confident that the difference in the proportion of inaccurate orders in 2002 for the two fast food restaurants is between −0.09 and −0.01. Notice that 0 is not in the confidence interval, so there is a significant difference in the proportion of inaccurate orders at the two restaurants.

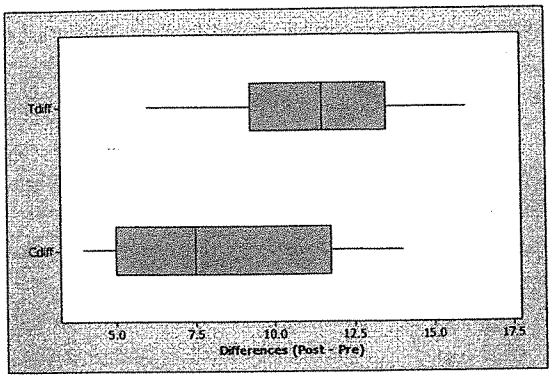
13.41 (a) This is a two-sample $t$ test. The two groups of women are (presumably) independent. (b) df = 45 − 1 = 44. (c) The sample sizes are large enough, $n_1 = n_2 = 45$, that the averages will be approximately Normal, so the fact that the individual responses do not follow a Normal distribution has little effect on the reliability of the $t$ procedure.

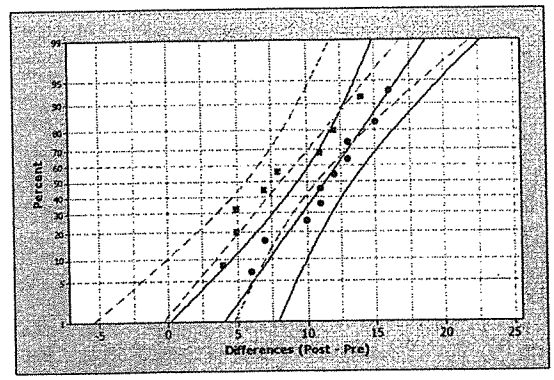
13.42 (a) This is an observational study because the researchers simply observed the random samples of women; they did not impose any treatments. (b) We want to test $H_0: p_N = p_B$ versus $H_a: p_N > p_B$. The combined sample proportion is $\hat{p}_c = \frac{183+68}{220+117} \doteq 0.7448$ and the test statistic is $z = \frac{0.8318-0.5812}{\sqrt{0.7448(1-0.7448)(1/220+1/117)}} \doteq 5.02$, with a $P$-value < 0.0001. We have very strong evidence that a smaller proportion of female Hispanic drivers wear seat belts in Boston than in New York.

13.43 We want to test $H_0: p_H = p_W$ versus $H_a: p_H \neq p_W$. The combined sample proportion is $\hat{p}_c = \frac{286+164}{539+292} \doteq 0.5415$ and the test statistic is $z = \frac{0.5306-0.5616}{\sqrt{0.5415(1-0.5415)(1/539+1/292)}} \doteq -0.86$, with a $P$-value = 0.3898. Since 0.3898 > 0.05, there is not a significant difference between Hispanic and white drivers. For the size of the difference, construct a 95% (or other level) confidence interval. A 95% confidence interval for $p_H - p_W$ is

$(0.5306-0.5616) \pm 1.96\sqrt{\frac{0.5306\times 0.4694}{539} + \frac{0.5616\times 0.4384}{292}} = (-0.1018, 0.0398)$. With 95% confidence we estimate the difference in the proportions for Hispanic and white drivers who were seat belts to be between −0.10 and 0.04. Notice that 0 is in the 95% confidence interval, so we would conclude that there is no difference at the 5% significance level.

13.44 We want to test $H_0: \mu_T = \mu_C$ versus $H_a: \mu_T > \mu_C$, where $\mu_T$ is the mean difference (post − pre) for the treatment group and $\mu_C$ is the mean difference (post − pre) for the control group. The boxplots (on the left below) show that the distributions are roughly symmetric with no outlier, and the Normal probability plots (on the right below) show linear trends which indicate that the Normal distribution is reasonable for these data.




The test statistic is $t = \dfrac{11.40-8.25}{\sqrt{3.17^2/10+3.69^2/8}} \doteq 1.91$, with $0.025 < P\text{-value} < 0.05$ and df = 7 (Minitab gives a $P$-value of 0.039 with df=13). The $P$-value is less than 0.05, so the data give good evidence that the positive subliminal message brought about greater improvement in math scores than the control. (b) A 90% confidence interval for $\mu_T - \mu_C$ is $(11.40-8.25) \pm 1.895\sqrt{3.17^2/10+3.69^2/8}$ = (0.03, 6.27) with df = 7; (0.235, 6.065) using Minitab with df = 13. With 90% confidence, we estimate the mean difference in gains to be 0.235 to 6.065 points better for the treatment group. (c) This is actually a repeated measures design, where two measurements (repeated measures) are taken on the same individuals. Many students will probably describe this design as a completely randomized design for two groups, with a twist—instead of measuring one response variable on each individual, two measurements are made and we compare the differences (improvements).

13.45 (a) A 99% confidence interval for $p_M - p_W$ is $(0.9226-0.6314) \pm 2.576\sqrt{\dfrac{0.9226\times 0.0774}{840}+\dfrac{0.6314\times 0.3686}{1077}}$ = (0.2465, 0.3359). Yes, because the 99% confidence interval does not contain 0. (b) We want to test $H_0: \mu_M = \mu_W$ versus $H_a: \mu_M \neq \mu_W$. The test statistic is $t = \dfrac{272.40-274.7}{\sqrt{59.2^2/840+57.5^2/1077}} \doteq -0.87$, with a $P$-value close to 0.4. (Minitab reports a P-value of 0.387 with df = 1777.) Since 0.4 > 0.01, the difference between the mean scores of men and women is not significant at the 1% level.

13.46 (a) Matched pairs $t$. (b) Two-sample $t$. (c) Two-sample $t$. (d) Matched pairs $t$. (e) Matched pairs $t$.

13.47 (a) A 99% confidence interval for $\mu_{OPT} - \mu_{WIN}$ is $(7638-6595) \pm 2.581\sqrt{289^2/1362+247^2/1395}$ = (1016.55, 1069.45). (b) The fact that the sample sizes are both so large (1362 and 1395).