$

$$r^2 = (.89)^2 = .79$$

$$b = (.89) \frac{7.2422}{13.1335} = 0.49$$

$$a = 18.5 - (.49)(39.9) = -1.05$$

$$\hat{Y} = -1.05 + .49X$$

$$\hat{Y} = -1.05 + .49(25) = 11.2$$

The scatterplot shows that the relationship between creativity test scores and the production of puns is linear. The correlation coefficient is quite high with $r = .89$. With a coefficient of determination of .79, you can say that almost 80 percent of the variance of the two tests is common variance. The two tests seem to be tapping the same abilities. In sum, data such as these support the hypothesis that there is a relationship between creativity and humor.

5.

Student	X	Y	X^2	Y^2	XY
1	28	3.16	784	9.99	88.48
2	4	2.55	16	6.5	10.20
3	47	3.10	2209	9.61	145.7
4	19	3.97	361	15.76	75.43
5	43	1.84	1849	3.39	79.12
6	50	2.99	2500	8.94	149.50
7	34	2.07	1156	4.28	70.38
8	21	3.01	441	9.06	63.21
$\Sigma =$	246	22.69	9316	67.53	682.02

$$\bar{X} = \frac{246}{8} = 30.75$$

$$\bar{Y} = \frac{22.69}{8} = 2.84$$

$$S_x = \sqrt{\frac{9316 - \frac{246^2}{8}}{8}} = 14.80$$

$$S_y = \sqrt{\frac{67.53 - \frac{22.69^2}{8}}{8}} = 0.63$$

$$r = \frac{\frac{682.02}{8} - (30.75)(2.84)}{(14.80)(0.63)} = -0.22$$

$$b = (-0.22) \frac{0.63}{14.80} = -0.0094$$

$$a = 2.84 - (-0.0094)(30.75) = 3.13$$

$$Y' = 3.13 + (-0.0094)X$$

$$Y' = 3.13 + (-0.0094)4 = 3.09$$

Thus, a student with a class rank of 4 would have a GPA predicted to be 3.09.

Chapter 6

Multiple-Choice Questions _____

1. 3 3. 4 5. 3 7. 4 9. 3
 11. 1 13. 3 15. 3 17. 3 19. 1

Short-Answer Questions _____

1. A theoretical distribution is based on mathematics and logic, whereas an empirical distribution is obtained from observations.
3. The total number of students is 1400.
 - a. $\frac{500}{1400} = .36$
 - b. $\frac{200}{1400} = .14$

c. $\frac{400 - 300}{1400} = .50$

d. Subtracting answer (b) (.14) from 1.00 gives .86.

5. The binomial distribution is based on the probability of event occurring that have only two possible outcomes. Normal distributions are based on events that have multiple outcomes.

Problems _____

1. a. empirical d. empirical
 b. empirical e. empirical
 c. empirical f. empirical

3.

a. $z = \frac{23 - 20}{4} = 0.75, p = .2266$

b. $z = \frac{27 - 20}{4} = 1.75, p = .0401$

c. $z = \frac{36 - 20}{4} = 4.00, p = .00003$

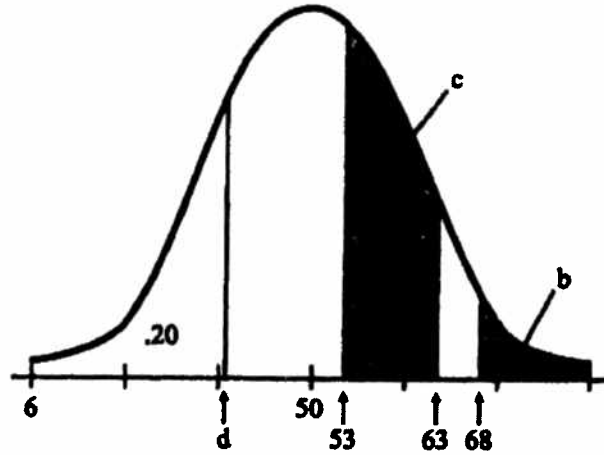
The probability of obtaining 36 matches in 100 attempts by chance alone is .00003. Some other explanation (like ESP or cheating) seems more likely.

5. a. $z = \frac{1 - 7}{3.74} = -1.60, \text{proportion} = .0548$

b. Figure 5.1 shows a proportion of .077

c. The distribution of playing cards is rectangular but the normal curve was used to calculate the proportion .0548.

7. a. For $z = 2.00$, proportion = .0228; $.0228 \times 1000 = 22.8$ or about 23 people. Normal curve with scores and proportions needed for Problems 7b, 7c, and 7d.



d. $z = \frac{68 - 50}{10} = 1.80$, proportion = .0359

e. $z = \frac{63 - 50}{10} = 1.30$, proportion = .4232 and $z = \frac{53 - 50}{10} = 0.30$,
 proportion = 0.1179; $.4302 - 0.1179 = .2853$, the proportion scoring
 between 53 and 63.

f. The z score associated with a proportion of .20 that is below the mean
 is $-.84$.

