

Statistics: The Science of Decisions Project Instructions

Background Information

In a Stroop task, participants are presented with a list of words, with each word displayed in a color of ink. The participant's task is to say out loud the color of the ink in which the word is printed. The task has two conditions: a congruent words condition, and an incongruent words condition. In the congruent words condition, the words being displayed are color words whose names match the colors in which they are printed: for example RED, BLUE. In the incongruent words condition, the words displayed are color words whose names do not match the colors in which they are printed: for example PURPLE, ORANGE. In each case, we measure the time it takes to name the ink colors in equally-sized lists. Each participant will go through and record a time from each condition.

Questions for Investigation

As a general note, be sure to keep a record of any resources that you use or refer to in the creation of your project. You will need to report your sources as part of the project submission.

1. What is our independent variable? What is our dependent variable?

The independent variable is the condition of the words: congruent or incongruent.

The dependent variable is the time it took participants to say out loud the color of the printed words' ink

2. What is an appropriate set of hypotheses for this task? What kind of statistical test do you expect to perform? Justify your choices.

An appropriate null hypothesis would be that between the congruent and incongruent lists, there is no difference in the average time it takes to name the ink colors.

An appropriate alternative hypothesis would be that there *will* be a difference in the time it takes to name the ink colors when reading the congruent or incongruent lists.

This experiment leverages within-subject design (participants record times for **both** conditions and the word lists for each condition are equally-sized), allowing us to use a t-test for dependent paired samples.

Our alternative hypothesis does not state which condition is hypothesized to have a higher average time, and so we can use a two-tailed, paired sample t-test.

H0: $\bar{X}(\text{congruent}) = \bar{X}(\text{incongruent})$

HA: $\bar{X}(\text{congruent}) \neq \bar{X}(\text{incongruent})$

We will use sample statistics (calculated from our experiment on the 24 participants) to make statistical inferences on the population parameters that we hypothesize on.

Now it's your chance to try out the Stroop task for yourself. Go to this link, which has a Java-based applet for performing the Stroop task. Record the times that you received on the task (you do not need to submit your times to the site.) Now, download this dataset which contains results from a number of participants in the task. Each row of the dataset contains the

performance for one participant, with the first number their results on the congruent task and the second number their performance on the incongruent task.

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

```
> data <- read.csv("stroopdata.csv")
> summary(data)
```

Congruent		Incongruent	
Min.	: 8.63	Min.	:15.69
1st Qu.	:11.90	1st Qu.	:18.72
Median	:14.36	Median	:21.02
Mean	:14.05	Mean	:22.02
3rd Qu.	:16.20	3rd Qu.	:24.05
Max.	:22.33	Max.	:35.26

```
> sd(projdata$Congruent)
[1] 3.559358
```

