

Test a Perceptual Phenomenon

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1. What is our independent variable? What is our dependent variable?
The type of the list of words is the independent variable – it takes two values - congruent and incongruent. The dependent variable is the time it takes to name the ink colors of the words in equally sized congruent and incongruent 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.

Following are the appropriate set of hypothesis:

$$H_0: \mu_c - \mu_{ic} \geq 0$$

$$H_a: \mu_c - \mu_{ic} < 0$$

μ_c = Average time it takes to name the ink colors in the congruent words list for the entire population

μ_{ic} = Average time it takes to name the ink colors in the incongruent words list for the entire population

According to Stroop effect, for everyone in the population, on average, naming the ink colors in the congruent words list is faster than naming the ink colors in the incongruent word list which we have indicated as the alternative hypothesis H_a . The null hypothesis H_0 is that for the entire population, on average, naming the ink colors in the congruent word list takes the same or more time than naming the ink colors in the incongruent word list.

We will use a sample of 24 participants for whom we have the times they took to name the ink colors of the congruent word list and the incongruent word list. We will use the sample means \bar{X}_c (congruent list) and \bar{X}_{ic} (incongruent list) to compute the mean difference in times taken between naming the colors in the congruent and incongruent word list \bar{X}_d

and sample standard deviation of the difference S_d to make inferences about the difference in times taken between the two lists by the population. So in our analyses, if we reject the null, then that would be evidence in favor of Stroop effect.

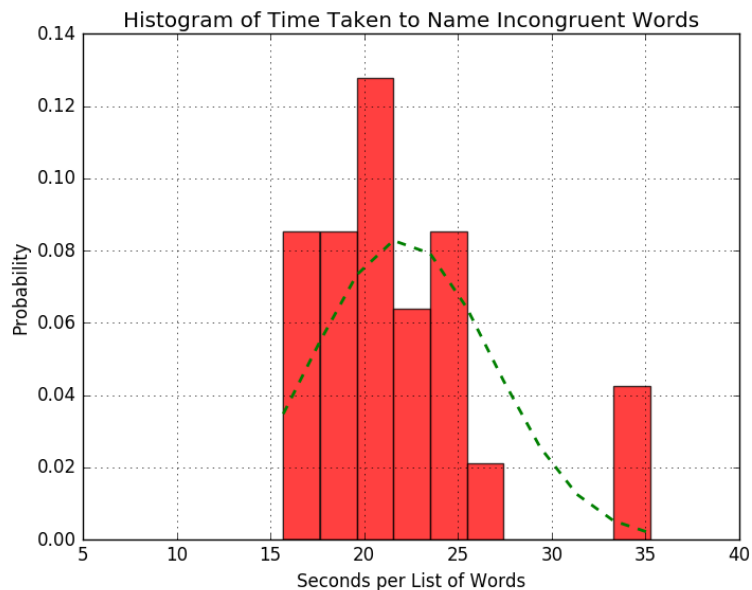
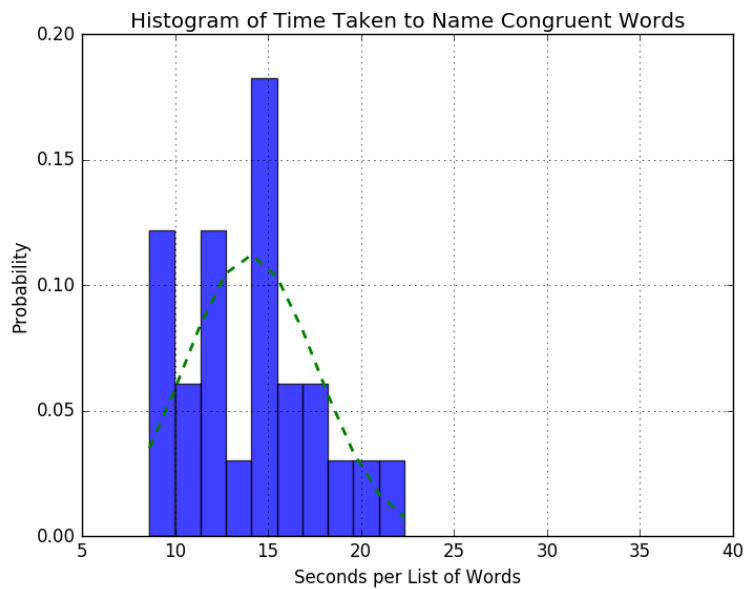
We will test this hypothesis using a dependent one-tailed t-test for paired samples since in this sample, we are using a within-subjects designs where each participant takes 2 tests – first where the participant names a list of congruent words and second where the same participant names a list of incongruent words. Since we are explicitly testing whether naming congruent words is faster than naming incongruent words, it makes sense to use the one-tailed t-test for dependent paired samples.