$-.84 = \frac{X - 50}{10} = 41.6$, the score that separates out the lowest one-fifth of
 the population

Chapter 7

Multiple-Choice Questions _____

1. 2 3. 2 5. 2 7. 3 9. 3
 11. 1 13. 3 15. 1 17. 2 19. 3

Short-Answer Questions

1. The Central Limit Theorem says that the form of the sampling distribution of the mean of any population will have a mean equal to μ , a standard deviation equal to $\frac{\sigma}{\sqrt{N}}$, and will approach a normal curve if sample size is large.
3. According to the Central Limit Theorem, the sampling distribution of the mean will approach a normal curve, regardless of the shape of the population distribution, if the sample size is 30 or greater. The techniques of Chapter 7 are, therefore, appropriate for this skewed distribution when the sample size is this large.
5. The confidence interval can tell us that we have 95% confidence that a particular range contains the population mean. If our sample mean is outside of that range, it is probably not from that distribution.

Problems

$$1. \sigma_{\bar{x}} = \frac{100}{\sqrt{50}} = 14.14$$
$$z = \frac{\bar{X} - \mu}{\sigma_{\bar{x}}} = \frac{725 - 750}{14.14} = -1.77$$
$$p = .0384$$

The claim is on somewhat shaky ground. If the claim of 750 hours is correct, you would expect to get a mean of 725 or lower from 50 bulbs less than 4% of the time.

$$3. \bar{X} = \frac{11,340}{36} = 315; \quad s = 60.00; \quad s_{\bar{x}} = \frac{60}{\sqrt{36}} = 10$$
$$t_{99}(30 \text{ df}) = 2.75$$
$$LL = \bar{X} - t(s_{\bar{x}}) = 315 - 2.75(10.00) = 287.5 \text{ volts}$$
$$UL = \bar{X} + t(s_{\bar{x}}) = 315 + 2.75(10.00) = 342.5 \text{ volts}$$

The mean shock level of the students at the college with humanitarian ideals is between 287.5 volts and 342.5 volts (99 percent confidence). Because the mean value for Americans is 285 volts, conclude that the students at the College of HI are willing to administer more shock (be more cruel, perhaps) than the average American.

$$5. \quad \bar{X} = \frac{1224}{36} = 34.001; \quad s = 2.402; \quad \frac{725 - 750}{14.14} = -1.77 = 0.400$$

$$t_{95}(30 \text{ df}) = 2.042$$

$$LL = 34.00 - 2.042(0.400) = 33.18$$

$$UL = 34.00 + 2.042(0.400) = 34.82$$

We are 95 percent confident that the interval 33.18 to 34.82 contains the unknown population mean of the film. Because the interval is entirely above 33, the population mean of all films, conclude that the students rated this film higher than the average film.

7. Each person's sample is likely to be different. What is important is the procedure.
- Identify each score with a one-digit number from 0 to 9.
 - Haphazardly find a place to start in the table of random numbers.
 - Record the first six digits you come to, ignoring a digit that appears more than once.
 - Translate the six digits into the six scores, which now constitute a random sample.

Chapter 8

Multiple-Choice Questions _____

1. 2 3. 1 5. 3 7. 3 9. 3
 11. 4 13. 4 15. 4 17. 2 19. 2

Short-Answer Questions ---

1. A Type I error is committed when you conclude that the null hypothesis is false but it is, in fact, true. A Type II error is committed when you do not reject a false null hypothesis.
3. A null hypothesis is rejected when the difference between the sample statistic and the population parameter is so large that the difference is unlikely, *if the null hypothesis is true*. The null hypothesis is retained when the difference between the sample statistic and the population parameter is not very large; that is, the difference is what you would expect if the null hypothesis is true. When you reject the null hypothesis, you are left with an alternative hypothesis. When you retain the null hypothesis, you are left with it *and* the alternative hypothesis.
5. a. $H_0: \mu_0 = 285$. $t_{.05} (19 \text{ df}) = 2.093$. Retain the null hypothesis. There isn't a statistically significant difference willingness to provide "shock" now versus in the early 1960's
b. $r_{.05} (20 \text{ df}) = .4227$. (From Table A, Appendix B.). A correlation coefficient of .44 is statistically significant. We could conclude that there is strong agreement of what facial expressions represent across cultures.

Problems ---

1. $\Sigma X = 540$ $\Sigma X^2 = 25,036$
 $\bar{X} = 45.00$; $s = 8.180$; $s_{\bar{x}} = 2.361$
 $t = \frac{45.51}{2.361} = -2.54$; $df = 11$
 $t_{.05} (11 \text{ df}) = 2.201$

Students who were in academic difficulty had a mean Personal Control Score that was less than the norm for college students ($p < .05$).

$$d = \frac{45.51}{8.18} = -0.734$$

The effect size index 0.73 indicates that being in academic difficulty has an effect on PC scores that is classified as large (almost).

$$3. \quad \bar{X} = \frac{235}{30} = 7.83; \quad s_x = \sqrt{\frac{1931 - \frac{235^2}{30}}{29}} = 1.763; \quad s_{\bar{x}} = \frac{1.763}{\sqrt{30}} = 0.322$$

$$t = \frac{7.83 - 7}{0.322} = 2.578; \quad df = 29 \quad d = \frac{7.83 - 7}{1.763} = .47$$

$t_{.05} (29 \text{ df}) = 2.045$. Since our obtained t value exceed the critical t value, we can claim we have a group that has shown significant improvement in short term memory capacity (we can reject our null hypothesis). The effect size ($d = 0.44$) is a medium effect size estimate.

$$5. \quad \Sigma X = 200 \quad \Sigma X^2 = 1206$$

$$\bar{X} = 5; \quad s_x = 2.30; \quad s_{\bar{x}} = .364$$

$$t = \frac{5 - 6}{.34} = -2.75; \quad df = 39 \quad d = \frac{5 - 6}{2.30} = .43$$

$t_{.05} (30 \text{ df}) = 2.042$. There is a significance difference between what participants typically choose in this situation versus what they do when exposed to low numbers. The effect size, $d=.43$, suggesting that this is a medium effect.

