The t inferences for comparing the treatment means assume normal population distributions. The box plots do not show any substantial skew, but there is an extreme outlier for the cell phone group. One subject in that group had a very slow mean reaction time, 960 milliseconds.

Questions to Explore

a. Explain how to find the ranks for the Wilcoxon test by showing which of the 64 observations get ranks 1, 2, 63, and 64.

b. Table 15.5 shows the SPSS output for conducting the Wilcoxon test. Report and interpret the mean ranks.

Table 15.5 SPSS Output for Wilcoxon Test with Data from Cell Phone Study

```
Ranks
                group          N    Mean Rank    Sum of Ranks
TIME            Control        32     27.03         865.00
                Cell phone     32     37.97        1215.00
                Total          64
Test Statistics
                                TIME
Wilcoxon W                    865.000
Z                              −2.350
Asymp. Sig. (2-tailed).019
```

c. Report the test statistic and the P-value for the two-sided Wilcoxon test. Interpret.

Think It Through

a. Let's look at the smallest and largest observations for each group that were shown above:

Cell phone:	456	468	482	501	. . . . .	672	679	688	960
Control:	426	436	444	449	. . . . .	626	626	642	648

We give rank 1 to the *smallest* reaction time, so the value 426 gets rank 1. The second smallest observation is 436, which gets rank 2. The largest of the 64 reaction times, which was 960, gets rank 64. The next largest observation, 688, gets rank 63.

b. Table 15.5 reports mean ranks of 27.03 for the control group and 37.97 for the cell phone group. The smaller mean for the control group suggests that that group tends to have smaller ranks, and thus faster reaction times.

c. The z test statistic takes the difference between the sample mean ranks and divides it by a standard error. Table 15.5 reports $z = -2.35$. The P-value of 0.019, reported as "Asymp. Sig. (2-tailed)," is the two-tail probability for the two-sided H_a. It shows strong evidence against the null hypothesis that the distribution of reaction time is identical for the two treatments. Specifically, the sample mean ranks suggest that reaction times tend to be slower for those using cell phones.

Insight

The observation of 960 would get rank 64 if it were *any* number larger than 688 (the second largest value). So, *the Wilcoxon test is not affected by an outlier.* No matter how far the largest observation falls from the next largest, it