

PSYCHOLOGY
INTERNAL ASSESSMENT

THE STROOP EFFECT

"An experimental investigation into the interference of conflicting stimuli on a response task"

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Abstract

The aim of this experiment was to investigate the Stroop effect, that is if automatised processes such as reading would interfere with naming a colour or the name of a word. The experiment was a simple replication of Stroop (1935). The design was a repeated measures and the participants were chosen by convenience sampling as this was easiest. The IV was whether a congruent word list or incongruent word list was presented. The DV was the time in seconds that it took the participants to state the colour of ink in which each word was presented. The participants were therefore presented with word lists where the words were in either congruent or incongruent colour.

The results supported the Stroop effect. The mean time it took participants to name the correct colour in condition 1 (congruent) was 4.8 compared to 9.9 in condition 2 (incongruent). The SD in condition 1 was 0.99 and in condition 2 the SD was 2.05.

The conclusion was that the Stroop effect could be observed in this experiment and this is in line with Stroop (1935) and many subsequent replications of that study. It therefore seems that the Stroop effect is fairly consistent.

(197 words)

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INTRODUCTION

Perception is the process by which information in the environment is transformed into an experience of objects, sounds and events. Perception involves physiological processes of the senses as well as processes within the brain which integrate and interpret sensory inputs. Perception processes have been suggested to be built up from a combination of stimulus information, expectations and hypotheses. Furthermore, much psychological research has been conducted in attempt to shed light on the area of attention and inhibitions in relation to information processing, and a distinction between automatic and controlled processing has been suggested by numerous researchers within this perspective. An experiment in demonstration of this was conducted by J.R. Stroop (1935)¹ who introduced the colour naming experiment known as the Stroop Effect, where he showed that people's ability to read words interfere when they have to name colours of words.

Stroop (1935) asked participants to read words as quickly as possible in one condition and in a second condition (the congruent condition), participants had to name the ink colour in which each word were printed as quickly as possible. In a third condition (the incongruent condition), participants had to name the ink colour in which each word was printed, however in this condition the words themselves were colour names. For example, the participants were exposed to the word blue printed in red ink, and they had to name the colour of the word. Stroop found that the participants were much slower at naming the ink colours when the stimuli were themselves colours as (as in the third, incongruent condition), indicating that a possible explanation for the Stroop effect is that people quickly and automatically process the meaning of the word. This would therefore interfere with the ability to process "red" in the incongruent condition, and consequently delay the response.

Schneider and Shiffrin (1977)² supported this explanation in their automaticity model in which they distinguished between controlled and automatic attentional processing. They suggested that *controlled processing* involves conscious directing towards a task, occurs slowly and is capacity-limited, while *automatic processing* is unavoidable and difficult to modify, occurs fast and without conscious awareness, and is unaffected by capacity limitations. Schneider and Shiffrin's model does provide a possible explanation for the findings of the Stroop Effect in that, it indicates that once the automatic skill of reading is obtained it becomes unavoidable and hard to modify, which further

¹ J. Ridley Stroop (1935) Journal of Experimental Psychology, 18, pp. 643-662.

² Gross, Richard Psychology: The Science of Mind and Behaviour Hodder & Stoughton, London, 2001. p.193

explains the controlled process, in which there is a difficulty in not reading a word, but stating the colour of the ink. Furthermore, Stroop's findings are supported by the speed processing model, put forward by Morton and Chambers (1973)³ suggesting that people are able to read words faster than state colours. They argued that since reading is claimed to be automatic and stating colours is not, the information from each dimension seems to clash when having to name a colour. Due to this, it appears that people make mistakes and hesitate and it takes longer time in answering.

Our experiment is a partial replication of that of J.R. Stroop (1935).

The aim of our experiment is to investigate the effect of two "contradicting" stimuli (the congruent and incongruent wordlists), on the time it takes participants to answer correctly.

METHOD

DESIGN

The design repeated measures was chosen, in order to control for participant variables such as intelligence. The possible disadvantages in using this design could be order effects such as fatigue and boredom, which could affect the results of the experiment. In order to minimize order effects half of the participants were presented with the congruent wordlist first and then with the incongruent one, and the other half of the participants were firstly presented with the incongruent wordlist which was then followed by the congruent one.

Moreover, ethical considerations were followed, in that each participant was briefed before the experiment, and debriefed after it. During these proceedings it was made clear to them that their anonymity would be protected, and that they had the right to withdraw from the experiment at any time. The participants were not deceived in any way, and no physical or psychological harm was caused inflicted on any of the participants. Furthermore, all participants signed an informed consent form⁴.