Overall interpretation: Direct, blatant stimuli are more effective in changing behavior than subtle, subliminal stimuli.

Chapter 9

Multiple-Choice Questions _____

1. 4 3. 2 5. 3 7. 2 9. 3
11. 4 13. 4 15. 4 17. 4 19. 4

Short-Answer Questions _____

1.
 - a. Paired samples; $df = 13$
 - b. Paired samples; $df = 20$
 - c. Independent samples; $df = 28$
 - d. Independent samples; $df = 22$
 - e. Paired samples; $df = 33$

3.
 - a. Actual difference between the populations. The greater the actual difference, the more likely the rejection of the null hypothesis.
 - b. The size of the standard error of a difference. The smaller it is, the more likely the rejection of the null hypothesis. It can be made smaller by increasing sample size or reducing sample variability.
 - c. Alpha. The larger alpha is, the more likely the rejection of the null hypothesis.

5.
 - a. The populations the samples are from are normally distributed.
 - b. The populations the samples are from have variances that are equal.
 - c. Extraneous variables are eliminated, perhaps by random assignment of participants to groups.

7. If you worked the problems yourself, you probably were stumped for a while on No. 8. The method (set) you had developed by solving the first seven did not work for the eighth. How adaptable were you? Did you abandon your set quickly when it did not work, or did you stick with it?

This is an independent-samples design. The first seven problems established a mental set that solved the problem. That set was “fill the middle jar and from it

fill the left jar once and the right jar twice.” This set was detrimental in solving the eighth problem, which could be easily solved by “fill the left jar and from it fill the right jar once.”

9. When using a pre-post test measure, the best statistical procedure to use is the paired samples *t* test..

Problems _____

1.

Participant	Before	After	<i>D</i>	<i>D</i> ²
1	5	6	-1	1
2	4	4	0	0
3	3	5	-2	4
4	3	4	-1	1
5	2	4	-2	4
6	2	3	-1	1
7	1	3	-2	4
8	0	2	-2	4
	$\Sigma = 20$	31	-11	19

$$\bar{X} = 2.50$$

$$s_D = \sqrt{\frac{19 - \frac{-11^2}{8}}{7}} = \sqrt{\frac{19 - 15.1250}{7}} = \sqrt{\frac{3.8750}{7}} = \sqrt{.5536} = .7440$$

$$s_D = \frac{.7440}{\sqrt{8}} = .2630$$

$$t = \frac{2.50 - 3.875}{.2630} = 5.228;$$

$$df = N - 1 = 8 - 1 = 7 \quad t_{.01}(7 \text{ df}) = 3.499 \quad p < .01$$

$$d = \frac{\bar{X}_1 - \bar{X}_2}{s_D} = \frac{1.375}{.7440} = 1.848$$

The boys displayed significantly more hostility toward minority groups after frustration than they did before. The effect size index, 1.85, shows that the effect

of frustration is quite large. Note that this is purely a psychological effect - the minority groups were not actually present in the experiment and not connected with the frustration.

3.

	Shown	Not Shown
ΣX	80	118
ΣX^2	1120	2392
N	6	6
\bar{X}	13.333	19.667
	3.2660	3.771

$$\hat{s}_{\bar{x}_1} = \frac{3.2660}{\sqrt{6}} = 1.333$$

$$\hat{s}_{\bar{x}_2} = \frac{3.7771}{\sqrt{6}} = 1.5420$$

$$s_{\bar{x}_1 - \bar{x}_2} = \sqrt{1.3333^2 + 1.5420^2} = \sqrt{1.7777 + 2.3778} = 2.0385$$

$$t_{.95}(10 \text{ df}) = 2.228$$

$$LL = (\bar{X}_1 - \bar{X}_2) - t(s \bar{X}_1 - \bar{X}_2) = (19.667 - 13.333) - 2.228(2.0385) = 1.79 \text{ seconds}$$

$$UL = (\bar{X}_1 - \bar{X}_2) + t(s \bar{X}_1 - \bar{X}_2) = (19.667 - 13.333) + 2.228(2.0385) = 10.88 \text{ seconds}$$

We can be 95 percent confident that the effect of watching other cats solve the problem reduces the time needed to solve the problem by 1.79 to 10.88 seconds. That is, cats learn by imitation; the data support Hobhouse. (Indeed, this experiment was modeled after one by Hobhouse.) [Note that because 0 is not in the 95 percent confidence interval, the null hypothesis can be rejected at the .05 level.]

