**12.56** No, it would not be appropriate to find a 95% confidence interval for the mean. The sample is not a random sample as the ages at death of the first ladies are not representative of the ages at death of any larger population. The data set might even be considered to be population data where the population is the group of all women who have ever been a First Lady of the United States.

**12.57** **a.** Women: Approximate 95% confidence interval is about .84 to .96.
Men: Approximate 95% confidence is about .60 to .81.

Women: $\hat{p} = \frac{84}{93} = .903$ and confidence interval is $.903 \pm 1.96\sqrt{\frac{.903(1-.903)}{93}}$

Men: $\hat{p} = \frac{53}{75} = .707$ and confidence interval is $.707 \pm 1.96\sqrt{\frac{.707(1-.707)}{75}}$.

**b.** Approximate 95% confidence interval for difference is .196 ± (1.96)(.061), or about .077 to .316. (Using 2 instead of 1.96 is okay.)
Parameter is $p_1 - p_2$ = difference in proportions of college men and women who would say they would return the money.
Sample estimate is $\hat{p}_1 - \hat{p}_2 = .903 - .707 = .196$

Standard error is $s.e.(\hat{p}_1 - \hat{p}_2) = \sqrt{\frac{.903(1-.903)}{93} + \frac{.707(1-.707)}{75}} =$ = .061

Multiplier is z* = 1.96 (which can be rounded to 2)

**c.** The intervals in part (a) provide separate estimates for men and women of the proportion who would say they would return the money. The two separate intervals make it evident that the proportion is higher for the population of women. This is confirmed in part (b), because the interval for the difference in proportions does not include 0, so we can conclude that a difference exists.

**12.59** **a.** The interval will be wider for 95% than for 90% confidence.

**b.** The interval will be narrower if the sample size is doubled.

**c.** Assuming the standard deviation stays the same, the width will remain the same if the sample size is the same. The observed value of a sample mean does not affect the width of the confidence interval.

**12.65** **a.** The comparison of dominant vs. nondominant hands is a paired situation; these are not independent samples, because an individual's two scores will certainly be related to each other and not independent. Furthermore, there is an obvious pairing here: Each individual's dominant hand should be paired with that same individual's nondominant hand.

**b**. The order of using the two hands was randomized to avoid confounding the difference between the hands with the difference between doing the task the first and second times. If all students used their non-dominant hand first, for example, an observed difference between the two hands could be due to a learning effect rather than the effect of dominant and non-dominant hands.

**c.** A 90% confidence interval for the mean difference is about −0.04 to 2.17 (see below).

Parameter is $\mu_d$ = mean difference in number of beans placed with dominant hand and number placed with non-dominant hand by people in population represented by sample.

This is paired data, so the sample of *differences* should be analyzed using the method of Section 12.4.

The relevant formula is $\bar{d} \pm t^* \frac{s_d}{\sqrt{n}}$. Here, $t^*$ =2.14 (df = 15−1 = 14). The values of d-bar and s are 1.067 and 2.434, respectively. Thus, the SEM (standard error of the mean) is 2.434/sqrt(15) = 0.628.

Thus, the 90% confidence interval given above is found by taking

1.067 ± 2.14(0.628).

*Check necessary conditions:* Since the sample size is smaller than 30, it is a good idea to check to see whether the normality assumption (for the population) is reasonable. A dotplot and/or a boxplot can be used to verify that the sample of differences is more or less symmetric and there are no outliers. Thus, the normality assumption necessary for small samples seems justifiable.

**d.** Because the interval covers 0, we cannot say that manual dexterity (as measured by this task) is better, on average, for the dominant hand. Based on these data, it remains plausible that the mean difference is 0.

**12.67** **a.** A 95% confidence interval is about 5.0 to 15.3 points, computed as 10.16 ± (2)(2.577) (see below).

The parameter is $\mu_1 - \mu_2$ = difference in mean IQ scores at age 4 for children of mothers who did not smoke during pregnancy (group 1) versus children of mothers who smoked at least 0 cigarettes per day during pregnancy (group 2).

*Interpretation*: With 95% confidence, we can say that in the populations represented by these samples, the mean IQ score at age 4 is between about 5.06 and 15.26 points higher for children whose mothers did not smoke during pregnancy compared to children whose mothers smoked during pregnancy.

For computing Sample estimate ± Multiplier × Standard error:

Sample estimate is $\bar{x}_1 - \bar{x}_2$ = 113.28 – 103.12 = 10.16 points.

Standard error (pooled) = $s_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}} = 13.5\sqrt{\frac{1}{66} + \frac{1}{47}} = 2.577$

Multiplier ≈ 2 (because the sample sizes are large). Exact multiplier is $t^*$ = 1.98 (df = 111)

*Check necessary conditions:* The sample sizes are sufficiently large. We assume the samples represent random samples from the populations of interest.

**b.** *Purpose of statement*: The statement gives a confidence interval that has been adjusted for some confounding variables and other differences between the two groups (mother smoked or not) that might affect the comparison of IQ scores. For instance, it might have been the case that mothers who smoked also drank more alcohol during pregnancy, and that some of the difference in IQ scores could be attributed to that confounding variable.
*Interpretation*: After adjustments for possible confounding variables, we can say with 95% confidence that the difference in mean IQ scores at age 4 is between .02 and 8.68 for children of mothers who do not smoke during pregnancy versus mothers who smoke at least 10 cigarettes a day during pregnancy. Notice that the adjustments have reduced the estimated magnitude of the difference, but it is still the case that the interval does not cover 0.

