**Chapter 0 Solutions**

**0.1**
a. Response = Sleep (Quantitative), Explanatory = Major (Categorical)
b. Response = Final (Quantitative), Explanatory = Exam1 (Quantitative)
c. Response = Final time (Quantitative), Explanatory = Gender (Categorical, Binary)
d. Response = Handedness (Categorical, Binary), Explanatory = Major (Categorical), Gender (Categorical, Binary), Final (Quantitative)

**0.2**
a. Response = Hand (Categorical, Binary), Explanatory = Gender (Categorical, Binary)
b. Response = Final Time (Quantitative), Explanatory = Sleep (Quantitative), Exam1 (Quantitative), Quizzes (Quantitative)
c. Response = Major (Categorical), Explanatory = Gender (Categorical, Binary)
d. Response = Gender (Categorical, Binary), Explanatory = Political (Categorical), Sleep (Quantitative)

**0.3**
a. The units are MLB games. The response variable is the Game time in minutes (Quantitative). The explanatory variables are Runs (Quantitative), Margin (Quantitative), Pitchers (Quantitative), Attendance (Quantitative), and League (Categorical).
b. The units are putts. The response variable is Made (yes/no, categorical). The explanatory variable is the Distance of the putt (in feet, Quantitative).
c. The units are games Brees played in 2016. There is no particular response or predictor in this part. The variables are Passing Yards (Quantitative), Pass Attempts (Quantitative), Completions (Quantitative), and Touchdown Passes (Quantitative).

**0.4**
a. The units are points (or serves) in a volleyball match. The response variable is outcome (win/lose, Categorical). The explanatory variable is the type of serve (jump/overhand, Categorical).
b. The units are games in the 2016 and 2017 seasons for those sports. The response variable is Home win/loss (Categorical). The explanatory variable is the League (Categorical).
c. The units are golfers. The response variables are the average driving Distance (Quantitative) and percent in the fairway (Quantitative). The explanatory variable is gender (male/female, Categorical).

**0.5**
a. The experimental units are the nutrition experts.
b. This is an experiment because the bowl sizes and spoon sizes were randomly assigned to the units.

c. The response variable is the Serving Size (Quantitative).

d. The explanatory variables are the Bowl size (large/small, Categorical) and Spoon size (large/small, Categorical).

**0.6** a. Type of diet and whether the person completed the study are categorical. The weight losses after each time period are all quantitative.

b. The response variables are the different weight losses (after 2, 6, and 12 months). The explanatory variable is the type of diet (Atkins, Ornish, Weight Watchers, and Zone).

c. This is an experiment since the subjects were randomly assigned to the diets.

**0.7** a. The response variable is $WineQuality$ (Quantitative).

b. The explanatory variables are $WinterRain$ (Quantitative), $AverageTemp$ (Quantitative), and $HarvestRain$ (Quantitative).

c. The coefficient of $WinterRain$ is positive (0.00117), so higher wine quality is associated with more winter rain.

d. The coefficient of $HarvestRain$ is negative ($-0.00386$), so higher wine quality is associated with less harvest rain.

e. The coefficient of $AverageTemp$ is positive (0.0614), so higher wine quality is associated with more (higher) average growing temperature.

f. This is an observational study because none of the explanatory factors can be controlled or randomly assigned.

**0.8** a. The response variable is Wins (the number of wins for the team, Quantitative).

b. The explanatory variables are PF (points for, Quantitative) and PA (points against, Quantitative).

c. Using the coefficient of points scored, $PF$, $0.5(3) = 1.5$ more wins.

d. Using the coefficient of points allowed, $PA$, $-0.3(-3) = 0.9$ more win.

e. The increase in expected wins for each extra point in average offensive scoring (0.5) is more than the increase in expected wins for each point decrease in average points allowed (0.3), so focus on improving offense.

f. This is an observational study. No treatments were applied.

**0.9** a. The population for the registrar is all members of an entering class at the college.

b. The registrar's summaries are parameters because they are computed using the entire population.

c. The population for the Mathematics Department is students interested in taking a math course who take a placement exam.

d. The department's summaries are statistics because they are based on a sample from the population.

**0.10** a. The population for the farmer is all pumpkins grown on his farm.

b. The farmer's summary is a parameter because it is computed using the entire population.

c. The population for the customer is the set of pumpkins from this farm that are for sale at the grocery store.

d. The customer's summary is a statistic because it is based on a sample from the population.

**0.11** a. Yes, there appears to be an effect due to the size of the bowl. For both spoon sizes, there is a higher mean serving size for the larger bowl.

b. Yes, there appears to be an effect due to the size of the spoon. For both bowl sizes, there is a higher mean serving size using the larger spoon.

c. Spoon size would seem to have a larger effect. The mean serving size increases by $5.81-4.38 = 1.43$ ounces for small bowls and $6.58 - 5.07 = 1.51$ ounces for large bowls when the spoon sizes increases. The corresponding changes for increasing bowl size are $5.07 - 4.38 = 0.69$ for small spoons and $6.58 - 5.81 = 0.77$ for large spoons.

d. The estimated effects for increasing bowl size, 0.69 ounce for small spoons and 0.77 ounce for large spoons, are similar.

**0.12** a. The response variables are the weight losses. The explanatory variable is the *Adherence* score.

b. If there is a significant difference in weight loss, they can attribute it to the type of diet because this was an experiment and the diets were randomly assigned.

c. The *Adherence* scores were measured and not randomly assigned, so a significant association between weight loss and *Adherence* should not be interpreted as necessarily being a cause-and-effect relationship.

**0.13** a. The predicted number of wins for the Packers using this model is $Wins = 3.6 + 0.5(27.0) - 0.3(24.25) = 9.825$.

b. Since the Packers actually won 10 games, the residual is $Actual - Predicted = 10 - 9.825 = 0.175$.

c. $11 - 3.04 = 7.96$, so the model predicts 7.96 wins for the Giants.

**0.14** a. For the 2016 New England Patriots, the average offense is $PF = 441/16 = 27.5625$ and the average defense is $PA = 250/16 = 15.625$, so the expected number of wins from the model is $Wins = 3.6 + 0.5(27.5625) - 0.3(15.625) = 12.7$.

b. $Residual = Actual - Predicted = 14 - 12.7 = 1.3$. The Patriots won 1.3 games more than the model would predict based on their average points scored and allowed.

c. Given their average scoring and points allowed, the residual of $-3.48$ means the Chargers won almost 3.48 fewer than would be expected under this model.

**0.15** a. For a wooden roller coaster, $TypeCode = 0$, so the predicted $TopSpeed = 54 + 7.6(0) =$ 54 mph.

b. For a steel roller coaster, $TypeCode = 1$, so the predicted $TopSpeed = 54 + 7.6(1) = 61.6$ mph.

c. The difference in predicted top speeds is $61.6 - 54 = 7.6$, which is the coefficient of the $TypeCode$ variable. The value is added on to the prediction for steel roller coasters, but not for wooden roller coasters.

