Research on Stroop Effect and its’ Generalisability

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[Abstract] The Stroop effect is the difference in time which two stimuli with one stimulus having a distracting factor. The Stroop effect occurs when word reading is dominant among skilled readers that it is difficult for readers to ignore the written word and say the color of the ink instead of the color word that is written. There have been continuous experiments on monolinguals and bilinguals and questions on rather gender, age, environment and other possible factors affected the stroop effect.

[Keywords] Stroop Effect, Japanese, Wilcoxon Test, Reading, Color

[Stroop Effect]
The Stroop effect is the difference in time which two stimuli with one stimulus having a distracting factor. The Stroop effect occurs when word reading is dominant among skilled readers that it is difficult for readers to ignore the written word and say the color of the ink instead of the color word that is written.

According to MacLeod, there have been more than 700 studies that have addressed parts of the Stroop Effect. Before the 700 studies, John Ridley Stroop was the first person to address this phenomenon. In the original study, by J. Stroop in 1935, the participants were given two stimuli which were the color words and the color of the ink. In this study, the participants were given a list of color words with ink color that correspond to the word and another list of color words with the ink color that has no relations with the color word. The participants were divided into two groups each with a list of color words that corresponded to the ink color and another list of color words that did not correspond to the ink color. Each participant was timed when they started saying the color of the ink until they completed the list. Whenever they made a mistake, the participants were to correct the mistake before they continued but if they did not correct the mistake, Stroop calculated the time taken per word, multiplied it by the number of uncorrected errors and added it to the original time. Stroop found out that the participants completed the list faster in the congruent condition compared to the incongruent condition.

[Dyer’s Study]
Similar to Stroop’s study, Dyers studied two different languages which were Spanish and English. There were 71 Spanish-English bilinguals, 40 English monolinguals, and 11 Spanish monolinguals from South Florida. The results showed that the participants’ performances were slower in bilinguals than monolinguals. There were no significant differences in color reading but in color naming, bilinguals performed worse. Even though 5% - 10% were slower in reading the word color, results showed no significant differences between the 2 groups.

[Sumiya and Healy’s Study]
In Sumiya and Healy’s study, the participants were to name ink colors either in Japanese or in English. The Japanese color terms were either loan English terms or Japanese traditional terms. 24 Japanese-English bilinguals (7 men, 17
women) ranged from age 21-43 participated. The participants took less time to call out the word color written in Japanese or English than English pronunciation words written in Japanese.

An experiment was to investigate the difference in time it takes to complete a list with color words and the ink color being congruent and incongruent in Japanese. 12 participants were chosen by opportunity sampling who are currently learning or have learned Japanese as a foreign language. First the female participants were given the congruent word list then the incongruent word list and vice versa for the male participants. They were timed from the point where they began calling out the first word until they finished the last word on the list. The independent variables were the list of 20 words congruent to the word and ink color and the other was a list of 20 words incongruent to the word and ink color. Depending on the gender of the participants, the order of the list given differed, congruent list then incongruent list and vice versa.

To find the value of significant difference, the Wilcoxon test was used and it showed that the observed t was lesser than the critical value of t. It meant that null hypothesis was rejected and the experimental hypothesis that it will take the participants less time to say the ink color that is congruent with the color words than to say the ink color that is incongruent with the color words.

**Null Hypothesis:** There will be no significant difference in the time the participants take to finish the word list that is congruent with the ink color and the color words and the word list that is incongruent with the ink color and the color words.

**[Method]**

**Design**

**Independent Variable:** In Japanese, calling out a list of ink color that correspond to the color words and calling out a list of ink color that does not correspond to the color words

**Dependent Variable:** The time it takes to read the color of each on the lists

This experiment uses repeated measures which makes it easier to compare the results of the two independent variables. By using repeated measures, it minimized the variance, control for differences in ability, and more economical on participants.

The participants received the participant consent form before the experiment so they would be aware of the rights that the participants have such as withdrawal during the experiment and also give them information about the experiment. After the experiment, the participants were given a debriefing form which explained to them the purpose of the experiment and also gave them rights to exclude their results from experiment conducted. They could also request for more information on the experiment and also ask for their results.

**Research Question:** To investigate the Stroop effect for reading colors in Japanese for participants with Japanese as a foreign language

**Experimental Hypothesis:** It will take the participants less time to say the ink color that is congruent with the color words than to say the ink color that is incongruent with the color words.

**Participants:** 10 students and 2 adults were chosen by opportunity sampling since it was
convenient, the limited availability of participants, and time contraints. The participants were called individually and the experiment was conducted. The participants were students learning Japanese at an International School at Bangkok, and 2 adults who have previously learned Japanese. The participants’ age were ranged from 16 to 18, 48, and 58. 5 males and 7 females participated.

