Stroop Effect Analysis
William Koehrsen
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1. The independent variable is the congruity of the word list; that is, if the ink color of the word matches the word (congruent) or if the ink color of the word does not match the word (incongruent). The dependent variable is the average time in seconds it takes for the participant to complete the identification of all the ink colors in the word list.

2. The Null Hypothesis is that the population mean time to complete the identification of the ink colors for the incongruent word list will be less than or equal to the population mean time to identify all the ink colors for the congruent word list.
   The Alternative Hypothesis is that the population mean time to complete the incongruent word list test will be greater than the population mean time to complete the congruent word list.

   Mathematically, the Null Hypothesis is expressed as:
   $$\boldsymbol{H_0}: \mu_{\boldsymbol{I}} \leq \mu_{\boldsymbol{C}}$$
   where μ_I is the population mean time to complete the incongruent test and μ_C is the population mean time to complete the congruent test. This can also be expressed as $\mu_{\bar{d}} \leq 0$ where $\mu_{\bar{d}}$ is the population mean difference ($\mu_{\bar{d}} = \mu_{\boldsymbol{I}} - \mu_{\boldsymbol{C}}$).

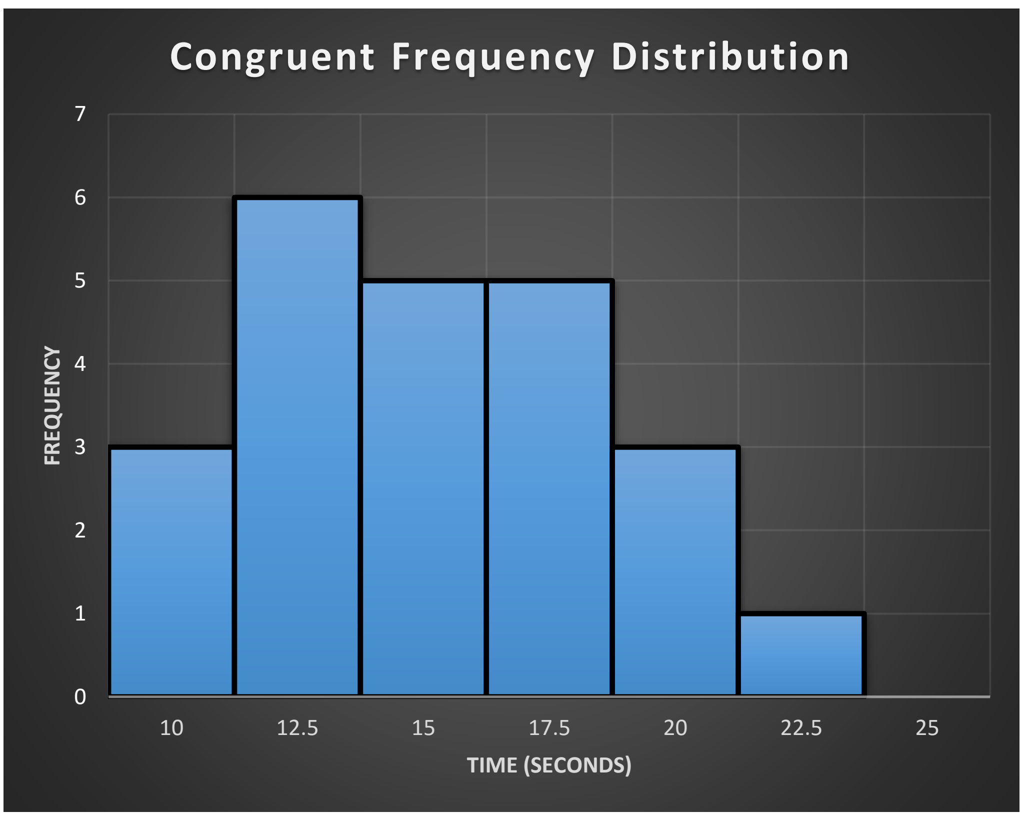
   Mathematically, the Alternative Hypothesis is expressed as:
   $$\boldsymbol{H_A}: \mu_{\boldsymbol{I}} > \mu_{\boldsymbol{C}}$$
   where μ_I is the population mean time to complete the incongruent test and μ_C is the population mean time to complete the congruent test. This can also be expressed as $\mu_{\bar{d}} > 0$ where $\mu_{\bar{d}}$ is the population mean difference ($\mu_{\bar{d}} = \mu_{\boldsymbol{I}} - \mu_{\boldsymbol{C}}$).