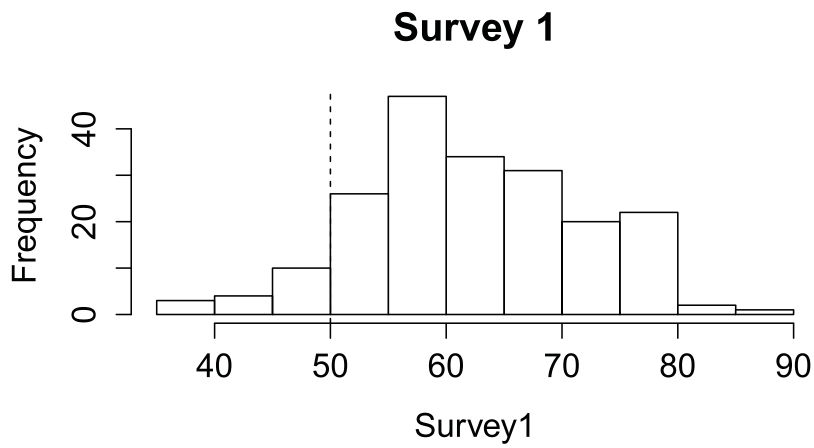
**0.16** a. Older roller coasters might be slower so the coefficient of $Age$ would be negative. Larger roller coasters probably go faster, so the other three variables (total length, maximum height, maximum vertical drop) would most likely have positive coefficients.

b. A roller coaster gets its speed from dropping, so the maximum vertical drop would probably be the best of these variables for predicting top speed.

c. The coefficients of $Height$, $Drop$, and $Length$ are all positive as expected from part (a). The negative coefficient of $Age$ also agrees with the expectation that older coasters go slower. The only surprise is the negative coefficient of $TypeCode$ because the coefficient of $TypeCode$ was positive in the original model.

d. $Speed = 33.4 + 0.10(150) + 0.11(100) + 0.0007(4000) - 0.023(10) - 2.0(1) = 59.97$ mph.

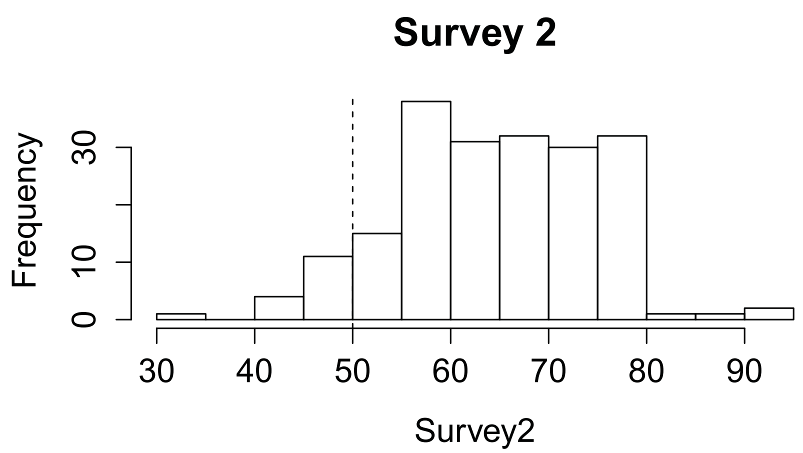
**0.17** a. The distribution of Survey 1 is roughly normal, with a mean that appears to be higher than 50.




b. The model is $y = \mu + \epsilon$ where $\mu > 50$.

c. The fitted model is $\hat{y} = 62.52$.

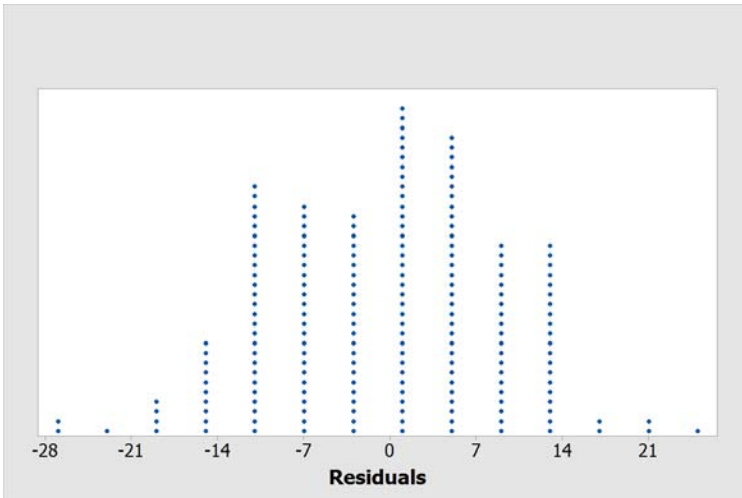
**0.18** a. The distribution of Survey 2 is roughly normal, with a mean that appears to be higher than 50.

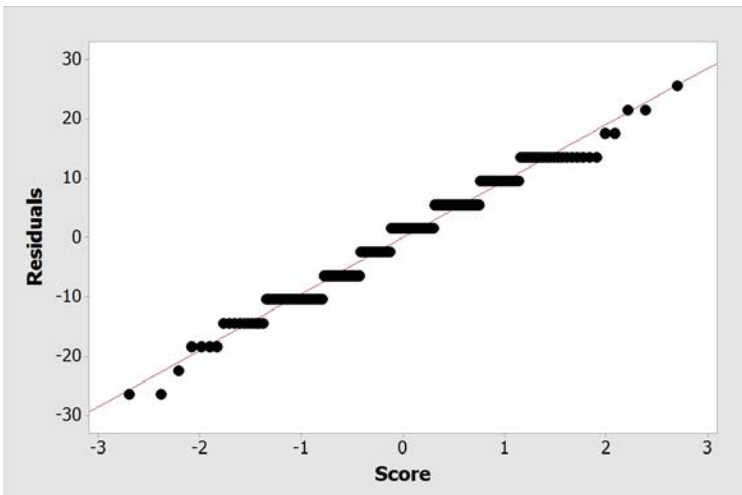



b. The model is $y = \mu + \epsilon$ where $\mu > 50$.

c. The fitted model is $\hat{y} = 65.03$.

**0.19** a. Here are a dotplot and normal quantile plot of the residuals.




The residuals are approximately normally distributed.