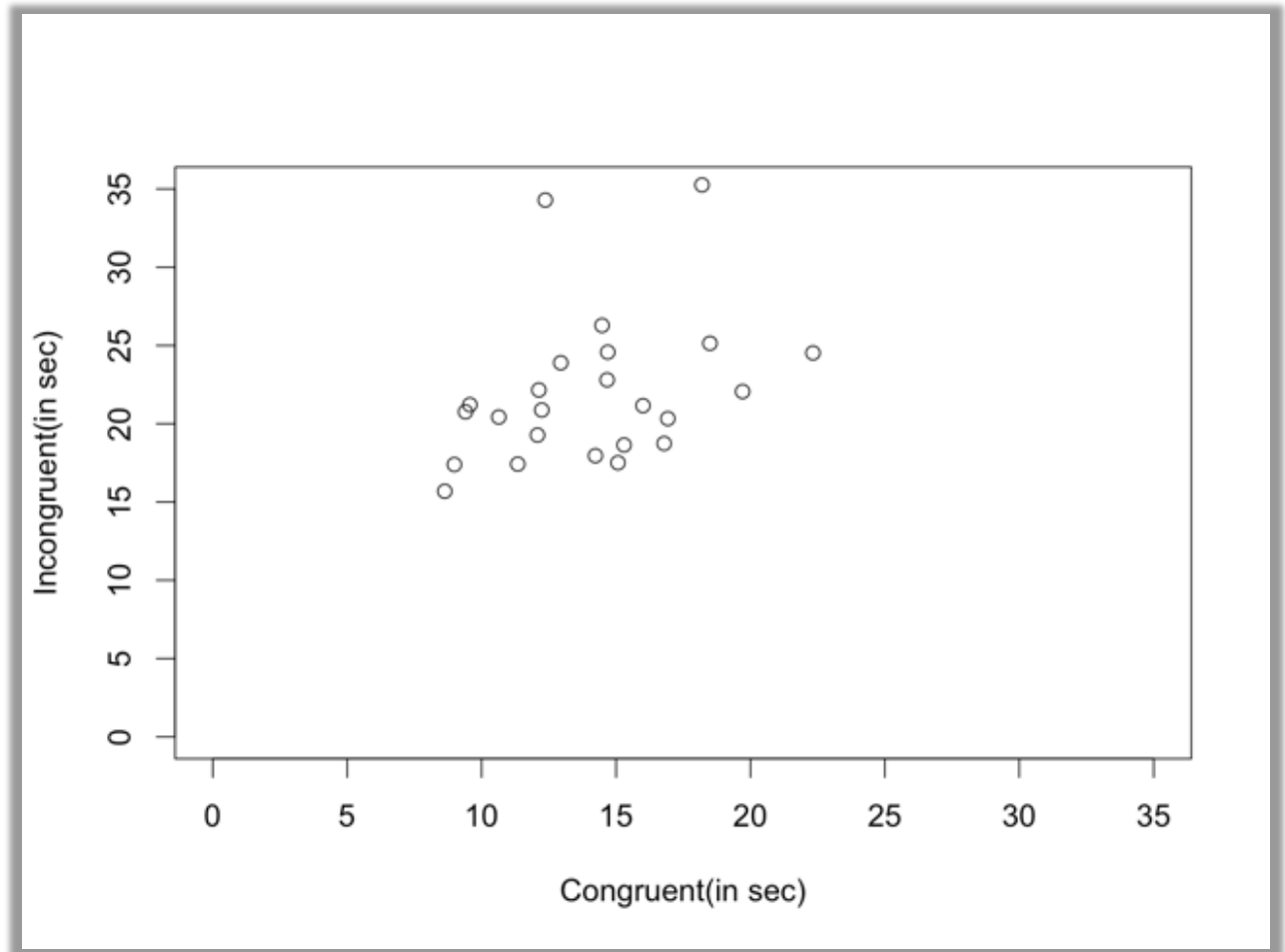
```
> sd(projdata$Incongruent)
[1] 4.797057
```

The sample size for each condition is 24. The mean for the Congruent sample is 14.05 seconds. The mean for the Incongruent sample is 22.02 seconds. The standard deviations are 3.56 and 4.79 seconds for the congruent and incongruent samples, respectively.

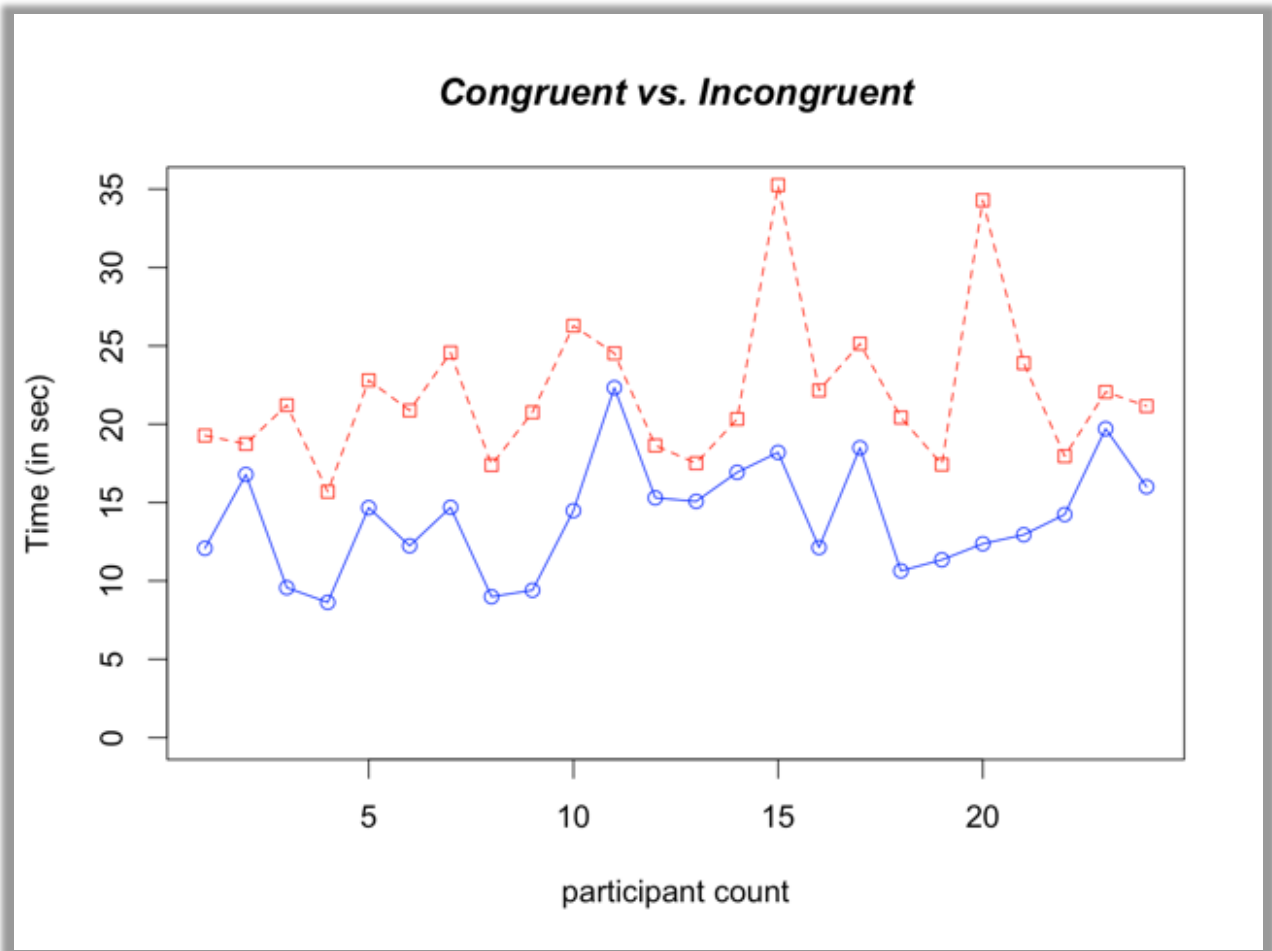
4. Provide one or two visualizations that show the distribution of the sample data. Write one or two sentences noting what you observe about the plot or plots.