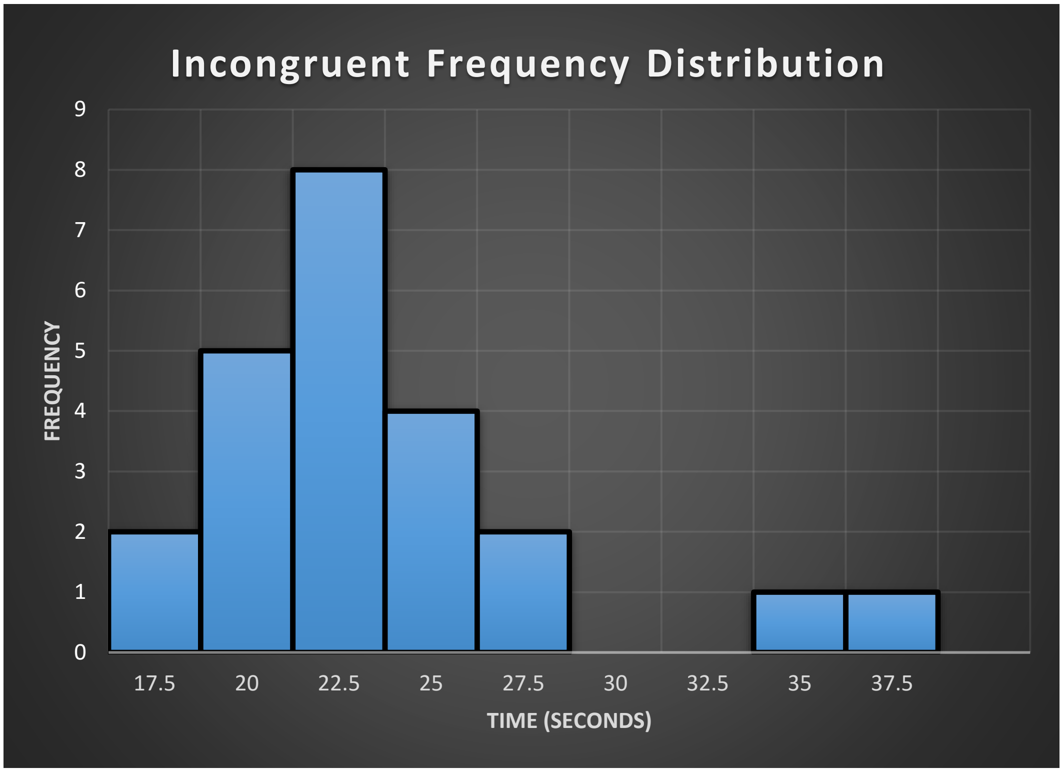
   I expect to perform a paired samples t-Test because the same subjects are being measured under two different conditions and I want to assess whether or not the population mean difference between the two sets of observations is zero. The study is a repeated-measures design with dependent samples because the subjects perform the same test under different conditions. I must perform a t-Test because the population mean and standard deviation are not known and I am trying to draw a conclusion about the population mean difference from the samples. My alternative hypothesis, that the average time to complete the identification of the ink colors on the incongruent word list will be longer than the average time on the congruent word list, was informed by my personal performance on several Stroop tests I conducted on myself using [1].

3.

Descriptive Statistic	Congruent Set	Incongruent Set
Mean (s)	14.05	22.02
Sample Standard Deviation (s)	3.56	4.80

4. I choose to represent the data with frequency distributions. As can be seen in the charts, the congruent data is a more uniform distribution while the incongruent data is closer to a normal distribution with two outliers on the upper end of the range. The incongruent data is more spread out as can be seen in the charts and which is indicated quantitatively by the sample standard deviation. It is also possible to qualitatively observe that the incongruent sample times to complete the test tend to be greater than those of the congruent sample times allow the t-Test must be performed to determine if this is a statistically significant result.