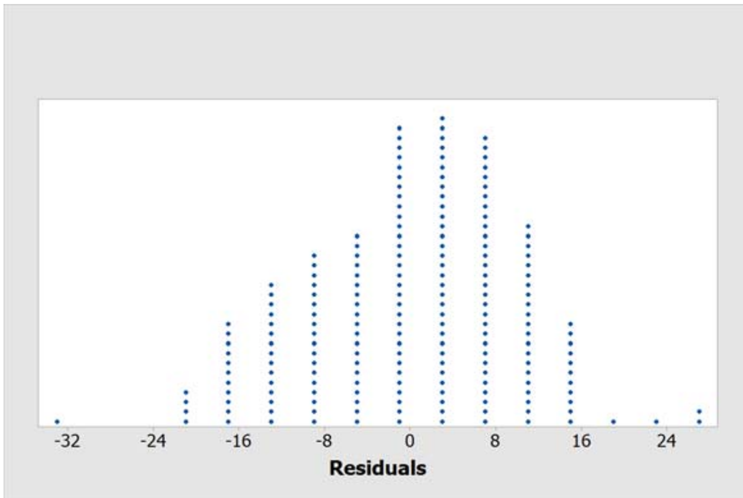
b. `One-Sample T: Survey1`

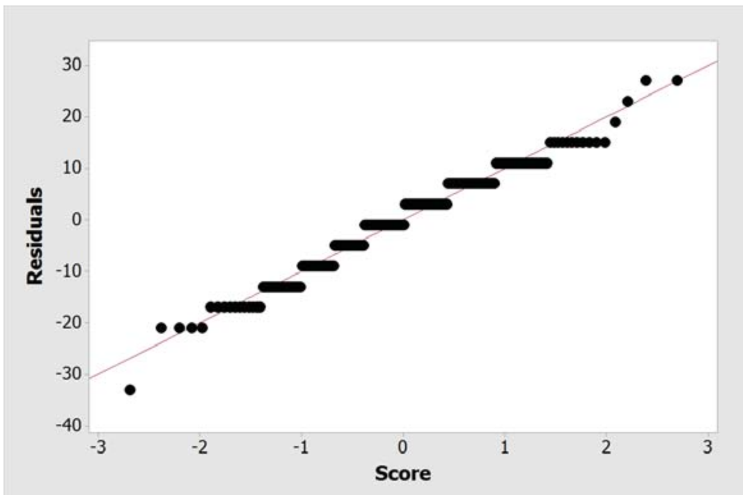
```
Test of  = 50 vs > 50


Variable    N    Mean  StDev  SE Mean  95%LowerBound      T      P
Survey1   200  62.520  9.526    0.674         61.407  18.59  0.000
```

With a $P$-value of $\approx 0$ we reject the null hypothesis.

c. It appears that people like the students surveyed do better than 50-50 when guessing the gender of a person by viewing their handwriting.

**0.20** a. Here are a dotplot and normal quantile plot of the residuals.



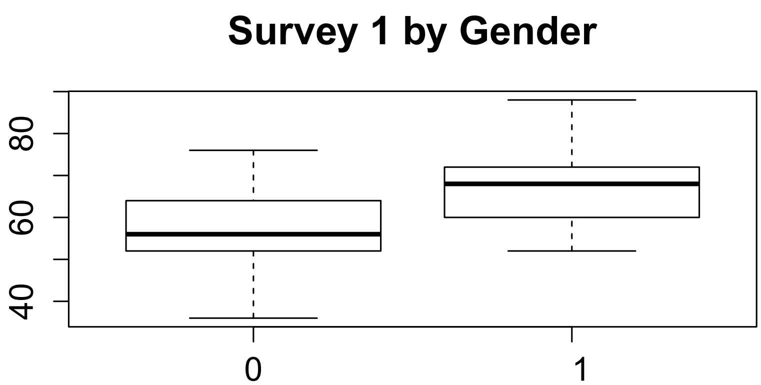

The residuals are approximately normally distributed.

b.
```
One-Sample T: Survey2

Test of  = 50 vs > 50


Variable    N    Mean  StDev  SE Mean  95%LowerBound      T      P
Survey2   198  65.030  9.994    0.710         63.856  21.16  0.000
```

With a $P$-value of $\approx 0$ we reject the null hypothesis.

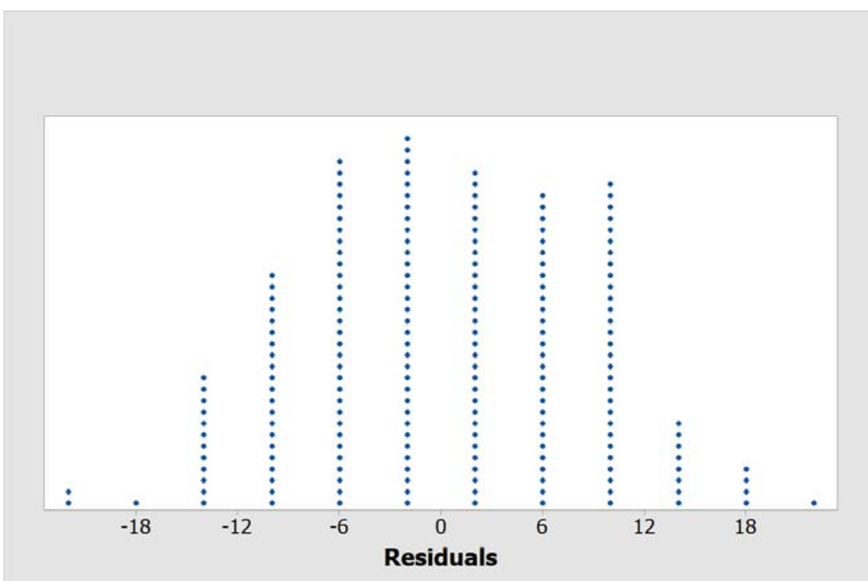
c. It appears that people like the students surveyed do better than 50-50 when guessing the gender of a person by viewing their handwriting.

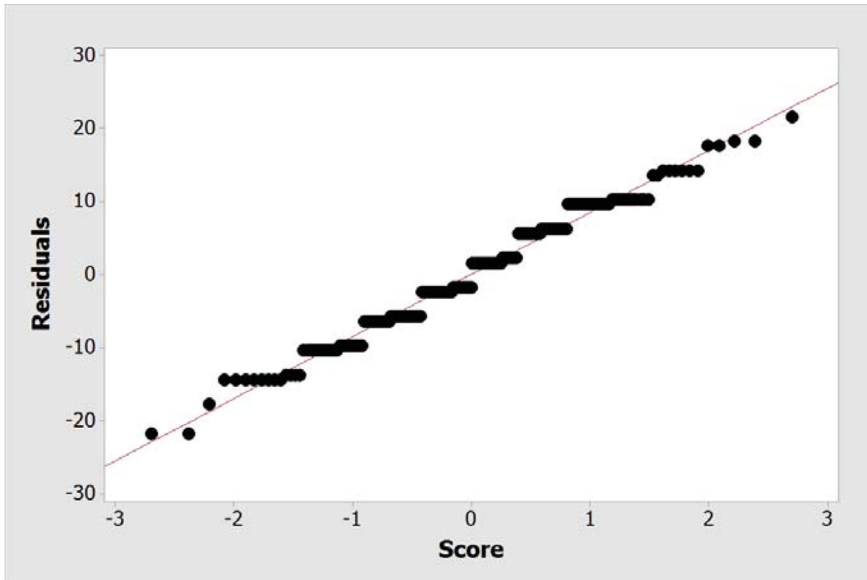
**0.21** a. A boxplot shows that women have a slightly better success rate. Both distributions are roughly symmetric. Also the women's rates cover a much tighter range of values than the men's. The model is $\hat{y} = \mu_i + \epsilon$ where $\mu_1$ is the population mean for the women and $\mu_2$ is the population mean for the men. In the boxplot, 0 indicates men and 1 indicates women.