5. We would use an independent samples t since the people are in separate groups.

	Changed answers	Did not change answers
ΣX	413	378
ΣX^2	43,685	28,786
N	5	5

\bar{X}	82.6	75.60
	11.94	7.23

$$\hat{s}_{\bar{x}_1} = \frac{11.94}{\sqrt{5}} = 5.34 \qquad \hat{s}_{\bar{x}_2} = \frac{7.23}{\sqrt{5}} = 3.23$$

$$s_{\bar{x}_1 - \bar{x}_2} = \sqrt{s_{\bar{x}_1}^2 + s_{\bar{x}_2}^2} = \sqrt{5.34^2 + 3.23^2} = \sqrt{28.52 + 10.43} = 6.24$$

$$t = \frac{\bar{X}_1 - \bar{X}_2}{s_{\bar{x}_1 - \bar{x}_2}} = \frac{82.6 - 75.60}{6.24} = 1.12$$

$$t_{(.05)} (8 \text{ df}) = 2.306$$

Since our obtained t value does not exceed the critical value, we retain the null hypothesis and conclude that there is no evidence to support the idea that there is a difference in scores on exams based on whether or not a participant changes his or her answers. From a purely theoretical standpoint, however, this experiment has perhaps too few participants, and thus low power, to reject a null, given the null was false.

Chapter 10

Multiple-Choice Questions _____

1. 4 3. 3 5. 3 7. 3 9. 2
 11. 2 13. 3 15. 2 17. 2 19. 4

Interpretation _____

1. The independent variable is hospital location (Crimea, England, France) or hospital type (military, civilian). The dependent variable is "improvement scores." The F value produced by the ratio of the two mean squares is 6.04. Because $F_{.01} (2, 32 \text{ df}) = 5.34$, you can conclude that there are significant differences among the hospital populations in improvement scores.

The f value is 0.529, which is large. The effect of the hospital location has a large effect on improvement scores.

The $s_{\bar{x}}$ = value for Tukey tests is 1.31. The tabled value for HSD at the .01 level for three groups and a df_{error} of 32 is 4.46. When England and Crimea are compared HSD = 4.58. (The value for the France-Crimea comparison is even larger). A comparison of England and France produces an HSD of 0.76. Patients in the military hospital in Crimea showed significantly greater improvement scores than patients in either English or French hospitals. The English and French hospitals were not significantly different.

3. The ANOVA method described in Chapter 10 requires independent groups. These data are correlated because each wine taster rated all four wines. A correlated measures design is required for this problem. (See Chapter 12.)
5. The ANOVA is a statistical procedure that works to compare two or more means. If there are only two means, you can use either a t test or an ANOVA. Both will yield similar results that will allow for the same type of interpretation.

Problems _____

1. Independent variable: Predictability of reinforcement
Dependent variable: Persistence during extinction

	Very Predictable	Fairly Predictable	Unpredictable
	8	16	18
	13	11	19
	11	15	22
	8		16
			15
ΣX	40	42	90
ΣX^2	418	602	1650
\bar{X}	10	14	18

$$SS_{\text{tot}} = 2670 - \frac{172^2}{12} = 204.67$$

$$SS_{\text{treat}} = \frac{40^2}{4} + \frac{42^2}{3} + \frac{90^2}{5} - \frac{172^2}{12} = 142.67$$

$$SS_{\text{error}} = \left[418 - \frac{40^2}{4} \right] + \left[602 - \frac{42^2}{3} \right] + \left[1650 - \frac{90^2}{5} \right] = 62.00$$

CHECK: $142.67 + 62.00 = 204.67$

Source	SS	df	MS	F
Predictability	142.67	2	71.335	10.35
Error	62.00	9	6.888	
Total	204.67	11		

$F_{.01} (2,9 \text{ df}) = 8.02$. The three schedules produced significantly different amounts of persistence during extinction. Three Tukey HSD tests produce

$$\text{HSD (Very vs. Fairly)} = 2.84$$

$$\text{HSD (Fairly vs. Un)} = 2.96$$

$$\text{HSD (Very vs. Un)} = 6.45$$

$\text{HSD}_{.01} = 5.43$. Persistence during extinction depends on the predictability of reinforcement during learning. Unpredictable reinforcement leads to significantly more persistence than very predictable reinforcement.

$$3. \quad \Sigma X_{\text{tot}} = 49 + 74 + 78 + 83 = 284$$

$$\Sigma X^2_{\text{tot}} = 269 + 574 + 636 + 711 = 2190$$

$$SS_{\text{tot}} = 2190 - \frac{284^2}{40} = 173.60$$

$$SS_{\text{anesthetics}} = \frac{49^2}{10} + \frac{74^2}{10} + \frac{78^2}{10} + \frac{83^2}{10} - \frac{284^2}{40} = 68.60$$

$$SS_{\text{error}} = \left[269 - \frac{49^2}{10} \right] + \left[574 - \frac{74^2}{10} \right] + \left[636 - \frac{78^2}{10} \right] + \left[\frac{711 - 83^2}{10} \right]$$

$$= 28.90 + 26.40 + 27.60 + 22.10 = 105$$

CHECK: $173.60 = 68.60 + 105$

Source	SS	df	MS	F	p
Anesthetics	68.60	3	22.8667	7.84	< .01
Error	105.00	36	2.9167		
Total	173.60	39			

$$f = \frac{\sqrt{\frac{3}{40}(22.8667 - 2.9167)}}{\sqrt{2.9167}} = 0.716$$

An $f = 0.716$ is larger than 0.40, a value that is considered large. Thus, anesthetics have a large effect on Apgar scores.

