| Subject | Before | After |
|---|---|---|
| 1 | 137 | 130 |
| 2 | 201 | 180 |
| 3 | 167 | 150 |
| 4 | 150 | 153 |
| 5 | 173 | 162 |

**Biofeedback.** In the past, many bodily functions were thought to be beyond conscious control. However, recent experimentation suggests that it may be possible for a person to control certain body functions if that person is trained in a program of *biofeedback* exercises. An experiment is conducted to show that blood pressure levels can be consciously reduced in people trained in this program. The blood pressure measurements (in millimeters of mercury) listed in the table represent readings before and after the biofeedback training of five subjects.

(a) If we want to test whether the mean blood pressure decreases after the training, what are the appropriate null and alternative hypotheses?

(b) Perform the test in (a) with $\alpha = 0.05$.

(c) What assumptions are needed to assure validity of results.

[$D_i = \{7, 21, 17, -3, 11\}, \bar{D} = 10.6, s_D = 9.32, t = 10.6/(9.32/sqrt5) = 2.54, t_{4,0.95} = 2.131847.$]

**Methods of reading.**

In a psychological experiment a random sample of 20 students is randomly divided into two groups: *phonetic group* and *memorization group* with 10 students in each group. At the end of instruction, we measure all 20 students' reading times on a standard passage. The data are shown in the table below.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Phonetic (X) | 5.8 | 5.1 | 6.6 | 4.7 | 5.6 | 5.9 | 5.7 | 4.3 | 4.5 | 5.0 |
| Memorization (Y) | 5.9 | 6.1 | 5.1 | 4.7 | 4.6 | 6.4 | 6.7 | 5.1 | 5.0 | 4.6 |

[$\bar{X} = 5.32, \bar{Y} = 5.42, s_X = 0.72, s_Y = 0.78.$]

Test the hypothesis that the two types of instruction are different. Use $\alpha = 10\%$. Assume $\sigma_X = \sigma_Y$.

[Sol: $\bar{X} = 5.32, \bar{Y} = 5.42, s_X = 0.72, s_Y = 0.78, s_p = 0.753, t = -0.297, t_{18,0.05} = 1.734$, Do not reject $H_0$.
]

**Energy.** Two relatively new energy-saving concepts in home building are solar-powered homes and earth-sheltered homes. An individual is drawing up plans for a new home and wants to compare expected annual heating costs for the two types of inovation. Independent random samples of solar powered homes (which receive 50% of their energy from the sun) and earth-sheltered homes yielded the accompanying summary data on annual heathng costs.

| Solar-powered | Earth-sheltered |
|---|---|
| $n_1 = 120$ | $n_2 = 60$ |
| $\bar{X} = \$285$ | $\bar{Y} = \$280$ |
| $s_X = \$35$ | $s_Y = \$30$ |

Is there evidence ($\alpha = 5\%$) that the annual costs of heating earth-sheltered homes is significantly less than the annual costs of heating solar-powered homes. [Hint. You can use $z$ cut-points. $\sqrt{\frac{s_X^2}{n_1} + \frac{s_Y^2}{n_2}} = 5.02$.]

**Milking Cows.** A feeding test is conducted on a herd of 25 milking cows to compare two diets, one of de-watered alfalfa and the other of field-wilted alphalpha. A sample of 12 cows randomly selected from the herd are fed dewatered alfalfa; the remaining 13 cows are fed field- wilted alfalfa. From observations made over a three-week period, the average daily milk production is recorded for each cow.

| | |
|---|---|
| Field-wilted alphalpha (X) | 44, 44, 56, 46, 47, 38, 58, 53, 49, 35, 46, 30, 41 |
| Dewatered alphalpha (Y) | 35, 47, 55, 29, 40, 39, 32, 41, 42, 57, 51, 39 |

Researchers are interested in comparing the mean daily milk yields per cow between two diets. As a matter of fact, researchers suspect that the field-wilted alphalpha diet gives significantly larger mean.

Assume $\alpha = 0.05$ and perform the appropriate test. State clearly your decision. Assume that measurements come from the normal populations with the same (but unknown) variances.

[You may find the following info useful: $\bar{X} = 45.15, \bar{Y} = 42.25, s_X = 8, s_Y = 8.74$.]

$s_p = 8.361252, s_p^2 = 69.91053, t = 0.8664011, t_{23,0.05} = 1.71$.

**Left-handed grippers.** Measurements of the left- and right-hand gripping strengths of 10 left-handed writers are recorded.

| Person | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Left hand (X) | 140 | 90 | 125 | 130 | 95 | 121 | 85 | 97 | 131 | 110 |
| Right hand (Y) | 138 | 87 | 110 | 132 | 96 | 120 | 86 | 90 | 129 | 100 |

• Do the data provide strong evidence that people who write with left hand have a greater gripping strength in the left hand then they do in the right hand? Use $\alpha = 0.05$.

• Would you change your opinion on significance if $\alpha$ were 0.1?

[You may find the following info useful: $\bar{d} = \bar{X} - \bar{Y} = 3.6, s_d = 5.46$.]

**Marijuana.** Investigators have studied the effects of marijuana on human physiology. One common belief held by laypersons is that marijuana affects pupil size. Weil et al.[1] studied number of subjects. Each was administered a high dose of marijuana by smoking a potent marijuana cigarette. The subjects ware all males, 21 to 26 years of age, all of whom smoked tobacco cigarettes regularly but have never tried marijuana. In this study, pupil size was measured with a millimeter rule under constant illumination with eyes focused on an object at a constant distance. Pupil size was measured before and after smoking marijuana. The part of data are given below.

| Individual | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Before marijuana | 6 | 5 | 3 | 3 | 5 | 3 |
| After marijuana | 6 | 7 | 9 | 5 | 9 | 9 |

1. Describe the hypotheses of interest for testing. (Hint. The alternative should be one sided)
2. What is the error of II kind in the terms of the problem?
3. Perform the test at 5% significance level.
4. You assumed data come from normal populations. Why then you can not use $z$ cut-points.

**Economic fuel.** An industrial plant wants to determine which of two types of fuel (gas or electric) will produce more useful energy at the lower cost. One measure of economical energy production, called the *plant investment per quad,* is calculated by taking the amount of money (in dollars) invested in the particular utility by the plant and dividing by the delivered amount of energy (in quadrillion British thermal units). The smaller this ratio, the less an industrial plant pays for its delivered energy.

Random samples of 11 plants using electrical utilities and 16 plants using gas utilities were taken, and the plant investment per quad was calculated for each. The data produced the results shown in the table.

| | Electric | Gas |
|---|---|---|
| Sample size | $n_1 = 11$ | $n_2 = 16$ |
| Mean Investment/Quad(Billions) | $\bar{x}_1 = 44.5$ | $\bar{x}_2 = 34.5$ |
| Sample Variance | $s_1^2 = 76.4$ | $s_2^2 = 63.8$ |

Do the data provide sufficient evidence at the $\alpha = 0.05$ level to indicate a difference in the average investment per quad between the plants using gas and those using electrical utilities?

[1] Weil, A. T., Zinberg, N. E., and Nelson, J. (1968). Clinical and psychological effects of marijuana in man. *Science, 1968, No 162, 1234-1242.*