b. The mean for the women is 66.459%, and the mean for the men is 57.802%. The fitted model, therefore, is $\hat{y} = 66.459$ for the women and $\hat{y} = 57.802$ for the men.

c. Here are a dotplot and normal quantile plot of the residuals.





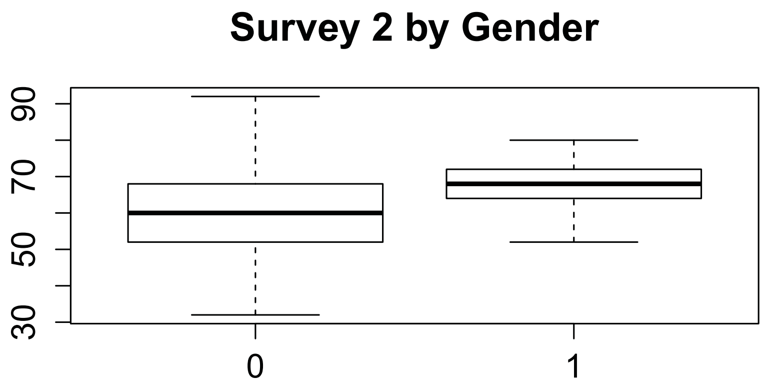

The residuals are approximately normally distributed. The results of the $t$-test are given:

```
Two-Sample T-Test and CI: Survey1, Gender

Two-sample T for Survey1

Gender    N   Mean  StDev  SE Mean
Male     91  57.80   8.97     0.94
Female  109  66.46   8.11     0.78


Difference =  (Male) -  (Female)
Estimate for difference:  -8.66
95% CI for difference:  (-11.06, -6.25)
T-Test of difference = 0 (vs ): T-Value = -7.10  P-Value = 0.000  DF = 183
```

The $P$-value is approximately 0, so we reject $H_0$.

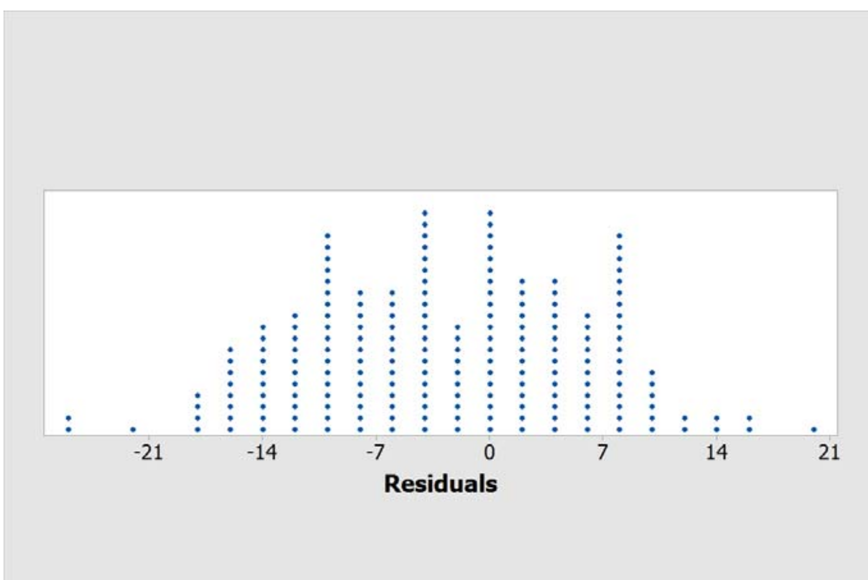
d. Since the $P$-value is so small, we reject $H_0$. It appears that men and women students do not have the same mean percentage correct answers when guessing the gender of the author of a handwriting sample.

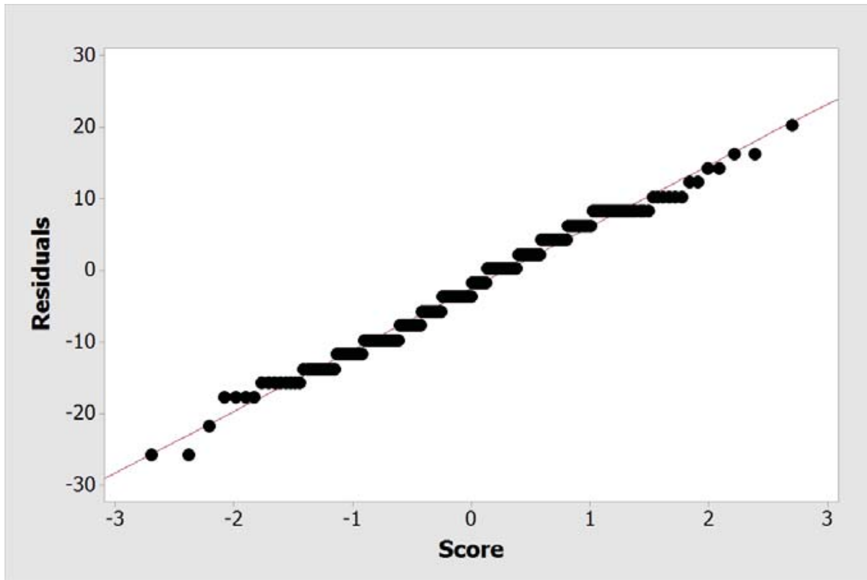
**0.22** a. A boxplot shows that women have a slightly better success rate. Both distributions are roughly symmetric. Also the women's rates cover a much tighter range of values than the men's. The model is $\hat{y} = \mu_i + \epsilon$ where $\mu_1$ is the population mean for the women and $\mu_2$ is the population mean for the men. In the boxplot, 0 indicates men and 1 indicates women.




b. The mean for the women is 67.71% and the mean for the men is 61.80%. The fitted model, therefore, is $\hat{y} = 67.71$ for the women and $\hat{y} = 61.80$ for the men.

c. Here are a dotplot and normal quantile plot of the residuals.