The first figure below plots each of the 24 Stroop task participants' times on both the Congruent (x-axis) and Incongruent (y-axis) lists. Notice that none of the 24 participants' times were identical for both lists. Also that the Incongruent times for each participant were higher than their time recorded for the Congruent list. This characteristic of the sample is visualized by the Congruent vs Incongruent scatter plot, as well as the second figure below: a line plot of the Incongruent and Congruent times for each of our 24 participants

```
> plot(Congruent,Incongruent, xlim = c(0,35), ylim = c(0,35), xlab = "Congruent(in sec)", ylab =
"Incongruent(in sec)")
```



```
> plot(Congruent, type="o", col="blue", ylim=c(0,35),ylab = "Time (in sec)", xlab = "participant count")  
> lines(Incongruent, type="o", pch=22, lty=2, col="red")  
> title(main="Congruent vs. Incongruent", col.main="black", font.main=4)
```



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?

```
> t.test(projdata$Incongruent,projdata$Congruent,var.equal = T)
```

Two Sample t-test

data: projdata\$Incongruent and projdata\$Congruent

t = 6.5323, df = 46, p-value = 4.595e-08

alternative hypothesis: true difference in means is not equal to 0

95 percent confidence interval:

5.510462 10.419121

sample estimates:

mean of x mean of y

22.01592 14.05113

H0: Congruent population mean = Incongruent population mean

HA: Congruent population mean != Incongruent population mean

Sample Differences Description (Incongruent - Congruent):
n=24, mean=7.96, standard deviation=4.86, standard error=0.99

Paired-Sample t-Test: $t(23) = 6.53$, $p = 4.595e-08$

Confidence Interval on mean difference: 95% CI = (5.51,10.41)

For a two-tailed, paired-sample t-test at an alpha level of 0.05, **we can reject the null hypothesis.**

The paired-sample difference's extremely low p-value (4.595e-08) suggests it is very likely that the condition of the word list (congruent or incongruent) has a statistically significant effect on the population's time taken to finish each list.

The high t-statistic for the sample difference (incongruent minus congruent) suggests that statistically, it takes longer for the population to complete an incongruent list.

This aligns with both the intuition and past experience of the mine.

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!

This effect can be due to perception of observer's while viewing different color and reading different name. The brain possesses words more quickly than colors and hence it took more time for the incongruent words

Another variant can be the Emotional Stroop Test - In this test the participant must identify the emotion on the face of the person instead of the printed word on the face as seen below

A

INCONGRUENT



CONGRUENT



Figure 3. Emotional Stroop Example

Reference Material - <https://thestroopeffect.wikispaces.com/Variations+of+the+Stroop+Test>