Material:
- Timer
- 2 color word lists (Appendix C)
- Participant Consent Form (Appendix B)
- Debriefing form (Appendix D)

Procedure:
1. Participants came to the assigned location during break or free time during their assigned time and date
2. They were given the participant consent form so they knew the rights of the participants and agreeing to take part in the experiment (Appendix B)
3. Participants listened to the instructions (Appendix A)
4. A sheet with word list was placed (female received List 1 first, male received List 2 first)
5. Participants started calling out the ink color as soon as the experimenter started timing
6. Participants were allowed to correct the mistakes (Experimenter was not allowed to tell the participants if it was wrong)
7. Participants were told to say “Done” or “Finished” when they completed the list. Timing would stop
8. Steps 5,6,7 were repeated with the incongruent list (Appendix C.ii) or congruent list (Appendix C.i)
9. After the experiment, they were given the debriefing form to read and sign
10. Signed forms were returned to experimenter and participants were dismissed

[Result]

<table>
<thead>
<tr>
<th></th>
<th>Relationship between the ink color and the color words</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Congruent word list</td>
</tr>
<tr>
<td>Mean</td>
<td>28.58 sec.</td>
</tr>
<tr>
<td>Median</td>
<td>26.66 sec.</td>
</tr>
<tr>
<td>Mode</td>
<td>None</td>
</tr>
<tr>
<td>Variance</td>
<td>133.4 sec.</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>11.5</td>
</tr>
<tr>
<td>Range</td>
<td>39.1 sec.</td>
</tr>
</tbody>
</table>

**[FIGURE 1]** Appendix C of word list for experiment

**[FIGURE 2]** Data concluded from the raw data
The average times it took the participants to call out the words were 28.58 for congruent word list and 39.59 for the incongruent word list. By observing the calculated value from the table and the graph above, calling out the ink color written on the incongruence list took the participants a longer time. By observing the standard deviation of congruent word list and incongruent word list which was 11.5 and 17.1, it shows that the participants’ time of calling out the color words on the congruent word list was closer to the mean than the incongruent word list. By using the statistical test, no assumption of the population distribution of the sample needed to be made. Also the range shows the difference between the longest and the shortest time.

Since my experiment was in repeated measures with interval data, in order to find the value of the significant difference between the calling out of the congruent and the incongruent list, Wilcoxon rank test was used.

Observed Value of T = 4
Number of participants: N = 12
Critical value of T: T = 17 (one-tailed, p=0.05)

Since the observed value of T (4) is less than the critical value of T for one-tailed test (17), the research hypothesis is accepted whereas the null hypothesis is rejected. Therefore by accepting the research hypothesis, it is stating that it will take the participants less time to say to the ink color that is in congruent with the color words than the ink color that has no congruence with the color words. When the observed value is less than the critical value of T, it means that there is less than 5% probability that the results are due to chance.

[Discussion]

The purpose of this experiment was to investigate the stroop effect for reading color in Japanese for participants with Japanese as a foreign language. The participants were slower in saying the ink color which was incongruent with the color words because the automatic process of reading. Reading is a dominant skill a person has and it is difficult to ignore the words and just say the ink color. It is likely that the participants’ reading ability is automatic. As a variation of Stroop’s original experiment, it was conducted in Japanese instead of English. It is similar to Sumiya and Healy’s study which was an investigation of Japanese and English whereas this experiment was just in Japanese. The finding of this experiment can be explained as follows: when word reading is dominant among skilled readers, it is difficult for them to ignore written words and say the ink color instead. Similar to Stroop, Dyers, Sumiya and Healy’s study, it took the participants longer time to call out the color words on the incongruent word list than the congruent word list. Similar to the results of Stroop’s experiment, reading is dominant also in participants with Japanese as second language.

There were several strengths to this experiment. First, the experiment was conducted with a standardized procedure which means the experiment can be easily replicated. This experiment can be generalized to various ages because the participants aged 16 to 58 participated. There were fair amount of male and female participants to control for gender differences. The switch in order of the list also
increased reliability so the participants did not have the chance to practice before which could have speeded up the time. Since the participants were in different levels of Japanese, it increased generalisability of findings. The participants were not deceived and after the experiment, the participants were debriefed, and it was done in a short amount of time.

There were some limitations to this experiment. From all 12 participants, 11 of them were Asians which would make it hard to generalize to other populations. Some participants had their experiment conducted in a noisy location such as the school canteen which distracted the participant’s concentration whereas some experiments were conducted in the quiet school library. Due to the difference in Japanese ability, some participants had a hard time remembering the color in Japanese which affected the results. There were participants who did not understand the instruction fully which also affected the time it took to complete the result since they understood the instructions while doing their 2nd list. Because the participants had to remember the colors in Japanese, it was stressful to some participants who forgot the color and had to force themselves to remember. Even though the students were given the list in different order, all females received list 1 first while all males received list 2 which could have affected the results.

Possible areas to improve would be to find participants, who had similar ability in Japanese, keep the location control to decrease the chance of confounding variables and have a more representative sample. Trying to get participants with a wider range of nationalities, equal number in gender, and wider range of age differences to participate would increase external validity. To increase mundane realism, it would be better to relate it more closely to everyday life. People read unconsciously but if people pay attention and practice in incongruent situations, speed will increase in reading words or color.

To make sure the experiment would be valid to all population around the world, students not only from Asia should have been chosen to participate. From the participants, there was a student from IB psychology class who participated but it unlikely that the result was affected because the student did not know about the Stroop effect and it was just one student.

[Conclusion]

The results showed that the time it takes to call out the ink color with the color word being congruent was shorter than the time to call out the ink color with the color word being incongruent. Since the observed value T was lesser than the critical value of T, the research hypothesis was accepted and null hypothesis was rejected. In conclusion the Stroop effect is present when reading color words for participants with Japanese as a foreign language.