The residuals are approximately normally distributed. The results of the $t$-test are given:

```
Two-Sample T-Test and CI: Survey2, Gender

Two-sample T for Survey2

Gender    N   Mean  StDev  SE Mean
Male     89   61.8   11.3      1.2
Female  109  67.71   7.88     0.76


Difference =  (Male) -  (Female)
Estimate for difference:  -5.95
95% CI for difference:  (-8.75, -3.16)
T-Test of difference = 0 (vs ): T-Value = -4.21  P-Value = 0.000  DF = 152
```

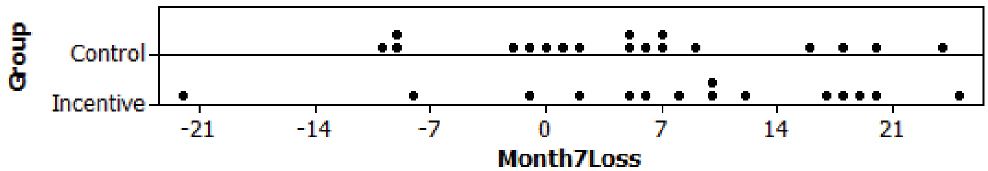
The $P$-value is approximately 0, so we reject $H_0$.

d. Since the $P$-value is so small, we reject $H_0$. It appears that men and women students do not have the same mean percentage correct answers when guessing the gender of the author of a handwriting sample.

**0.23** CHOOSE: The model is $Y = \mu_i + \epsilon$, where $\mu_1$ and $\mu_2$ are the mean seven-month weight losses without and with the financial incentive. The random error term is $\epsilon \sim N(0, \sigma_i)$, where $\sigma_1$ and $\sigma_2$ are the standard deviations of seven-month weight losses under the two conditions.

FIT: From the summary statistics, $\hat{\mu}_1 = \overline{y}_1 = 4.64$ and $\hat{\mu}_2 = \overline{y}_2 = 7.80$. Also, we estimate the respective standard deviations with $\hat{\sigma}_1 = s_1 = 9.84$ and $\hat{\sigma}_2 = s_2 = 12.06$.

ASSESS: From the comparative dotplots, we see no significant departures from an assumption of normality for the two groups. Normal probability plots also show no substantial concerns with normality.




To see if we really need different means for the two groups, we test $H_0 : \mu_1 = \mu_2$ vs. $H_a : \mu_1 \neq \mu_2$. Some computer output for doing this test is shown as follows:

```
Two-sample T for Month7Loss

Group       N  Mean  StDev  SE Mean
Control    18  4.64   9.84      2.3
Incentive  15   7.8   12.1      3.1

Difference = mu (Control) - mu (Incentive)
Estimate for difference:  -3.16
95% CI for difference:  (-11.14, 4.82)
T-Test of difference = 0 (vs not =): T-Value = -0.81  P-Value = 0.423  DF = 26
```

The $P$-value (0.423) is not very small, so there is not a significant difference in mean weight loss after seven months between the two groups.

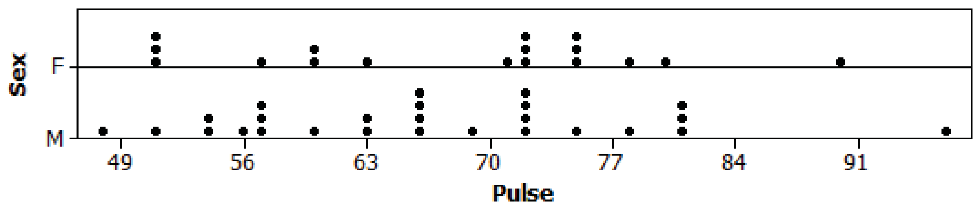
USE: The follow-up study shows that the initial difference in mean weight loss due to the financial incentive that was apparent in the data after four months no longer holds when subjects were measured again after seven months. Thus, we do not have sufficient evidence to conclude that the financial incentives help increase weight loss after seven months.

**0.24** a. CHOOSE: We use the model $Y = \mu_i + \epsilon$, where $\mu_1$ and $\mu_2$ are the mean pulse rates for women and men, respectively. The random error term is $\epsilon \sim N(0, \sigma_i)$ where $\sigma_1$ and $\sigma_2$ are the standard deviations of the pulse rates for each gender.

FIT: From the summary statistics in the computer output below, the estimated means are $\overline{x}_1 = 67.8$ for female students and $\overline{x}_2 = 66.7$ for male students.

```
Sex   N  Mean  StDev
F    17  67.8   11.4
M    26  66.7   11.3
```

ASSESS: From the comparative dotplots, we see no significant departures from an assumption of normality of the distribution of pulse rates for either gender. Normal probability plots also show no substantial concerns with normality.




To see if we really need different means for the two genders, we test $H_0 : \mu_1 = \mu_2$ vs. $H_a : \mu_1 = \mu_2$. Some computer output for doing this test is shown below.

```
Two-sample T for Pulse
T-Test of difference = 0 (vs not =): T-Value = 0.33  P-Value = 0.743  DF = 34
```

The $P$-value (0.743) is large, so there is not a significant difference in mean pulse rates by gender.

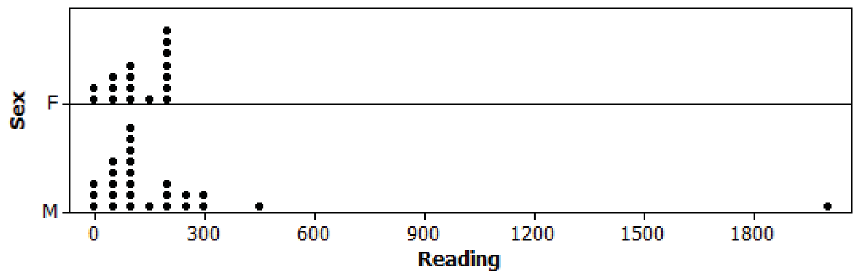
USE: No, we do not see evidence of a clear difference in mean resting pulse rates between female and male students.

b. Answers will vary.

**0.25** The means for the *Reading* variable are shown in the output below.

| Sex | N | Mean | StDev |
|---|---|---|---|
| F | 17 | 125.1 | 73.1 |
| M | 26 | 203.3 | 381.9 |

We see that the mean for men in the sample is actually larger than the mean for women. This would provide no statistical evidence that the women expect to do *more* reading. However, dotplots of the *Reading* variable show a considerable outlier with one of the male students who claimed to expect to read 2000 pages per week. This could be a data error (or an overly ambitious student), which could greatly influence the estimate for the mean amount of reading for male students. If we remove that point, the male's mean drops to 131.4 pages per week, but it is still slightly larger than the mean for female students.