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

The participants in this sample take 14.1 seconds on average to name the list of congruent words and 22.0 seconds on average to name an equally sized list of incongruent words – so on average participants take approximately 8 seconds longer to name incongruent words than they take to name the congruent words. The variance of congruent list time is 12.7 seconds whereas the variance of incongruent list time is 23.0 seconds. The standard deviation of the time taken to name the congruent list is 3.6 seconds whereas the standard deviation of time taken to name the incongruent list of words is 4.8 seconds.

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.

Below are the distributions for the time taken for naming the list of congruent and incongruent words –



The distributions above indicate that the mean time taken to name the list of congruent words is lower than the mean time taken to name the list of

incongruent words. The distribution of time taken to name the incongruent list of words is also wider than the distribution of time taken to name the congruent words. The minimum time taken to name the list of congruent words is 8.6 seconds whereas the minimum time taken to name the list of incongruent words is 15.7 seconds. The maximum time taken to name the list of congruent words is 22.3 seconds whereas the maximum time taken to name the list of incongruent words is 35.2 seconds.

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?

I performed a dependent one-tailed t-test for paired samples. I calculated the difference between times taken to name the congruent word list and the incongruent word list. I computed the average of this difference and the standard deviation of this difference. On average, it takes **7.96 seconds** less to name the list of congruent words than it does to name the list of incongruent words. Then I calculate the t-statistic using the mean difference divided by the standard error of this difference. The standard error of this difference is calculated as the standard deviation of the difference divided by the square root of the number of participants which is 24. The t-statistic is **-8.02** and the one-tailed t-critical value for an alpha level of 0.05 and sample size of 24 is **-1.71**. Since the t-statistic is greater than the t-critical value in absolute terms, we can reject the null that the time taken to name the coherent list of words is greater than or equal to the time taken to name the incoherent list of words. The 95% confidence interval for the difference between times taken to name the congruent list and the incongruent list is (-6.27, - 9.66) seconds. The average difference between times taken to name the congruent and the incongruent lists is -7.96 seconds.

Yes, the results of the experiment match up with my expectations. It is easier to name the color of the word when the color and the writing of the word match. We would need to think longer when the color and the writing don't match and when we need to name the color not the writing. So it is

likely that naming the list of incoherent words would take longer than naming an equally size list of coherent words.

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? Some research about the problem will be helpful for thinking about these two questions!

In case of list of the incongruent words, we need to look at discolored words, toss out the actual writing of the words and pronounce only the color of the word – in effect this determines an individual's ability in **selective attention**.

Alternative tasks that would result in a similar effect are –

1. Stroop effect has been used to examine whether kids have Attention Deficit Hyperactivity Disorder.
2. Grocery shopping: During grocery shopping we need to use selective attention since each product has several brands, sizes and types – (for example, different flavors for potato chips). We can save time by preparing a grocery list with details on what we really need to buy. We would have a similar experience if we were buying a car or shopping for a bank or credit card. Since so much information is available online, it would help to do research on the potential purchases and narrow down the list of items we would like to shop in person.
3. Other applications of the test maybe to examine the impact of lack of good sleep and nutrition on cognitive abilities of an individual.

References:

1. https://en.wikipedia.org/wiki/Stroop_effect
2. <http://www.fss.uu.nl/psn/web/people/personal/kenemans/Lansbergen07NP.pdf>
3. <http://www.thesimpledollar.com/the-stroop-effect-and-your-wallet/>