

Project 1

Test a Perceptual Phenomenon

Udacity
Data Analyst Nanodegree Program

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Problem 1

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

Independent variable: word condition (either congruent or incongruent).

Dependent variable: time it takes in seconds to read out loud the list of words.

Problem 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 H_0 is that the population's average completion time (μ) for the congruent (C) word condition is equal to or greater than the incongruent (I) condition, and the alternative hypothesis H_A is that the incongruent word condition will take significantly longer to complete than the congruent condition. Thus:

$$H_0 : \mu_C \geq \mu_I$$

$$H_A : \mu_C < \mu_I$$

We will perform a one-tailed dependent t-test for paired samples. It is a dependent test because our subjects take the test twice. We perform a t-test instead of a z-test because we do not know the population parameters μ and σ . Finally, we assume directionality beforehand which demands for a one-tailed test.

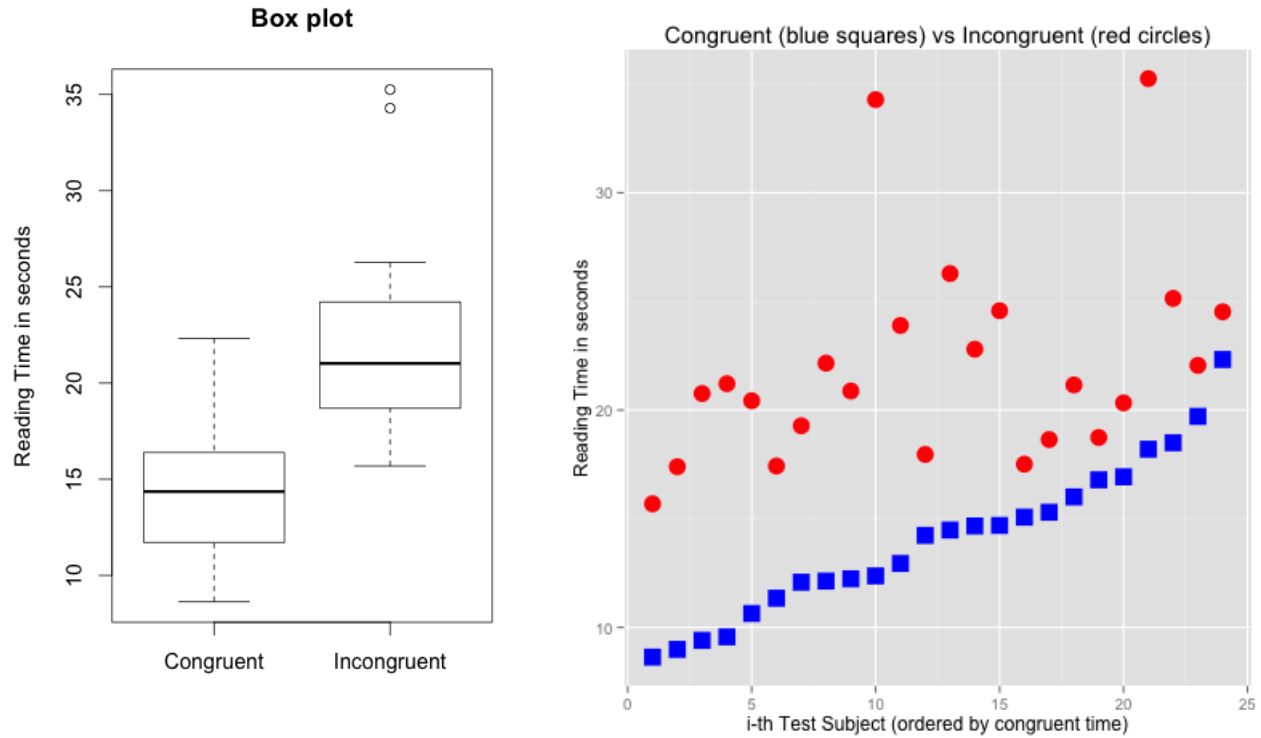
Problem 3

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

	Sample Size	Mean	Median	Variance	Standard Deviation
<i>Congruent</i>	24	14.05	14.36	12.67	3.56
<i>Incongruent</i>	24	22.02	21.02	23.01	4.8
$x_D = x_I - x_C$	24	7.96	7.67	23.67	4.86

Problem 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 box plot shows that the average time for the congruent condition is considerably lower. We can even see on the scatter plot that every individual test subject needed more time for the incongruent task. The time difference between both conditions is variable, ranging from only a couple of seconds up to approximately 20 seconds.

Problem 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?

For our one-tailed test we choose a *confidence level* of 99%. With 23 *degrees of freedom*, this gives us a *t-critical value* of 2.5.

We calculate the *t-statistic* as follows:

$$t = \frac{\bar{x}_D}{S_D/\sqrt{n}} = 8.03$$

with

$$\bar{x}_D = \bar{x}_I - \bar{x}_C = 7.97$$

$$S_D = \sqrt{\frac{\sum (x_{D_i} - \bar{x}_D)^2}{n-1}} = 4.86$$

$$n = 24$$

The t-statistic is bigger than our t-critical value. Thus, we consider this result as extremely statistically significant and therefore we reject our null hypothesis H_0 . We conclude from our paired samples that the population's completion time needed for the incongruent condition is significantly longer compared to the congruent condition.

The result is as expected, because it confirms the experience we had when performing the Stroop task by ourselves.

Problem 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?

According to Nobel Prize winner Daniel Kahneman we humans have two ways of thinking: One is fast and instinctive, the other is slow and logical. When doing the incongruent task both modes conflict with each other causing confusion and a slower response.

In his book *Thinking, Fast and Slow* [6.] he presents a similar task at page 25:

"Your first task is to go down both columns, calling out whether each word is printed in lowercase or in uppercase. When you are done with the first task, go down both columns again, saying whether each word is printed to the left or to the right of center by saying (or whispering to yourself) "LEFT" or "RIGHT".

LEFT		upper	
	left	lower	
right			LOWER
RIGHT		upper	
	RIGHT	UPPER	
	left	lower	
LEFT		LOWER	
	right	upper	

References

1. <https://www.udacity.com/course/viewer#!/c-ud134-nd>
2. https://en.wikipedia.org/wiki/Stroop_effect
3. <https://github.com/jdavis/latex-homework-template>
4. <https://en.wikibooks.org/wiki/LaTeX>
5. <http://docs.ggplot2.org/current/>
6. Daniel Kahneman, *Thinking, Fast and Slow*, 2011, ISBN 978-0-141-03357-0