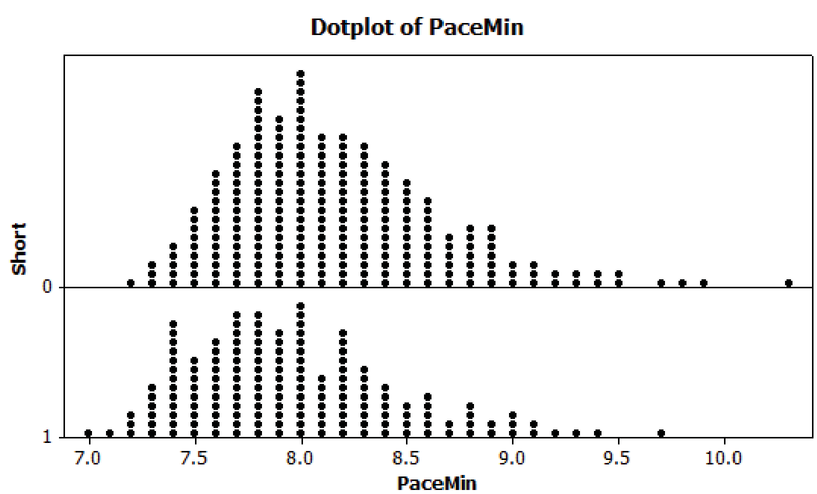



**0.26** CHOOSE: We use the model $Y = \mu_i + \epsilon$, where $\mu_0$ is the mean running pace for long runs and $\mu_1$ is the mean for short runs (5 miles or less).

FIT: From the summary statistics in the computer output below, the estimated means are $\overline{x}_0 =$ 8.158 minutes per mile for 680 long runs and $\overline{x}_1 = 7.961$ minutes per mile for 446 short runs.

```
Short     N   Mean  StDev
0       680  8.158  0.486
1       446  7.961  0.478
```

ASSESS: From the comparative dotplots, we see that a normality condition is reasonable, especially since these are very large sample sizes.




Each symbol represents up to 3 observations.

To see if the mean running paces are different between long and short runs, we test $H_0 : \mu_0 = \mu_1$ vs. $H_a : \mu_0 = \mu_1$. Some computer output for doing this test is shown below.

```
Two-sample T for PaceMin
T-Test of difference = 0 (vs not =): T-Value = 6.70  P-Value = 0.000  DF = 962
```

The $P$-value (0.000) is very small, so we have convincing evidence that the mean running pace is different between long and short runs.

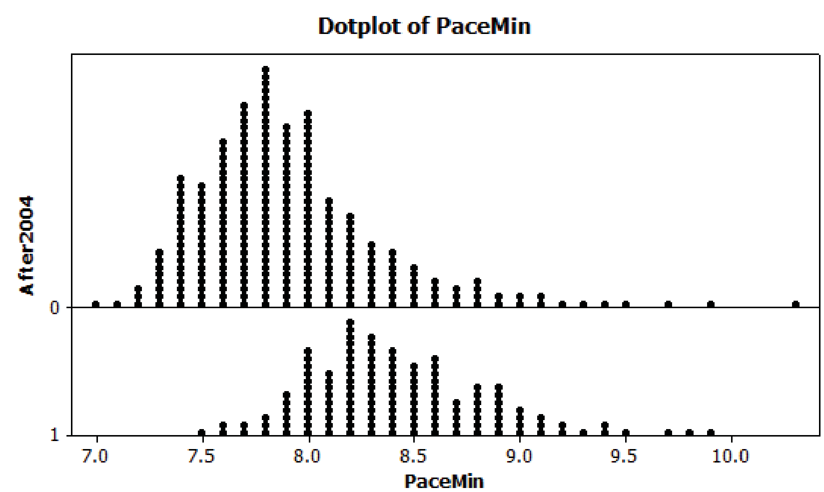
USE: Although the means for the running paces between the long and short runs are fairly close numerically (a difference of just $-0.197$ minute or about 12 seconds per mile), the large samples provide strong evidence that the mean pace is slower for long runs.

**0.27** a. CHOOSE: We use the model $Y = \mu_i + \epsilon$, where $\mu_0$ is the mean running pace for early years (2002–2004) and $\mu_1$ is the mean for later years (2005 and 2006).

FIT: From the summary statistics in the following computer output below, the estimated means are $\overline{x}_0 = 7.914$ minutes per mile for 751 runs in earlier years and $\overline{x}_1 = 8.411$ minutes per mile for 375 runs in later years.

| After2004 | N | Mean | StDev | SE Mean |
|---|---|---|---|---|
| 0 | 751 | 7.914 | 0.446 | 0.016 |
| 1 | 375 | 8.411 | 0.406 | 0.021 |

ASSESS: From the comparative dotplots, we see that a normality condition is reasonable, especially since these are very large sample sizes. The plots also show evidence that the distribution of paces is shifted to the right (slower paces) for runs in the later years.




Each symbol represents up to 3 observations.

To see if the mean running paces are different between the time periods, we test $H_0 : \mu_0 = \mu_1$ vs. $H_a : \mu_0 = \mu_1$. Some computer output for doing this test follows:

```
Two-sample T for PaceMin
95% CI for difference:  (-0.5488, -0.4446)
T-Test of difference = 0 (vs not =): T-Value = -18.71  P-Value = 0.000  DF = 813
```

The test statistic ($-18.71$) is very extreme and the $P$-value (0.000) is very small, so we have convincing evidence that the mean running pace has changed between the time periods.

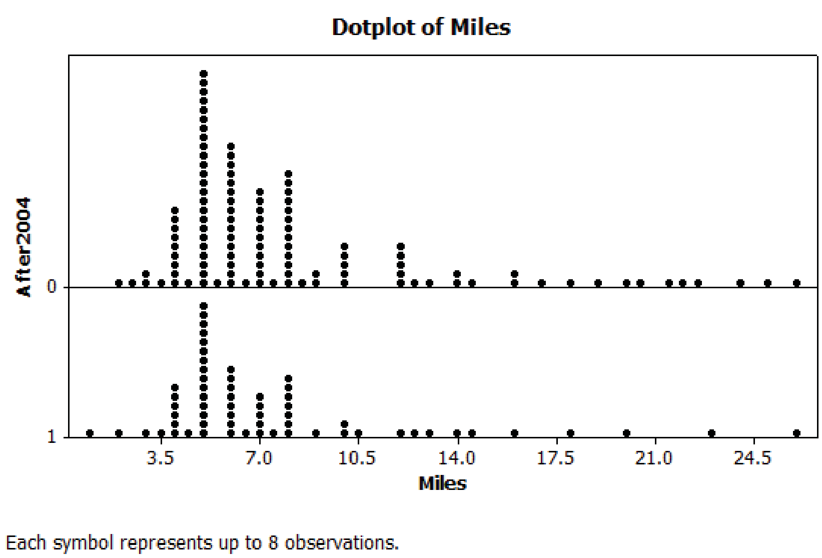
USE: The mean running pace is about a half minute per mile longer in the later years when compared to the first three years.

b. CHOOSE: We use the model $Y = \mu_i + \epsilon$, where $\mu_0$ is the mean miles per run for early years (2002–2004) and $\mu_1$ is the mean miles for later years (2005 and 2006).