5. A paired samples t-Test was conducted to compare average performance on the Stroop test with congruent and incongruent word lists. There was a statistically significant increase in the time in seconds to complete the identification of the ink colors on the incongruent word list (M=22.02, SD=4.80) as compared to the congruent word list (M=14.05, SD=3.56); t(23)=8.02, p=.0001. The 95% confidence interval for the mean difference between the incongruent samples and the congruent samples was (5.91, 10.02). Based on the analysis, I reject the null hypothesis and conclude that the average time to identify the ink colors of the words on the incongruent Stroop test was significantly longer than the average time to identify the ink colors of the words on the congruent test. The results do match up with my expectations as well as with the observations I made regarding my personal performance on the Stroop test.

   The numbers from the Paired Samples t-Test are summarized in the table below:

Mean Difference	7.96
Standard Deviation of Differences	4.86
Number of Samples	24
Degrees of Freedom	23
Standard Error of the Mean Difference	0.99
t-statistic	8.02
t-critical one tail with α = 0.05	1.714
t-critical two-tail with α = 0.05	2.069
95 % CI Lower Limit for Mean Difference	5.91

95% CI Upper Limit for Mean Difference	10.02
p	< 0.05
Actual p	< 0.0001
Cohen's d	1.64

All of the numbers were calculated in the included Excel spreadsheet. The t-critical values were from the t-table following this report. The actual p-value was calculated using [2].

6. Based on a preliminary investigation into the Stroop Effect [3][4], the variation in the time to identify the ink color is due to default stimuli processing methods of humans. When looking at text, we are accustomed to read the words and process them as language rather than as colors. Therefore, in the phrasing of John Stroop, there is "interference" in our cognitive processing when we are asked to identify the color of the ink rather than the actual meaning of the word. The Stroop Effect demonstrates that there is an internal automatic processing system that can be overridden with enough concentration and mental effort. This is intriguing because it suggests that we are not fully in control of our processing of stimuli from the outside world. Our brains essentially run many tasks on autopilot and it takes conscious effort to overcome these defaults. This "selective attention can be observed in many different facets of our lives. We can only consciously recognize a limited number of incoming information streams at a time. For example, if I am working on writing a paper while at the same time trying to hold a conversation, I find that either one or the other tasks suffers greatly. I cannot control both my language processing abilities and my listening/speaking channels at the same time much as participants of the Stroop Test find it difficult to engage the language channel and the color identification network simultaneously. It would be interesting to see if someone who has specifically trained at the Stroop tests for years would be able to overcome the default response and identify the ink color of the incongruous words as quickly as ink color of the congruent words. My hypothesis would be that with enough training, it would be possible, but who knows what effects that training would have on one's ability to function in an everyday setting!

References

[1] "Stroop Effect", Faculty.washington.edu, 2017. [Online]. Available: https://faculty.washington.edu/chudler/java/ready.html. [Accessed: 19- Mar- 2017].

[2] "P value calculator", Graphpad.com, 2017. [Online]. Available: http://www.graphpad.com/quickcalcs/. [Accessed: 19- Mar- 2017].

[3] "Stroop effect", En.wikipedia.org, 2017. [Online]. Available: https://en.wikipedia.org/wiki/Stroop_effect. [Accessed: 20- Mar- 2017].

[4] "Stroop effect", Psytoolkit.org, 2017. [Online]. Available: http://www.psytoolkit.org/lessons/stroop.html. [Accessed: 20- Mar- 2017].

Table entry for p and C is the point t^* with probability p lying above it and probability C lying between $-t^*$ and t^*.

