

Project 1 Report

Question 1: Variables

Independent Variable:

Whether the administered test is the congruent test or the incongruent test

Dependent Variable:

The time it takes to finish the test

Operational Definition:

Time in seconds

Question 2: Hypotheses and Type of Statistical Test

Definitions

μ_I = population mean of the incongruent test scores

μ_C = population mean of the congruent test scores

Hypotheses:

Mathematical Notation:

$$H_0: \mu_I - \mu_C \leq 0$$

$$H_a: \mu_I - \mu_C > 0$$

Natural Language:

- Null Hypothesis: The null hypothesis will be retained if the population mean of the incongruent test scores is equal to or less than the population mean of the congruent test scores.
- Alternative Hypothesis: The null hypothesis will be rejected if the population mean of incongruent test scores is greater than the population mean of the congruent test scores.

Type of Statistical Test:

I will be using a **dependent t-test for paired samples** using a “pre-test, post-test” method because I am testing to see if the average of the differences between test results of the congruent test and the incongruent test is statistically significant. If there is a difference between the mean of the scores of the congruent test and the mean of the scores of incongruent test, I will use a confidence level of $\alpha = 0.05$ to test whether the difference is statistically significant.

Assumptions:

I will be assuming that all participants of the tests are tested under the exact same testing conditions (time of day, location, same test materials). I assume that the participants are randomly selected from a defined population, and that the scores for both the incongruent and congruent tests are linked to the same participant for each row of data. (Emory University Psychology Department).

Question 3: Descriptive Statistics

Central Tendency:

	Congruent Test	Incongruent Test
Mean	14.05	22.02
Median	14.36	21.02

\bar{x}_D	7.964791667
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Variability:

	Congruent Test	Incongruent Test
Variance (sample)	12.67	23.01
Standard Deviation (sample)	3.56	4.80

S_D	4.86482691
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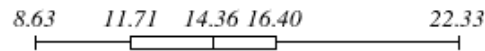
Measures of Central Tendency and Measures of Variability ideas came from Glencoe (see “Other Resources” on the last page of this report)

Question 4: Data Visualizations

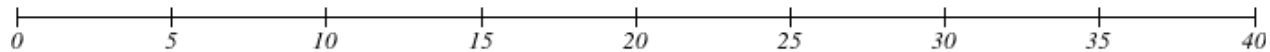
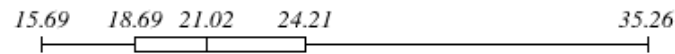
*Inspiration to use boxplot came from
<http://stats.stackexchange.com/questions/190223/how-to-visualize-independent-two-sample-t-test>

Boxplot:

Congruent



Incongruent



	Congruent	Incongruent
Minimum	8.63	15.69
Q1	11.71	18.69
Median	14.36	21.02
Q3	16.40	24.21
Maximum	22.33	35.26
Range	13.70	19.57
IQR	4.69	5.52

*Boxplot data table inspired by
<https://www.youtube.com/watch?v=TxuretcM5Uk>
<https://www.youtube.com/watch?v=TxuretcM5Uk>

(I used the Boxplot Grapher tool from <http://www.imathas.com/stattools/boxplot.html>)

Minimum:

The “best” times, or minimums, for both the congruent test (8.63 seconds) and the incongruent test (15.69 seconds) are very different from each other. This means that even the participant who was most adept at the incongruent test was still 7.06 seconds slower at finishing the incongruent test than the participant who was most adept at the congruent test.

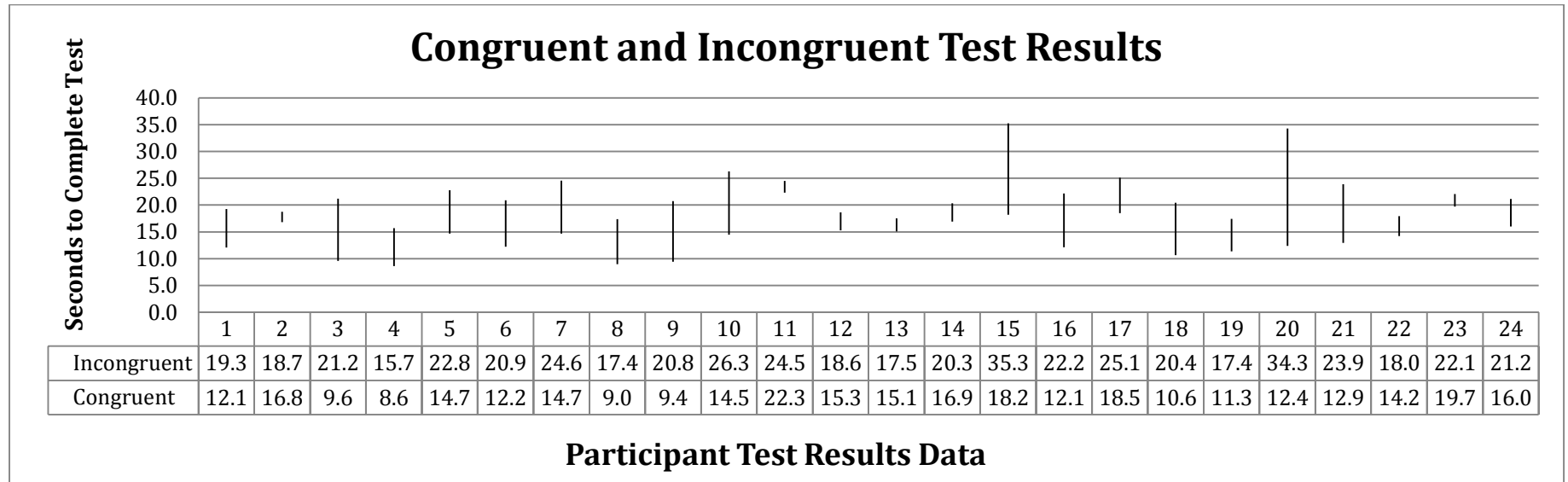
Q1 and Q3:

Q1 and Q3 of the congruent test are much faster times than Q1 and Q3 of the incongruent test. This means that the range where most scores fall in both tests are very different. On the graph, Q1 through Q3 for both tests don't overlap.