The $s_{\bar{x}}$ required for Tukey HSD tests is

$$\sqrt{\frac{2.9176}{10}} = .540$$

$$HSD_{.05} = 3.84$$

When the HSD tests are calculated, the Apgar scores of twilight neonates is significantly lower than any of other three methods. The other three methods do not differ significantly among themselves.

5. Since there are three levels of the independent variable, I would use an ANOVA on the data that follows.

	<u>No</u> <u>lecture</u>	<u>Lecture</u> <u>after</u>	<u>Lecture</u> <u>before</u>
	0.26	0.40	0.85
	0.29	0.47	0.88
	0.33	0.44	0.70
	0.15	0.37	0.79
	0.28	0.57	0.90
ΣX	1.31	2.25	4.12
ΣX^2	0.362	1.04	3.42
\bar{X}	0.26	0.45	0.82

$$SS_{\text{tot}} = 4.83 - \frac{7.68^2}{15} = 0.89$$

$$SS_{\text{treat}} = \frac{1.31^2}{5} + \frac{2.25^2}{5} + \frac{4.12^2}{5} - \frac{7.68^2}{15} = 0.82$$

$$SS_{\text{error}} = \left[0.362 - \frac{1.31^2}{5}\right] + \left[1.04 - \frac{2.25^2}{5}\right] + \left[3.42 - \frac{4.12^2}{5}\right] = 0.07$$

CHECK: $0.82 + 0.07 = 0.89$

Source	SS	df	MS	F
Course type	0.82	2	0.41	68.33
Error	0.07	12	0.006	
Total	.882	14		

$F_{.01}(2,14 \text{ df}) = 6.51$. The three classroom conditions produced significantly different amounts of test performance. Three Tukey HSD tests produce

HSD (No lecture vs. lecture before) = 16.17

HSD (No lecture vs. lecture after) = 5.48

HSD (Lecture before vs. lecture after) = 10.68

$HSD_{.01} = 4.60$. There is a significant difference between students who read after they have been lectured to remember more than the other groups. In fact, all the groups showed significant differences. The main point of interest is that students who only attend lecture and who don't read, don't score well!

Chapter 11

Multiple-Choice Questions _____

1. 1 3. 1 5. 1 7. 2 9. 1
11. 4 13. 4 15. 3 17. 4 19. 1

Interpretation _____

1. X AB Interaction: NS
A Main Effect: NS
B Main Effect: Probably significant
- Y AB Interaction: Probably significant
A Main Effect: Probably significant
B Main Effect: NS

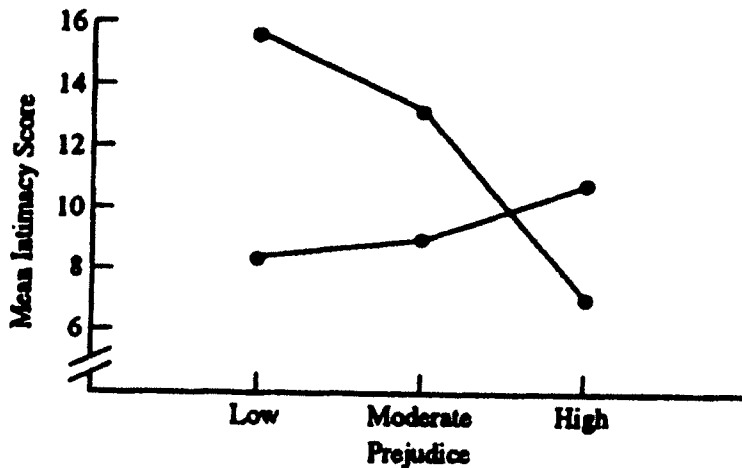
- 3. W AB Interaction: NS
 A Main Effect: Probably significant
 B Main Effect: Probably significant

- X AB Interaction: Probably significant
 A Main Effect: NS
 B Main Effect: Probably significant

- Y AB Interaction: NS
 A Main Effect: Probably significant
 B Main Effect: NS

- Z AB Interaction: NS
 A Main Effect: Probably significant
 B Main Effect: Probably significant

5. All effects are significant beyond the .01 level.



The graph of the cell means indicates that Rokeach is correct for those with low or moderate prejudice, i.e., prejudice is aroused more by perceived differences in values than by race. For high-prejudiced people, however, the reverse is true. Racial differences arouse more prejudice than do differences in values.