FIT: From the summary statistics in the computer output below, the estimated mean miles are $\overline{x}_0 = 7.49$ miles for 752 runs in earlier years and $\overline{x}_1 = 6.63$ miles for 375 runs in later years.

```
After2004    N  Mean  StDev  SE Mean
0          752  7.49   4.07     0.15
1          375  6.63   3.14     0.16
```

ASSESS: From the comparative dotplots, we see that both distributions are somewhat right skewed (lots of shorter runs and a few very long ones), so we do not have normally distributed populations. However, the sample sizes are very large so inference based on a $t$-distribution is still reasonable.



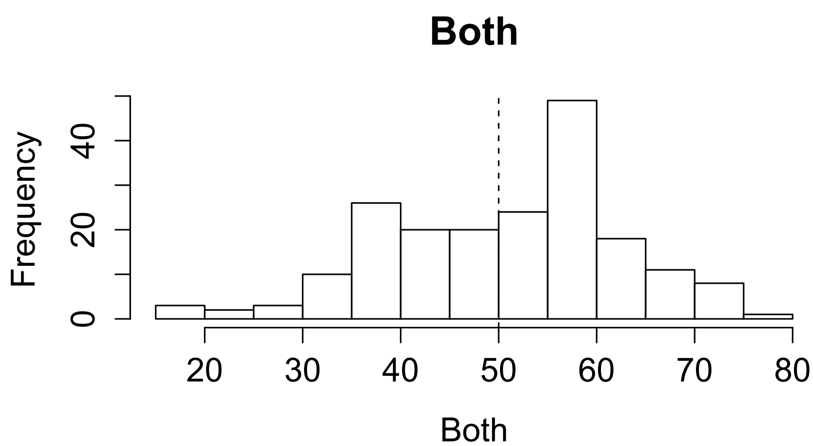
To see if the mean miles are different between the time periods, we test $H_0 : \mu_0 = \mu_1$ vs. $H_a : \mu_0 = \mu_1$. Some computer output for doing this test is shown below.

```
Two-sample T for Miles
95% CI for difference:  (0.432, 1.295)
T-Test of difference = 0 (vs not =): T-Value = 3.93  P-Value = 0.000  DF = 937
```

The test statistic (3.93) is large and the $P$-value (0.000) is very small, so we have convincing evidence that the number of miles run per day has changed between the time periods.

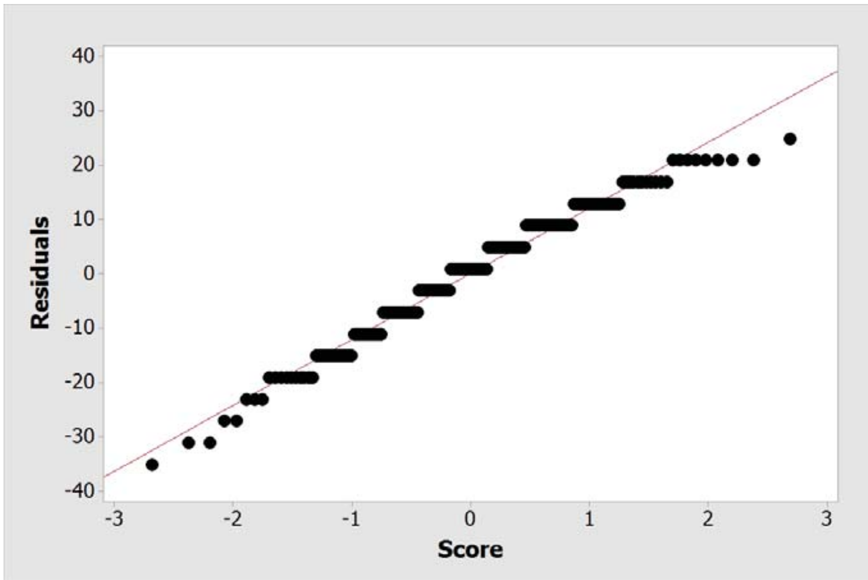
USE: Our data strongly indicate that the average distance run in the later years is less than the average in the earlier years. The 95% confidence interval shows that the average run is between 0.43 and 1.30 miles shorter during the later years.

**0.28** CHOOSE: The histogram shows that the distribution for *Both* is roughly normal, although there is a slight left skewness. The range is from 16 to 76 with a mean percentage success of 51.179%. The model we choose for this analysis is $\hat{y} = \mu + \epsilon$ where $\mu > 50$.




FIT: The sample mean is 51.179, so the fitted model is $\hat{y} = 51.179$.

ASSESS: The normal quantile plot of the residuals suggests that they are reasonably normally distributed.



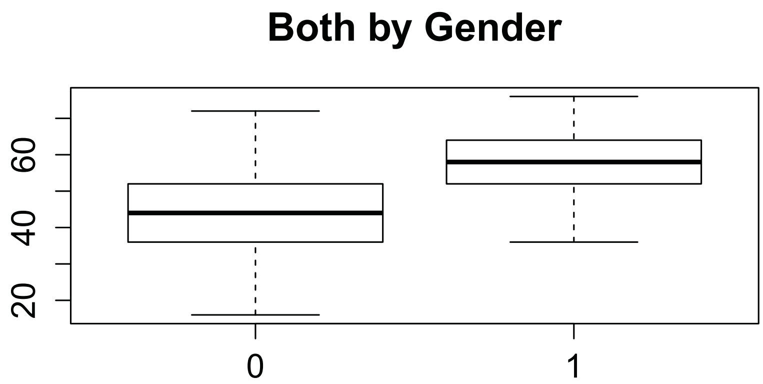

The details of the $t$-test, testing to see if the mean response for *Both* is significantly greater than 50%, are given below:

```
One-Sample T: Both

Test of  = 50 vs > 50


Variable    N    Mean   StDev  SE Mean  95%LowerBound     T      P
Both      195  51.179  12.116    0.868          49.746  1.36  0.088
```

