Udacity Data Analyst Nanodegree

P1: Test A Perceptual Phenomenon

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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, 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, ORANGE. 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.

Questions for Investigation

As a general note, be sure to keep a record of any resources that you use or refer to in the creation of your project. You will need to report your sources as part of the project submission.

1. What is our independent variable? What is our dependent variable?

> Independent variable: the words condition (congruent words or incongruent words)
>
> Dependent variable: the time it takes to name the ink colors in equally-sized lists

2. 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 should be that the mean time for colour recognition for congruent words is equal to or greater than the mean time for incongruent words, therefore implying a one-tailed test. The alternative hypothesis should be that the congruent words mean is less than the incongruent words mean.
>
> H_0: $\mu_C \geq \mu_I$
>
> H_A: $\mu_C < \mu_I$
>
> where μ is a population mean, the subscript "C" represents the congruent words condition, and the subscript "I" represents the incongruent words condition.

A one-tailed, dependent samples t-test comparing the difference in means (the time to name the ink colors for congruent words and incongruent words) should be performed. With this test, we seek to determine whether there is enough evidence in the provided sample of data to infer that the congruent words mean colour recognition time is less than the incongruent words mean colour recognition time for the entire population and not just the sample data.

A t-test is appropriate because the population variance is unknown and the sample size is less than 30. The following assumptions are required for t-tests for dependent means:[2]

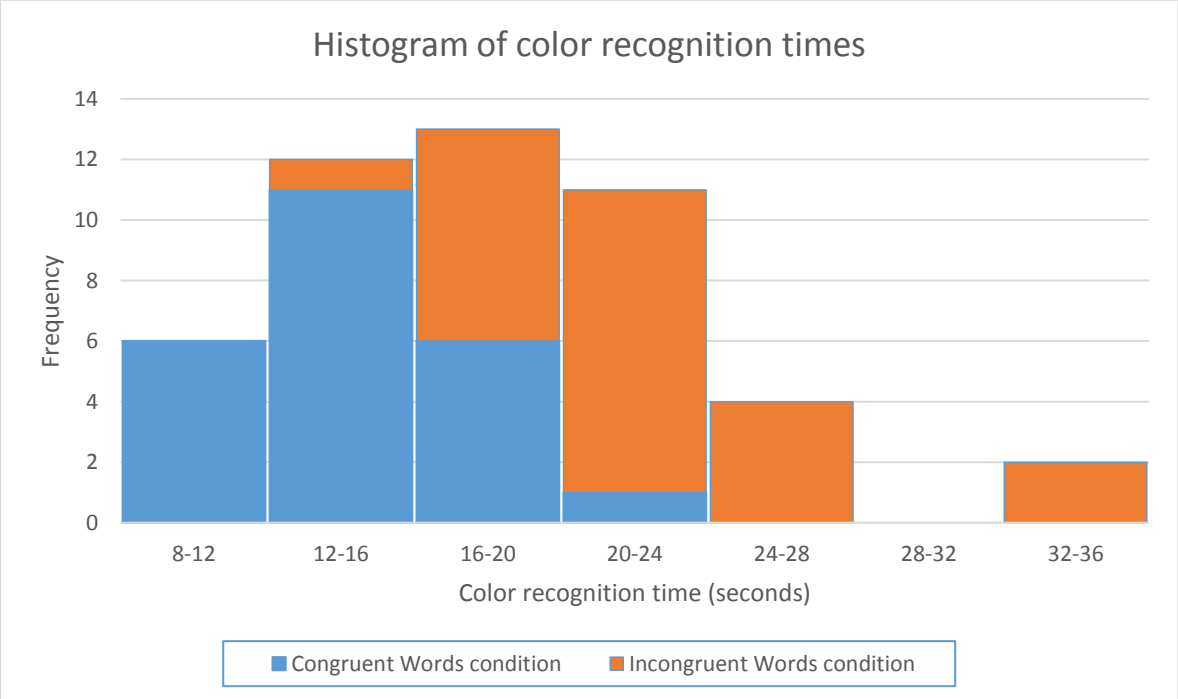
- Random sampling from a defined population
- Samples or sets of data used to produce the difference scores are linked in the population through repeated measurement, natural association, or matching
- Scores are normally distributed in the population; difference scores are normally distributed

A one-tailed test is appropriate under the assumption that incongruent word conditions will not improve recognition times, which is intuitive. The t-test should be of the dependent samples variety because the same subject is exposed to two conditions and tested for each.

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

Statistic	**Value**
Sample size	24
Average difference in time taken in each condition	-7.96
Std deviation of difference in time taken	4.86
Standard error	0.99

4. 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.



The bucket range of the congruent words condition data is 8 seconds to 24 seconds. The bucket range of the incongruent words condition data is 12 seconds to 36 seconds, i.e., noticeably to the right of the congruent words condition data.

5. Now, perform the statistical test and report 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?

$\alpha = .01$

$df = 23$

$t_{critical}$ for one-tailed test = -2.50

$t = -8.02$

At the 99% confidence level ($\alpha = .01$) and 23 degrees of freedom, the critical statistic value for a one-tailed test in the negative direction is -2.5. The calculated t-statistic for the difference in colour recognition time means of the congruent and incongruent word data is -8.02. Since the t-statistic is in the critical region, the null hypothesis is rejected. This matches our intuition and the data exploration performed (see histogram above). There is sufficient evidence at the $\alpha = .01$ level of significance to support the claim that it takes less time to recognize the colour of words with the congruent condition compared to words with the incongruent condition.

6. Optional: What do you think is responsible for the effects observed? Can you think of an alternative or similar task that would result in a similar effect?

I believe that the effects observed is due to the difference in the processing speed of the brain under the two conditions. There is a lag in the brain's ability to recognize the color of the word since the brain reads words faster than it recognizes colors. This is based on the idea that word processing is significantly faster than color processing. In a condition where there is a conflict regarding words and colors (e.g., Stroop test), if the task is to report the color, the word information arrives at the decision-making stage before the color information which presents processing confusion. Conversely, if the task is to report the word, because color information lags after word information, a decision can be made ahead of the conflicting information

The Numerical Stroop Effect demonstrates the close relationship between numerical values and physical sizes. Digits symbolize numerical values but they also have physical sizes. A digit can be presented as big or small (e.g., 5 vs. 5), irrespective of its numerical value. Comparing digits in incongruent trials (e.g., 3 5) is slower than comparing digits in congruent trials (e.g., 5 3) and the difference in reaction time is termed the numerical Stroop effect. The effect of irrelevant numerical values on physical comparisons (similar to the effect of irrelevant color words on responding to colors) suggests that numerical values are processed automatically (i.e., even when they are irrelevant to the task).

Source: Wikipedia:Stroop Effect

Source: Udacity Statistics Course Tutorials