Problems

$$1. SS_{\text{tot}} = 6299 - \frac{363^2}{24} = 6299 - 5490.3750 \\ = 808.6250$$

$$SS_{\text{cells}} = \frac{62^2}{6} + \frac{123^2}{6} + \frac{114^2}{6} + \frac{62^2}{6} - \frac{363^2}{24} \\ = 682.667 + 2521.50 + 2166 + 640.667 - 5490.3750 \\ = 520.4584$$

$$SS_{\text{education}} = \frac{178^2}{12} + \frac{185^2}{12} - \frac{363^2}{24} \\ = 2640.333 + 2852.0833 - 5490.3750 \\ = 2.0416$$

$$SS_{\text{arguments}} = \frac{187^2}{12} + \frac{176^2}{12} - \frac{363^2}{24} \\ = 2914.0833 + 2581.333 - 5490.3750 \\ = 5.0146$$

$$SS_{AB} = 6[(10.667-14.8333-15.5833+15.1250)^2 \\ +(20.50-15.4167-15.5833+15.1250)^2 \\ +(19.00-14.8333-14.6667+15.1250)^2 \\ +(10.3333-15.4167-14.6667+15.1250)^2] \\ = 6[(-4.6249)^2+(4.6250)^2+(4.6250)^2-(-4.6251)^2] \\ = 6(21.3810+21.3906+21.3906+21.3916)=513.3228$$

CHECK

$$SS_{AB} = 520.4584 - 2.0416 - 5.0416 \\ = 513.3752 \text{ (without rounding error)}$$

$$SS_{\text{error}} = \left(808 - \frac{64^2}{6}\right) + \left(2603 - \frac{123^2}{6}\right) + \left(2218 - \frac{114^2}{6}\right) + \left(670 - \frac{62^2}{6}\right)$$

$$= 125.333 + 81.50 + 52.00 + 29.33$$

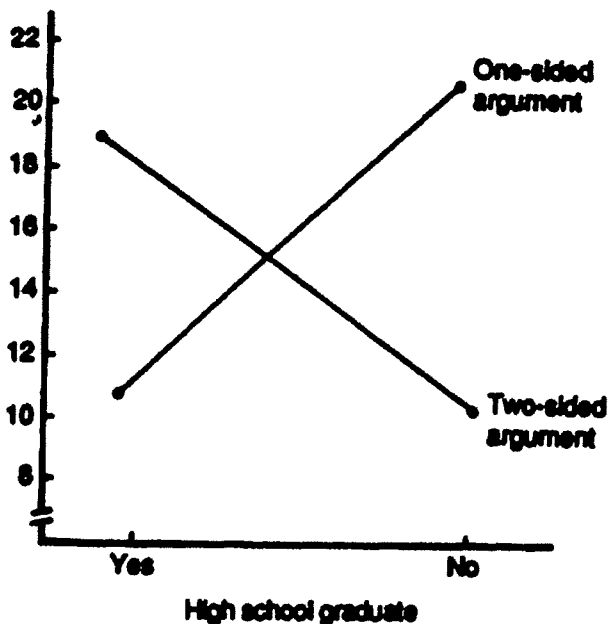
$$= 288.1667$$

CHECK

$$SS_{\text{tot}} = 808.6250 = 520.4584 + 288.1667$$

Source	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>p</i>
Education(A)	1	2.0416	2.0416	<1.00	>.05
Arguments (B)	1	5.0416	5.0416	<.01	>.05
AB	1	513.3228	513.3228	35.63	<.01
Error	<u>20</u>	<u>288.1667</u>	14.4083		
Total	23	808.6250			

Neither main effect was significant, which, by themselves, would indicate that neither educational level nor type of argument influenced attitude change. The significant interaction effect, however, tells a different story as can be seen from the interaction graph that follows.



Clearly, both variables influenced attitude change, but the effect of each variable was dependent upon the other. The one-sided argument was effective only for

nongraduates, whereas the two-sided argument was effective only for graduates of high school.

Chapter 12

Multiple-Choice Questions _____

1. 1 3. 3 5. 2 7. 4 9. 3
11. 4 13. 3 15. 2 17. 3 19. 1

Short-answer questions _____

1. In a repeated measures design, fewer participants need to be run, there is lower error due to differences between participants, and repeated measures experiments have more statistical power. Two disadvantages are that not all studies can be done as repeated measures, and there is the possibility of carryover effects.

Problems _____

$$1. \quad SS_{\text{tot}} = 47,623 - \frac{725^2}{15} = 47,623 - 35,041.667 = 12,581.333$$

$$SS_{\text{depth}} = \frac{75^2}{5} + \frac{250^2}{5} + \frac{400^2}{5} - \frac{725^2}{15} = 1125 + 12,500 + 32,000 - 35,041.667 = 45,625 - 35,041.667 = 10,583.333$$

$$SS_{\text{subjects}} = \frac{135^2}{3} + \frac{170^2}{3} + \frac{145^2}{3} + \frac{123^2}{3} + \frac{152^2}{3} - \frac{725^2}{15} = 35,461 - 35,041.667 = 419.333$$

$$SS_{\text{error}} = 12,581.333 - 10,583.333 - 419.333 = 1578.667$$

Source	SS	df	MS	F	p
Depth	10,583.333	2	5291.667	26.82	< .01
Subjects	419.333	4			
Error	1578.667	8	197.333		
Total	12,581.333	14			

$$F_{.01}(2, 8 \text{ df}) = 8.65$$

$$s_{\bar{x}} = \sqrt{\frac{197.33}{5}} = 6.282 \quad \text{HSD}_{.05} = 4.04 \quad \text{HSD}_{.01} = 5.64$$

$$\text{HSD (Shallow vs. Medium)} = 5.57; p < .05$$

$$\text{HSD (Shallow vs. Deep)} = 10.35; p < .01$$

$$\text{HSD (Medium vs. Deep)} = 4.78; p < .05$$

Interpretation. Memory depends on the level of processing while learning. When processing was deep, participants remembered more than when processing was medium ($p < .05$) and more than when processing was shallow ($p < .01$). In addition, medium processing produced better memory than shallow processing ($p < .05$).