Maximum:

The “worst” times, or maximums, for both the congruent test (22.33 seconds) and the incongruent test (35.26 seconds) are very different from each other. There is a large outlier of 35.26 seconds on the incongruent test worth noting.

Participant Test Results:



Least Amount of Difference between Tests:

The two participants whose results did not vary much between tests are the participant labeled “2” and the participant labeled “11.” Participant 2’s time to complete the incongruent test was only 1.9 seconds longer than the time it took them to complete the congruent test. Participant 11’s time to complete the incongruent test was only 2.2 seconds longer than the time it took them to complete the congruent test.

Most Amount of Difference between Tests:

The two participants whose results varied greatly between tests are the participant labeled “20” and the participant labeled “15.” Participant 20’s time to complete the incongruent test was 21.9 seconds longer than the time it took them to complete the congruent test. Participant 15’s time to complete the incongruent test was 17.1 seconds longer than the time it took them to complete the congruent test.

Question 5: Results

Point Estimate:

$$\bar{x}_I - \bar{x}_C = 7.96$$

Confidence Level:

$$\alpha = 0.05$$

Standard Deviation of Difference:

$$S_D = 4.86482691$$

t-Statistic:

$$t = \frac{7.96}{4.86/\sqrt{24}}$$
$$t = 8.02$$

P-Value:

$$P\text{-Value} < 0.00001$$

(calculated using Social Science Statistics's "P Value from T Score Calculator" at <http://www.socscistatistics.com/pvalues/tdistribution.aspx>)

t-Critical Value ($df = 23$, $\alpha = 0.05$):

$$t = 1.714$$

DECISION:

$$H_0: \mu_I - \mu_C \leq 0$$

$$H_a: \mu_I - \mu_C > 0$$

Reject H_0 because $t = 8.02$ is within the critical region and is statistically significant at $p < 0.05$.

Expectation:

After participating in the test online via the applet and finishing the congruent test with a score of 8.369 seconds and finishing the incongruent test with a score of 14.329 seconds, I hypothesized that most other participants would experience having a "slower" time on the incongruent test than on the congruent test. I expected that I would most likely have to reject the null hypothesis.

Question 6: Causes and Similar Tasks

Causes

According to John Ridley Stroop's original article, "Studies of interference in serial verbal reactions" published in 1935, the "automation of reading" in the brain is most likely what causes participants to be able to read the words in the congruent test quickly. In the incongruent test, participants are not just reading the words. Firstly, their brains are having resist the urge to read the word; secondly, their brains must identify the color of the word. Identifying the color of a word is not an automatic process for literate humans like reading is (Stroop, 1935). For this reason, participants will score "slower" times on the incongruent test.

Similar Tasks

There are variations of the original Stroop Effect experiment listed on the Stroop Effect Wikipedia page. The "Numerical" variation presents participants with two integers, one with a larger value than the other. In the congruent test, the largest of the two integers is written in a larger font than the smaller of the two integers. In the incongruent test, the smaller of the two integers is listed with a larger font than the largest of the two integers (Henik & Tzelgov, 1982). In this variation, it is more difficult for participants to identify the larger of the two integers in the incongruent test because the brain automatically assumes the physically "largest" integer is the integer with the largest value.

References

Works Cited

Emory University Psychology Department. (n.d.). *Test Assumptions*. Retrieved July 17, 2016, from Emory University Psychology Department Resources:
<http://www.psychology.emory.edu/clinical/bliwise/Tutorials/TOM/meanstests/asump.htm>

Henik, A., & Tzelgov, J. (1982). Is three greater than five: The relation between physical and semantic size in comparison tasks. *Memory and Cognition*.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*.

Other Resources

Boxplot Grapher Tool: <http://www.imathas.com/stattools/boxplot.html>

Boxplot Graph Excel 2016 Tutorial by Todd Grandle:
<https://www.youtube.com/watch?v=TxuretcM5Uk>

Glencoe: Measures of Variation:
http://www.glencoe.com/sites/pdfs/impact_math/ls8_c1_measures_of_variation.pdf

Glencoe: Measures of Central Tendency and Range:
http://www.glencoe.com/sites/pdfs/impact_math/ls8_c1_measures_of_variation.pdf

Stack Exchange, Statistics: How to visualize independent two sample t-test?:
<http://stats.stackexchange.com/questions/190223/how-to-visualize-independent-two-sample-t-test>

Social Science Statistics's P Value from T Score Calculator:
<http://www.socscistatistics.com/pvalues/tdistribution.aspx>

Stat Trek's page on Hypothesis Testing of Difference between Paired Means:
<http://stattrek.com/hypothesis-test/paired-means.aspx?Tutorial=AP>

Emory University Psychology Department's page on Assumptions for different kinds of statistical tests:
<http://www.psychology.emory.edu/clinical/bliwise/Tutorials/TOM/meanstests/asump.htm>