Project 1

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1 TEST A PERCEPTUAL PHENOMENON

1.1 IDENFITY VARIABLES IN THE EXPERIMENT

What is our independent variable? What is our dependent variable?

In this experiment, the independent variable is congruence or incongruence of words and colors. The dependent variable is the time of response under each condition.

1.2 ESTABLISH A HYPOTHESIS AND STATISTICAL TEST

What is an appropriate set of hypotheses for this task? What kind of statistical test do you expect to perform? Justify your choices.

The null hypothesis H_0: for the whole population, the mean time of response under congruent condition is greater than or equal to the mean time of response under incongruent condition.
The alternative hypothesis H_A: for the whole population, the mean time of response under congruent condition is less than the mean time of response under incongruent condition.
Since we don't have information about the population mean, the t-test should be used. From common sense we believe that time under incongruent condition should be greater than time under congruent condition, so a one-tail test is setup. And finally, this test is classified as dependent samples t-test because each participant appears in both groups.

1.3 Report descriptive statistics

Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability.

Here we define some notations of statistics.

- $\bar{t}_c$: the mean time under congruent condition
- $\bar{t}_i$: the mean time under incongruent condition
- $\bar{t}_d$: the mean of time difference (congruence - incongruence)
- s_c: the sample standard deviation of time under congruent condition
- s_i: the sample standard deviation of time under incongruent condition
- s_d: the sample standard deviation of time difference
- n: the sample size (of either condition)

The sample size of each group is 24.
The mean time under congruent condition $\bar{t}_c = 14.05$. Its sample standard deviation is $s_c = 3.56$.
The mean time under incongruent condition $\bar{t}_i = 22.02$. Its sample standard deviation is $s_i = 4.80$.

1.4 Plot the data

Provide one or two visualizations that show the distribution of the sample data. Write one or two sentences noting what you observe about the plot or plots.

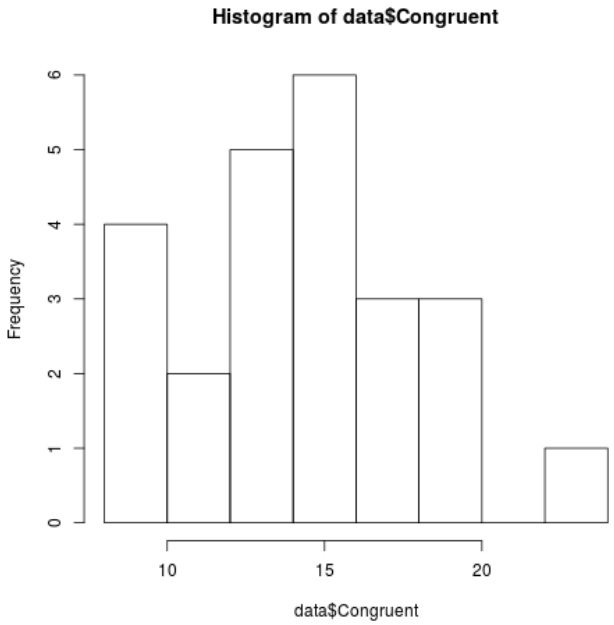

Figure 1.1: Histogram of Congruent Condition.

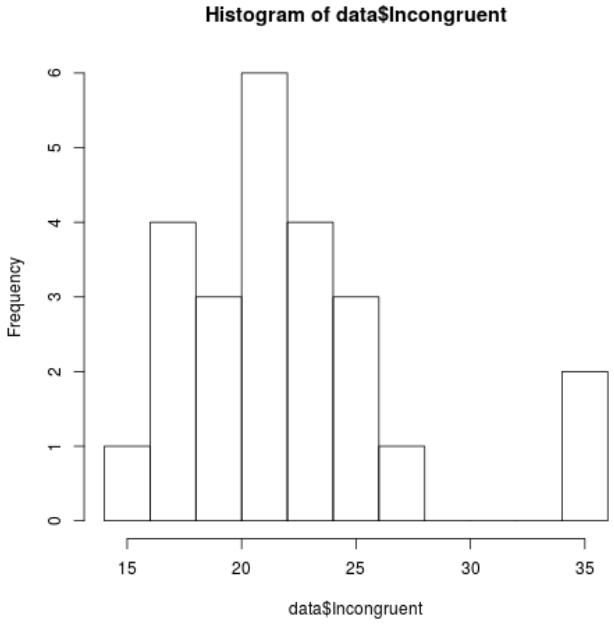

Figure 1.2: Histogram of Incongruent Condition.

The two plots have are similar in these aspects:

- Looks like normal distribution. The frequency in the middle is greater than each tail.
- Outliers exist at the right tail.

However, the mean in the second plot is greater than the first, and its variance is also larger.

1.5 Perform the statistical test and interpret your results

What is your confidence level and your critical statistic value? Do you reject the null hypothesis or fail to reject it? Come to a conclusion in terms of the experiment task. Did the results match up with your expectations?

The difference of means between two groups is $\bar{t}_d = \bar{t}_c - \bar{t}_i = -7.96$.
The standard error is given by

$$SE = \frac{s_d}{\sqrt{n}} = \frac{4.86}{4.90} = 0.99. \tag{1.1}$$

Thus the t-value is

$$t = \frac{\bar{t}_d}{SE} = \frac{-7.96}{0.99} = -8.02. \tag{1.2}$$

If the significant level $\alpha = 0.05$, since the degree of freedom is $df = 24 - 1 = 23$, the one-tail t critical value is $t_{critical} = -1.71$, and the two-tail t critical value should be $t_{critical2} = \pm 2.07$.
The confident interval is

$$(\bar{t}_d - t_{critical2} * SE, \bar{t}_d + t_{critical2} * SE) \ = \ (-10.01, -5.91) \tag{1.3}$$

Since $t < t_{critical}$, we reject the null hypothesis and favor the alternative hypothesis. So in the population, the mean time of response under congruent condition is less than that under incongruent condition.
Also from this experiment, we have 95% of confidence that in the population, the mean time of response under congruent condition is 10.01 sec to 5.91 sec less than the mean time of response under incongruent condition.
Those results do conform to our expectations.