$$3. \quad SS_{\text{tot}} = 4436176 - \frac{8134^2}{15} = 25378.93$$

$$SS_{\text{location}} = \frac{2676^2}{5} + \frac{2755^2}{5} + \frac{2703^2}{5} - \frac{8134^2}{15} = 4411442 - 4410797.07 = 644.93$$

$$SS_{\text{subjects}} = \frac{1547^2}{3} + \frac{1556^2}{3} + \frac{1828^2}{3} + \frac{1524^2}{3} + \frac{1679^2}{3} - \frac{8134^2}{15} = 4432515.32 - 4410797.07 = 21718.25$$

$$SS_{\text{error}} = 25378.93 - 21718.25 - 644.93 = 3015.75$$

Source	SS	df	MS	F	p
location	644.93	2	322.465	0.86	>.05
Subjects	21718.25	4			
Error	3015.75	8	376.97		
Total	512.00	14			

$$F_{.05}(2, 8 \text{ df}) = 4.46$$

Interpretation. There does not appear to be any significant differences between the three conditions. The F value is close to 1 indicating that there is no difference among the means. This is probably due to the small effect caused by the manipulation in the experiment.

Chapter 13

Multiple-Choice Questions

1. 3 3. 1 5. 1 7. 2 9. 1
 11. 2 13. 2 15. 4 17. 3 19. 2

Interpretation

1. Because $\chi^2_{.001}(1 \text{ df}) = 10.83$, the null hypothesis can be rejected; the two variables are not independent. In addition, $\phi = 0.40$.

The conclusion is that those with greater than 5 years of experience tend to be lumpers, and those with less than 5 years of experience tend to be splitters. There is a medium to large effect of experience on anthropologist's view of how the world is put together.

Problems

$$1. \chi^2 = \frac{32[(10)(12) - (8)(2)]^2}{(18)(14)(12)(20)} = 5.72 \quad \phi = \sqrt{\frac{5.72}{32}} = 0.42$$

$\chi^2_{.05} (1 \text{ df}) = 3.84$. Therefore, reject the null hypothesis and conclude that living conditions make a difference in survival rates. Those that were isolated were more likely to be alive than those that lived together. The effect of the living conditions on survival was intermediate between a medium effect and a large effect.

3. Goodness-of-fit.

	<i>O</i>	<i>E</i>	<i>O - E</i>	$\frac{(O - E)^2}{E}$
brown	222	226.8	-4.8	0.102
yellow	149	151.2	-2.2	0.032
Red	132	151.2	-19.2	2.438
Blue	102	75.6	26.4	9.219
green	44	75.6	-31.6	13.208
orange	107	75.6	31.4	13.042
Σ	756	756		$\chi^2 = 38.041$

$\chi^2_{.001} (5 \text{ df}) = 20.52$. The null hypothesis is rejected, $p < .001$. The distribution of colors in my bag was significantly different from the distribution advertised by the Mars company. In particular, there were too many blue and orange candies and not enough green candies.

5. This is a goodness-of-fit test of a 50:50 hypothesis. The expected value for each gender is 1,940,447, which is the total number of births divided by 2. Arranging calculations into a table,

	<i>O</i>	<i>E</i>	<i>O - E</i>	$\frac{(O - E)^2}{E}$
boys	1,985,596	1,940,447	45,149	1050.5
Girls	1,895,298	1,940,447	-45,149	1050.5
Σ	3,880,894	3,880,894		$\chi^2 = 2101.0$

$\chi^2_{.001} (1df) = 10.83$. Reject the hypothesis that girls and boys are born in equal numbers. Boys are born in greater numbers than girls. Indeed, the results for this one year mirror the results of many years in many countries: the birth rate is about 105 males for every 100 females (but the infant survival rate for males is lower).

Chapter 14

Multiple-Choice Questions _____

1. 3 3. 2 5. 1 7. 2 9. 2
 11. 5(6.5) 13. 4 15. 2 17. 4

Interpretation _____

1. A. Mann-Whitney U test
 B. Spearman r_s
 C. Wilcoxon matched-pairs signed-ranks T test
3. With $N = 9$, a T value of 5.0 or less is required for significance at $\alpha = .05$. Because the obtained T is 5.5, the hypothesis that the difference between the before and after scores is due to chance cannot be rejected.
5. A Wilcoxon-Wilcox multiple-comparisons test is appropriate.

	0 (73)	20 (54)	40 (44.5)	60 (27.5)
20(54)	19			
40(44.5)	28.5	9.5		
60(27.5)	45.5	26.5	17	
80(11)	62**	43	33.5	16.5

* $p < .05$

** $p < .01$

The conclusion from these data (and from Gates and many others) is that self-recitation improves recall. The trend in the data is steadily upward; the more self-recitation, the better the recall.

Problems _____

1.

