Proj2 - Statistics of Stroop Task

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Background Information

In a Stroop task, participants are presented with a list of words, with each word displayed in a color of ink. The participant's task is to say out loud the color of the ink in which the word is printed. The task has two conditions: a congruent words condition, and an incongruent words condition. In the congruent words condition, the words being displayed are color words whose names match the colors in which they are printed: for example RED(red), BLUE(blue). In the incongruent words condition, the words displayed are color words whose names do not match the colors in which they are printed: for example PURPLE(green), ORANGE(purple). In each case, we measure the time it takes to name the ink colors in equally-sized lists. Each participant will go through and record a time from each condition.

Investigation

Type of data

Dependent t-test for two conditions paired samples

What is independent variable?

The independent variable is whether the words shown are **congruent** with the ink colors or if they are **incongruent** with ink colors.

What is dependent variable?

The dependent variable is the amount of time it takes to name, out loud, the color of the inks in which the words are displayed.

Test hypothesis -- null hypothesis

$\mu = \frac{\sum x_i}{n}$

μ_c is the sample mean of the time spent naming the words in congruent test

μ_i is the sample mean of the time spent naming the words in incongruent test

Null hypothesis: there is no difference in population means of response time under incongruent and congruent scenarios

$H_0 : \mu_c = \mu_i$

Test hypothesis -- alternative typothesis

Alternative hypothesis: the time used to read list of incongruent words will be larger than the time in congruent words list

$H_A : \mu_c < \mu_i$

t-test

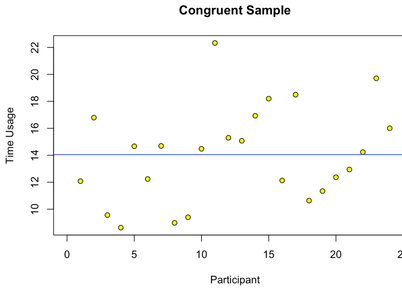
Since z-test works when we know population μ and σ. In this case, we have less than 30 samples, and we don't know the population's standard deviation. We will use t-test.

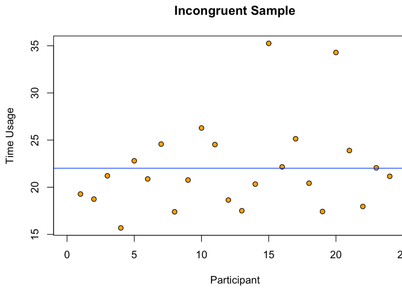
We should assume that the distributions are Gaussian.

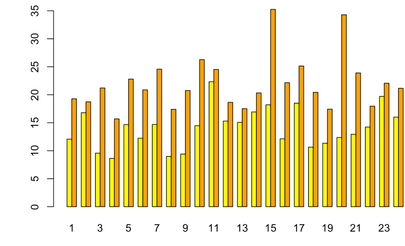
Based on the alternative hypothesis, t-test will be `one-tailed test in positive direction`

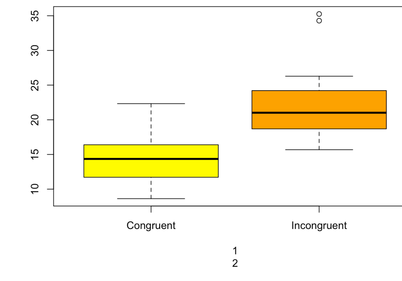
Find the t-critical values for a one-tailed test at $\alpha = 0.05$:
$t_{critical} = 1.714$

Data at a glance









Statistics tests

$n = 24$

$df = n - 1 = 23$

$\mu_c = 14.05; \sigma_c = 3.56$

$\mu_i = 22.02; \sigma_i = 4.80$

mean of difference between two conditions:
$M_D = 7.96$

standard deviation of difference:
$S_D = \sqrt{\frac{\sum (D_i - D)^2}{n-1}} = 4.86$

standard error:
$SEM = \frac{S_D}{\sqrt{n}} = 0.99$

t-statistic:
$t_{statistic} = \frac{M_D}{SEM} = 8.04$

$SE = \frac{\sqrt{S_c^2 + S_i^2}}{\sqrt{n}} = \sqrt{\frac{S_c^2}{n} + \frac{S_i^2}{n}} = 1.22$

95% confident interval for the mean difference:

$CI : M_D \pm t_{critical} \times SE = (5.87, 10.05)$

Desisions
Based on the t-statistic and t-critical value:

1. The results are statistically significant
2. **Reject the null** because $p < 0.05$
3. The time used to read list of incongruent words will be larger than the time in congruent words list
4. The result matches expectations because the incongruent task is much harder than congruent words. It takes longer time.

Optional:

Cohen's d:
$Cohen's\ d = \frac{M_D}{S_D} = 1.64$

Proportion(%) of variability in longer time due to incongruent words list:
$r^2 = \frac{t^2}{t^2 + df} = 0.74$

According to effect size measures, it is responsible for the effect observed.

Color stroop test can have many variations, such as warped words, emotional, spatial, numerical, etc. They all keep the same people do a normal test, and do a harder variranced test. The data sample should be similar effects.