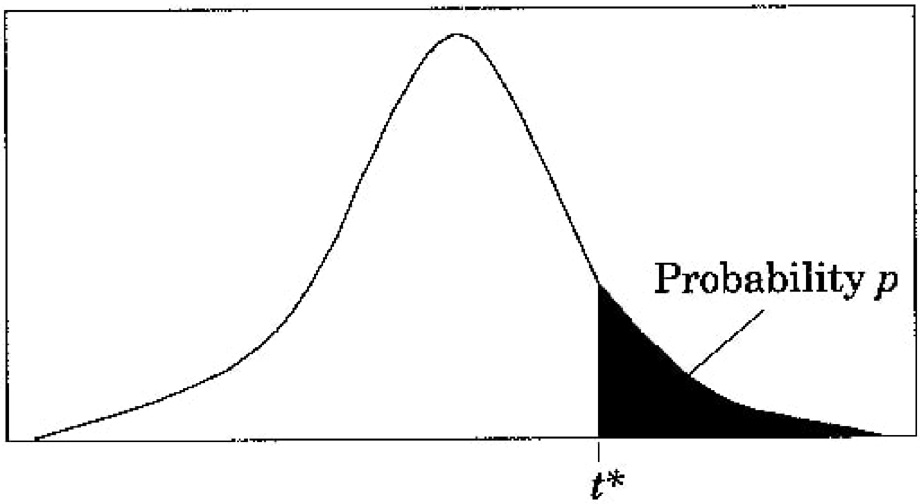


Table B *t* distribution critical values

	Tail probability p											
df	.25	.20	.15	.10	.05	.025	.02	.01	.005	.0025	.001	.0005
1	1.000	1.376	1.963	3.078	6.314	12.71	15.89	31.82	63.66	127.3	318.3	636.6
2	.816	1.061	1.386	1.886	2.920	4.303	4.849	6.965	9.925	14.09	22.33	31.60
3	.765	.978	1.250	1.638	2.353	3.182	3.482	4.541	5.841	7.453	10.21	12.92
4	.741	.941	1.190	1.533	2.132	2.776	2.999	3.747	4.604	5.598	7.173	8.610
5	.727	.920	1.156	1.476	2.015	2.571	2.757	3.365	4.032	4.773	5.893	6.869
6	.718	.906	1.134	1.440	1.943	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	.711	.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	.706	.889	1.108	1.397	1.860	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	.703	.883	1.100	1.383	1.833	2.262	2.398	2.821	3.250	3.690	4.297	4.781
10	.700	.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	.697	.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	.695	.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055	3.428	3.930	4.318
13	.694	.870	1.079	1.350	1.771	2.160	2.282	2.650	3.012	3.372	3.852	4.221
14	.692	.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.787	4.140
15	.691	.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	.690	.865	1.071	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	.689	.863	1.069	1.333	1.740	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	.688	.862	1.067	1.330	1.734	2.101	2.214	2.552	2.878	3.197	3.611	3.922
19	.688	.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	.687	.860	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.850
21	.686	.859	1.063	1.323	1.721	2.080	2.189	2.518	2.831	3.135	3.527	3.819
22	.686	.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	.685	.858	1.060	1.319	1.714	2.069	2.177	2.500	2.807	3.104	3.485	3.768
24	.685	.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	.684	.856	1.058	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.450	3.725
26	.684	.856	1.058	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	.684	.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.690
28	.683	.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	.683	.854	1.055	1.311	1.699	2.045	2.150	2.462	2.756	3.038	3.396	3.659
30	.683	.854	1.055	1.310	1.697	2.042	2.147	2.457	2.750	3.030	3.385	3.646
40	.681	.851	1.050	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551
50	.679	.849	1.047	1.299	1.676	2.009	2.109	2.403	2.678	2.937	3.261	3.496
60	.679	.848	1.045	1.296	1.671	2.000	2.099	2.390	2.660	2.915	3.232	3.460
80	.678	.846	1.043	1.292	1.664	1.990	2.088	2.374	2.639	2.887	3.195	3.416
100	.677	.845	1.042	1.290	1.660	1.984	2.081	2.364	2.626	2.871	3.174	3.390
1000	.675	.842	1.037	1.282	1.646	1.962	2.056	2.330	2.581	2.813	3.098	3.300
∞	.674	.841	1.036	1.282	1.645	1.960	2.054	2.326	2.576	2.807	3.091	3.291
	50%	60%	70%	80%	90%	95%	96%	98%	99%	99.5%	99.8%	99.9%
	Confidence level C											