Time on Target (T.O.T) in Seconds	Pilot Competency Score	T.O.T. Rank	Pilot Score Rank	D	D ²
18	37	4	7	3	9
15	57	6	2	4	16
28	63	1	1	0	0
25	41	2	6	4	16
9	31	8	8	0	0
17	51	5	3	2	4
23	42	3	5	2	4
11	45	7	4	3	9
					Σ=58

$$r_s = 1 - \frac{6(\sum D^2)}{N(N^2 - 1)} = 1 - \frac{6(58)}{8(63)} = .31$$

3.

Frontal	Rank
54	14
31	8
18	3
26	6
39	10
42	11
45	12
Σ	64

Parietal	Rank
47	13
30	7
12	1
17	2
21	4
25	5
35	9
Σ	41

$$\text{CHECK: } 64+41=105 = \frac{(14)(15)}{2}$$

Chapter 15 Answers

1. Chi Square test for independence
2. Independent samples t test
3. One-way ANOVA
4. Spearman r
5. Chi Square test for independence
6. Mann-Whitney U test
7. One sample t test
8. Regression equation
9. One-factor, repeated measures ANOVA
10. One-way ANOVA
11. Correlation coefficient
12. Mann-Whitney U test
13. Factorial ANOVA
14. Independent-sample t test
15. Effect size estimate
16. Wilcoxon matched-pairs, signed-ranks T test
17. Paired-samples t test
18. Regression equation

19. Independent-samples t test

20. Factorial ANOVA

Appendix A – Arithmetic and Algebra Review

Problems _____

1. 15.844

3. 34.657

5. 373.817

7. 65.28

9. 10.64

11. 0.026

13. 5.246

15. 18.25

17. $.50 + .05 + .125 = .875$

19. $.8571 + .625 + .9048 = 2.387$

21. $.375 - .2 = .175$

23. $.2 - .125 = .075$

25. $.6667 \times .5714 = .381$

27. $.7 \times .5 \times .6667 = .233$

29. $.5 \div .3333 = 1.500$

31. $.6316 \div .8571 = .737$

33. 1

35. -55

37. -3

39. -2

41. 10

43. 140

45. 2

47. -2.167

49. $\frac{15}{27} = .556$

51. $.22 \times 27 = 5.94$ or 6

53. 11

55. 2

57. -8, 28

59. -11.25, -4.75

61. 36

63. 342.25

Complex Problems

$$65. \frac{19}{3} = 6.3333$$

$$67. \frac{(66 - 12.5) + (75 - 12.8)}{9} = \frac{51.6 + 62.2}{9} = \frac{113.8}{9} = 12.644$$

$$69. \frac{25 - 72}{53.55} = \frac{-47}{53.55} = -.878$$

$$71. \frac{-6.8}{\sqrt{\frac{73}{9}(.1667 + .3333)}} = \frac{-6.8}{\sqrt{(8.111)(.5)}} = \frac{-6.8}{\sqrt{4.0556}} = \frac{-6.8}{2.0138} = -3.3767$$

$$73. \sqrt{\frac{(68 - 12.5)(54 - 24.2)}{42}} = \sqrt{\frac{55.5 + 29.8}{42}} = \sqrt{\frac{85.3}{42}} = \sqrt{2.031} = 1.425$$

$$75. x + 5 = (3)(4.25)$$

$$x = 12.75 - 5$$

$$x = 7.75$$

$$77. \frac{8}{4} = 2x - 2$$

$$2 + 2 = 2x$$

$$4 = 2x$$

$$2 = x$$

APPENDIX B – Grouped Frequency Distributions and Central Tendency

Problems _____

1. These data could be grouped with $i = 3$ or $i = 5$. We used $i = 5$ with multiples of 5 at the midpoints. Class intervals and central tendency statistics for $i = 3$ are given at the end of this answer.

Class Interval	f	fX
123-127	1	125
118-122	2	240
113-117	2	230
108-112	2	220
103-107	4	420
98-102	7	700
93-97	4	380
88-92	4	360
83-87	1	85
78-82	3	240
<u>73-77</u>	<u>1</u>	<u>75</u>
Σ	31	3075

$$\bar{X} = \frac{3075}{31} = 99.19$$

Median location = $\frac{N+1}{2} = \frac{31+1}{2} = 16$. Counting from the bottom of the distribution, there are 13 IQ's below 98-102 so the median is located among the 7 IQ's in that interval. The Median IQ is the midpoint of the interval, 100.

The mode is the midpoint of the interval 98-102 because that interval has more frequencies than the others: modal IQ = 100.

A mean IQ of 99.2 indicates that damage to the left cerebrum of women does not impair their IQ scores. With $i = 3$, the lowest interval is 72-74; $\bar{X} = 98.55$, Median = 101; Mode = 100.

3A.

$N = 32$
Median = 49

Class Interval	X	f
66-68	67	1
63-65	64	0
60-62	61	3
57-59	58	4
54-56	55	1
51-53	52	3
48-50	49	5
45-47	46	0
42-44	45	6
39-41	40	5
36-38	37	2
33-35	34	1
30-32	31	1

3B.

$N = 35$
Median = 30

Class Interval	X	f
68-72	70	1
63-67	65	0
58-62	60	2
53-57	55	0
48-52	50	4
43-47	45	2
38-42	40	5
33-37	35	1
28-32	30	3
23-27	25	2
18-22	20	4

13-17	15	5
8-12	10	2
3-7	5	2
-2-2	0	2

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