Data Analyst Project 1

Statistically Testing a Perceptual Phenomenon

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# 0. The Dataset of the Experiement

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Congruent | 12,079 | 16,791 | 9,564 | 8,63 | 14,669 | 12,238 | 14,692 | 8,987 | 9,401 | 14,48 | 22,328 | 15,298 |
| Incongruent | 19,278 | 18,741 | 21,214 | 15,687 | 22,803 | 20,878 | 24,572 | 17,394 | 20,762 | 26,282 | 24,524 | 18,644 |
| Congruent | 15,073 | 16,929 | 18,2 | 12,13 | 18,495 | 10,639 | 11,344 | 12,369 | 12,944 | 14,233 | 19,71 | 16,004 |
| Incongruent | 17,51 | 20,33 | 35,255 | 22,158 | 25,139 | 20,429 | 17,425 | 34,288 | 23,894 | 17,96 | 22,058 | 21,157 |

# 1. Independent and Dependent Variable

The **independent** variable is whether the subject was presented with a list of word corresponding to their coloration (**congruent**) or differing from it (**incongruent**). The **dependent** variable was the overall time it took a subject to read the list of words.

The experiment constitutes a “**within-subject design**”, that is, a test with dependent samples (repeated measures).

# 2. Hypothesis & Proposed Statistical Test

The **null-hypothesis** () is: The average time when reading an incongruent list of words is not significantly longer than the time to read a congruent list of words ().

The **alternative hypothesis** () is: The average time when reading an incongruent list of words is significantly longer than the average time when reading a congruent list of words ().

A suitable statistical test is a “**dependent samples**” (or “**paired samples**”) **one-tailed** **t-test**, as introduced in Introduction to Inferential Statistics, Lesson 10. This test applies nicely to experimental settings with subjects taking certain tests twice with a treatment in between, in this case, the modification of the coloration of the words.

# 3. Descriptive Statistics

The **number of samples** in each case is . Let and be the sample values for both the congruent and the incongruent case.

The **sample means** are for congruence and for incongruence .

The **sample standard deviations** are for congruence and for incongruence .

We have the **mean difference**  and the **combined standard deviation**  
.

We can compute the **standard error** with .

# 4. Visualizations of the Sample Data Distribution

Plot 1 shows a bar chart with the individual data points. It can be derived, that in each case, the time to read an incongruent list is longer than to read a congruent list of words.

Plot 2 shows a more aggregated view with a bar chart representing the histogram of each experiment (a bin width of 2s has been chosen). Overlaid is a smoothed out distribution of the data with percentiles denoted on the right (secondary) x-axis. The data in the histogram seems to be normally distributed in both different samples with means at around 15s (**congruent**) and 25s (**incongruent**), while the incongruent data set seems to be more spread out, potentially due to an outlier (data point at 35,255s).

# 5. Statistical Test, Confidence Level, Critical Value, Conclusion

The **degrees of freedom** for this experimental setup are . According to those, we can use the following **critical values**  for their corresponding -level (one-tailed):

|  |  |  |  |
| --- | --- | --- | --- |
| -level | 0.05 | 0.01 | 0.001 |
| Critical value | 1.714 | 2.500 | 3.485 |

The **t-value** is computed as follows: . The **-value** as calculated by “GraphPad QuickCalcs” [1] is “less than ”

Therefore, we can **reject the null only for an alpha value** and (since for and consequently for all .

That means that we **can we conclude that there is a significant difference** between the average time it takes to read a “congruent” and an “incongruent” list of words (“congruent”, again, meaning that the words are written in the color corresponding to the words literal meaning).

# 6. Contemplation

If there is indeed a significant difference, it could be explained neurologically by the brain confusing different actions potentials when perceiving inputs both from the visual, as well as from the language-related part of the brain.

To further explore this phenomenon, we could even get more certainty by increasing our sample size ().

# Ressources

Included into this submission is an excel spreadsheet that was used to perform the calculations in this report and create the diagrams. The t-Table is from:

<http://www.sjsu.edu/faculty/gerstman/StatPrimer/t-table.pdf>

[1] The -value was calculated using “GraphPad Quick Calcs”:

<http://www.graphpad.com/quickcalcs/> 🡪 Statistical Distributions and interpreting -Values -> Calculate P value from z, t, F, r or chi-square.