**5.30 Fuel efficiency of manual and automatic cars, Part I.** Each year the US Environmental Protection Agency (EPA) releases fuel economy data on cars manufactured in that year. Below are summary statistics on fuel efficiency (in miles/gallon) from random samples of cars with manual and automatic transmissions manufactured in 2012. Do these data provide strong evidence of a difference between the average fuel efficiency of cars with manual and automatic transmissions in terms of their average city mileage? Assume that conditions for inference are satisfied.[45]

	City MPG	
	Automatic	Manual
Mean	16.12	19.85
SD	3.58	4.51
n	26	26

City MPG
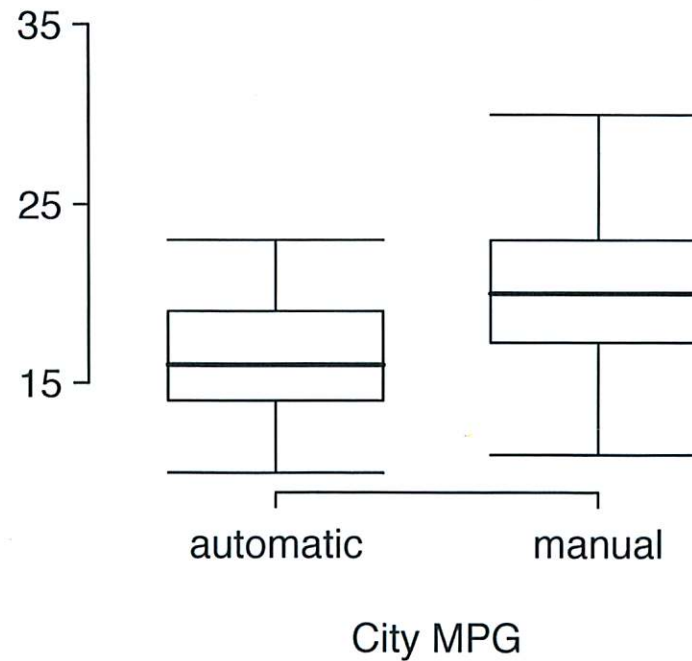
population ① = Automatic   population ② = Manual

$$\bar{y}_2 - \bar{y}_1 = 19.85 - 16.12 = 3.73 \quad \text{our estimate of the difference in mean fuel efficiency}$$

pooled standard deviation, $s_p = \sqrt{\dfrac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$

$$= \sqrt{\dfrac{25(3.58^2) + 25(4.51^2)}{50}}$$

$$= 4.07$$

$$SE_{\hat{y}_2 - \hat{y}_1} = 4.07\sqrt{\dfrac{1}{n_1} + \dfrac{1}{n_2}}$$

$$= 4.07\sqrt{\dfrac{1}{26} + \dfrac{1}{26}}$$

$$= 1.13$$

95% confidence interval for $\mu_2 - \mu_1$:

$$\bar{y}_{12} - \bar{y}_1 \pm t_{50}(0.975) \; 1.13 \qquad \left(\text{in } R : \; qt(0.975, 50) = 2.01 \right)$$

$$\approx \; 3.73 \pm 2.01 (1.13)$$

$$= \boxed{(1.46 , 6.00)}$$

With 95% confidence, the mean efficiency of manual cars is between 1.46 and 6.00 mpg higher than the mean efficiency for automatic cars.

Test of the null hypothesis $\mu_2 - \mu_1 = 0$:

$$t\text{-stat} = \frac{\bar{y}_2 - \bar{y}_1}{SE_{\bar{y}_2 - \bar{y}_1}} = \frac{3.73}{1.13} = 3.30$$

Compare to t_{50} for p-value, in R $\quad 2*(1 - pt(3.30, 50))$

$$\boxed{p\text{-value} = 0.0018}$$

There is convincing evidence manual cars have a higher mean fuel efficiency than automatic cars in 2012 (two sample t-test, p-value = 0.0018, $n_1 = n_2 = 26$)