**12.71** The parameter is $\mu_1 - \mu_2$ = difference in mean reported fastest ever driving speed for population of college women (group 1) versus population of college men (group 2).
*Confidence interval*: With the unpooled standard error, the 95% confidence interval for $\mu_1 - \mu_2$ is −23.7 to −14.3 mph. (The interval based on the pooled standard error is similar.) To find this, we need some info from R:

```
>ps1=read.table("http://www.stat.psu.edu/~dhunter/220/files
/datasets/ascii/pennstate1.txt",
 header=T, na.strings="*")
> attach(ps1)
> mean(Fastest[Sex=="Male"], na.rm=T)
[1] 107.4023
> mean(Fastest[Sex=="Female"], na.rm=T)
[1] 88.40196
> sqrt(var(Fastest[Sex=="Male"], na.rm=T))
[1] 17.4339
> sqrt(var(Fastest[Sex=="Female"], na.rm=T))
[1] 14.43131
```

Therefore, the estimate of $\mu_1 - \mu_2$ is 88.40 – 107.40 = -19.00. The standard error of the estimate is

$$\sqrt{\frac{17.43^2}{87} + \frac{14.43^2}{102}} = 2.35,$$

and the multiplier is approximately 2. (Actually 1.99 if you look at 80 df, since 86 is the smaller of 87-1 and 102-1.

*Interpretation*: With 95% confidence, we can say that the mean fastest ever driving speed is between about 14.3 and 23.7 mph slower for college women than it is for college men.

*Necessary assumptions*: We must assume that with regard to fastest driving speeds this sample of college students is representative of the larger population of college men and women.
*Check necessary conditions*: The sample sizes are large enough so that the t confidence interval for the difference in means can be used. (Even with large samples, it is useful to examine plots of the data. A comparative dotplot of these data is shown for Case Study 1.1 on page 2 of the text. That plot shows no extreme skewness and only a few mild, probably harmless outliers.)

**12.74** First, create a two-way table for the two variables to determine relevant counts:

```
>gss=read.table("http://www.stat.psu.edu/~dhunter/220/files
/datasets/ascii/GSS-93.txt",head=T,na="*")
> attach(gss)
> table(owngun,polparty)
      polparty
owngun Democrat Independent Other Republican
   No       242         205    10        153
   Yes      131         152     4        163
```

Of $n_1 = 316$ Republicans, the number owning a gun is 163 so $\hat{p}_1 = \frac{163}{316} = .516$. Of $n_2 = 373$ Democrats, the number owning a gun is 131 so $\hat{p}_2 = \frac{131}{373} = .351$ The 95% confidence interval for $p_1 - p_2$ is about .09 to .24 (note that it does not cover 0 so is evidence of difference in the population). This is computed as follows: The estimate of $p_1 - p_2$ is .516-.351 = .165. The standard error of this difference is

$$\sqrt{\frac{.516(.484)}{316} + \frac{.351(.649)}{373}} = 0.037,$$

which means that the (approximate) 95% confidence interval would be .165±2(0.037). If you wish, you can use 1.96 instead of 2 as the multiplier here.

**Part C**. Here's one way to produce the table:

| Height | motherht | fatherht | sex | family |
|---|---|---|---|---|
| 73.2 | 67 | 78.5 | M | 1 |
| 69.2 | 67 | 78.5 | F | 1 |
| 69 | 67 | 78.5 | F | 1 |
| 69 | 67 | 78.5 | F | 1 |
| 73.5 | 66.5 | 75.5 | M | 2 |
| 72.5 | 66.5 | 75.5 | M | 2 |
| 65.5 | 66.5 | 75.5 | F | 2 |
| 65.5 | 66.5 | 75.5 | F | 2 |
| 71 | 64 | 75 | M | 3 |
| 68 | 64 | 75 | F | 3 |
| 70.5 | 64 | 75 | M | 4 |
| 68.5 | 64 | 75 | M | 4 |
| 67 | 64 | 75 | F | 4 |
| 64.5 | 64 | 75 | F | 4 |

| | | | | |
|---|---|---|---|---|
| 63 | 64 | 75 | F | 4 |
| 72 | 58.5 | 75 | M | 5 |
| 69 | 58.5 | 75 | M | 5 |
| 68 | 58.5 | 75 | M | 5 |
| 66.5 | 58.5 | 75 | F | 5 |
| 62.5 | 58.5 | 75 | F | 5 |
| 62.5 | 58.5 | 75 | F | 5 |

**Part D**. Here's one way to produce the table:

| lastname | firstname | position | team | age | salary |
|---|---|---|---|---|---|
| Osuna | Antonio | Pitcher | Dodgers | 26 | 1050 |
| Pettite | Andy | Pitcher | Yankees | 26 | 5950 |
| Dunwoody | Todd | Outfield | Marlins | 24 | 222 |
| Sosa | Sammy | Outfield | Cubs | 30 | 9000 |