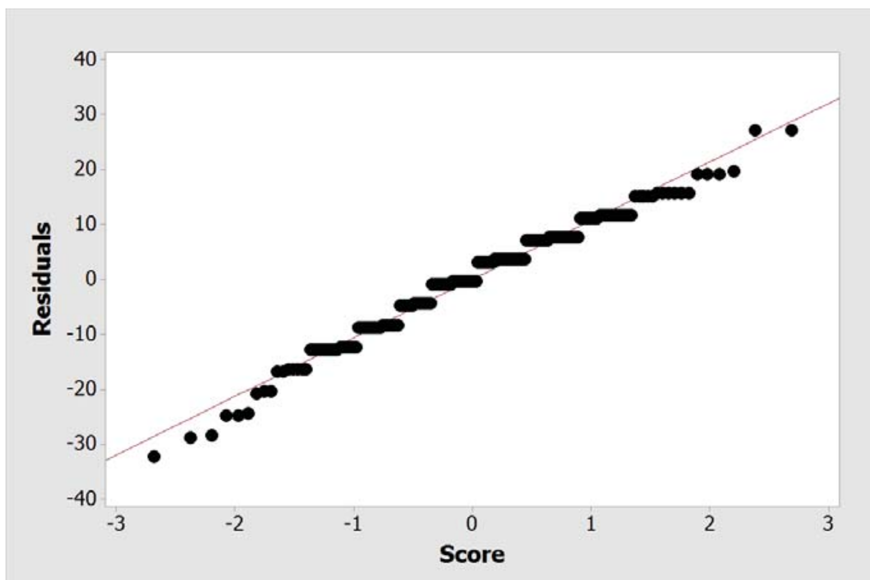
With a $P$-value of approximately 0.09, we do not reject $H_0$.

USE: We do not have enough evidence to say that students do significantly better than guessing on the gender of authors based on handwriting, when we take into consideration the responses to both surveys.

**0.29** CHOOSE: The boxplot shows that there seems to be a difference between men and women students with women doing better at guessing the gender of the author of handwriting samples. The model we choose for this analysis is $\hat{y} = \mu_i + \epsilon$ where $\mu_1$ is the mean percentage correct for women and $\mu_2$ is the mean percentage correct for men. In the boxplot, 0 indicates men and 1 indicates women.




FIT: The sample mean for women is 56.4 and the sample mean for men is 44.9, so the fitted model is $\hat{y} = 66.4$ for women and $\hat{y} = 44.9$ for men.
ASSESS: The normal quantile plot of the residuals suggests that they are reasonably normally distributed.




The details of the $t$-test, testing to see if the mean response for *Both* is significantly different for men and women students, are given below:

```
Two-Sample T-Test and CI: Both, Gender

Two-sample T for Both
```

```
Gender    N  Mean  StDev  SE Mean
Male     89  44.9   11.2      1.2
Female  106  56.4   10.2     0.99


Difference =  (Male) -  (Female)
Estimate for difference:  -11.47
95% CI for difference:  (-14.53, -8.41)
T-Test of difference = 0 (vs ): T-Value = -7.39  P-Value = 0.000  DF = 180
```

With a $P$-value of approximately 0, we reject $H_0$.
USE: It appears that there is a significant difference between the abilities of men and women to guess the correct gender of the author of handwriting samples, when using the results of two different surveys together.

**0.30** a. The summary statistics in the following computer output show the means and standard deviations for the resting pulse rates for both men and women, as well as the difference in means and pooled standard deviation.

```
Descriptive Statistics: Pulse
Sex   N   Mean StDev
  F  17   67.8  11.4
  M  26   66.7  11.3

Difference Pooled StDev
      1.17         11.31
```

The effect size is $1.17/11.31 = 0.10$. This is a relatively small effect size, so there is not an important difference in the mean resting pulse rates for male and female students.

b. The summary statistics in the following computer output show the means and standard deviations for the training pace (min/mile) for both long (0) and short(1) training runs, as well as the difference in means and pooled standard deviation.

```
Descriptive Statistics: PaceMin
Short      N   Mean   StDev
    0    680  8.158  0.486
    1    446  7.961  0.478

Difference Pooled StDev
    0.1965       0.4829
```

The effect size is $0.1965/0.4829 = 0.41$. This is a moderately large effect size, so there is a somewhat important difference in the mean pace for short and long runs (long runs tend to have a slower pace).

**0.31** a. The summary statistics in the following computer output show the means and standard deviations for the miles for training runs before and after 2004, as well as the difference in means and pooled standard deviation.

```
Descriptive Statistics: Miles
After2004    N   Mean StDev
        0  752  7.49  4.07
        1  375  6.63  3.14

Difference Pooled StDev
     0.863        3.789
```

The effect size is $0.863/3.789 = 0.23$. This is a relatively small effect size, so there is not an important difference in the mean lengths of training runs between the two periods..

b. The summary statistics in the following computer output show the means and standard deviations of guessing abilities for men and women, as well as the difference in means and pooled standard deviation.

```
Descriptive Statistics: Both
Gender   N    Mean   StDev
     0  89    44.9    11.2
     1 106    56.4    10.2

Difference Pooled StDev
    -11.47        10.70
```

The effect size is $|-11.47|/10.70 = 1.07$. This is a large effect size, so there is an important difference in the mean guessing abilities for men and women (because the difference is negative, women tend to do better).

**0.32** a. The Chicago Cubs' predicted winning percentage for 808 runs scored and 556 runs against is

$$\widehat{WinPct} = \frac{808^2}{808^2 + 556^2}(100) = 67.87\%$$

b. The actual Cubs' winning percentage for 2016 is $103/162 = 0.6358$, or 63.58%. The residual is $actual - predicted = 63.58 - 67.87 = -4.29\%$.

c. The Cubs did slightly worse in 2016 than their runs scored and allowed would predict. The actual winning percentage was 4.29% less than what was predicted, which, for a 162-game season, means the Cubs won 6 or 7 games less than would be expected based on their aggregate scoring.

d. The San Diego Padres' predicted winning percentage for 686 runs scored and 770 runs against is

$$WinPct = \frac{686^2}{686^2 + 770^2}(100) = 44.25\%$$

The actual Padres' winning percentage for 2016 is $68/162 = 0.4198$, or 41.98%. The residual is $actual - predicted = 41.98 - 44.25 = -2.27\%$.

The Padres also did worse than expected in 2016, given the runs they scored and allowed. The actual winning percentage was 2.27% less than predicted, which, for a 162-game season, means the Padres won about 3 or 4 fewer games than would be expected based on their aggregate scoring.

e. The Cubs fell short of their Pythagorean-predicted winning percentage by more than the Padres did ($-4.29\%$ to $-2.27\%$).

f. The Texas Rangers had an actual winning percentage (58.64%) that exceeded their Pythagorean-predicted winning percentage (50.53%) by the largest amount (residual = 8.12%). They won quite a few more games than would be expected from the number of runs they scored and allowed. Note that the Rangers won more games than they lost (95–67), even though their opponents nearly outscored them in aggregate (765 runs for to 757 runs against).

g. The Tampa Bay Rays did the worst compared to their expected winning percentage. They won 68 games and lost 94 (41.98%) but were predicted to win 47.04%, giving a residual of $-5.07\%$.