Independent variable: (I.V.) Use of congruent word list or incongruent word list.

Dependent variable: (D.V.) Time in seconds that it took the participants to state the colour of ink in which each word was presented.

³ Gross, Richard Psychology: The Science of Mind and Behaviour. Hodder & Stoughton, London, 2001, p 387-390

⁴ See Appendix VI

PARTICIPANTS

The target population for the experiments was International Baccalaureate students at Nørre Gymnasium of both sexes with an age range of 17-20. The reason for choosing IB students was to ensure a similarity between the participant's level of English language ability. It was additionally assumed that people in this age-group had good eyesight, and fast reflexes. Nevertheless, it had to be made certain that the participants were not suffering from dyslexia or colour blindness because this would affect the results. By means of "convenience sampling", ten males and ten females (N=20) were chosen to participate in the experiment. This method was chosen as it was the most convenient and the easiest in the present experiment.

MATERIALS.

- Two wordlists:
 - Congruent wordlist⁵
 - Incongruent wordlist⁶
- Standardized briefing instructions⁷
- Standardized debriefing instructions⁸
- Informed consent note⁹
- Stopwatch.

PROCEDURE.

The participants selected by means of convenience sampling were approached individually in a friendly way and asked if they would agree to be part of a psychological experiment. If they agreed,

⁵ See appendix IV

⁶ See appendix IV

⁷ See appendix V

⁸ See appendix V

⁹ See appendix VI

the standardized briefing instructions were read out loud to each participant, where-after the researchers asked if he/she would like to continue or withdraw, or if there were any further questions. Hereafter, the researcher thanked the participant for his/her consent and asked the participant to sign a notifying consent form, where-after he/she was taken to a quiet classroom, to avoid extraneous variables, and each participant was tested individually here.

Once the participant felt confidently aware of the task about to be performed, he/she was given the first wordlist, and the stopwatch was set. The wordlist was turned over when researchers instructed the participant to do so, and the time it took for the participant to state the colour of ink in which each of the listed words presented on the paper, was recorded. In order to avoid order effects, the participants in the first group were presented individually with the condition 1 first, followed by condition 2, and the participants in the second group were firstly presented with condition 2, followed by condition 1.

Once the participant's time on each task had been recorded, the standardized debriefing manual was read out loud by the researcher, and the participant was thanked for his or her participation. The participant was invited to ask question, and was informed that he/she was welcome to view the finished results of the reports at the completion of them.

RESULTS

DESCRIPTION OF RESULTS

The raw data shows¹⁰ a clear difference between the two conditions, and this is supported by the difference in the two means of 4.8 for condition 1 and 9.9 for condition 2.

Additionally, the scores occurred fairly close to the mean, in that the standard deviations were quite small, as seen in Table 1.

¹⁰ See appendix I

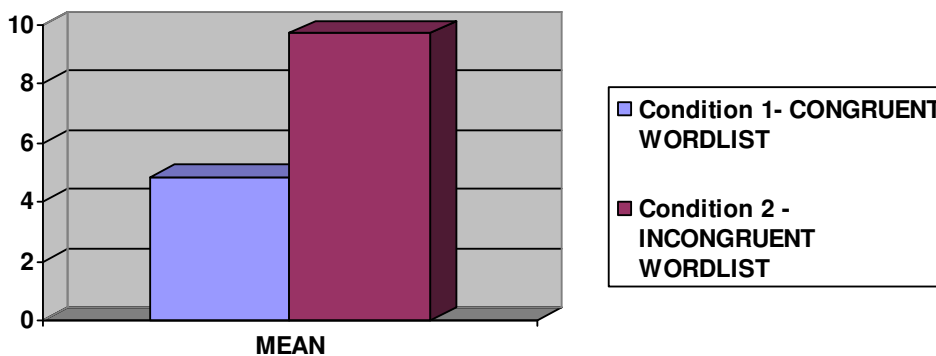
Table 1: MEASUREMENTS OF STANDARD DEVIATION AND OF THE CENTRAL TENDENCY OF CONDITION 1

AND 2:

	MEAN (seconds)	STANDARD DEVIATION
CONDITION 1 CONGRUENT WORDLIST	4.8	0.99
CONDITION 2 INCONGRUENT WORDLIST	9.9	2.05

Figure 1: MEANS OF PROCESSING TIME IN SECONDS COMPARED IN CONGRUENTS AND

INCONGRUENT WORDLIST.



DISCUSSION.

The aim of this experiment was to investigate the effect of conflicting stimuli on a response task, and the obtained results - showing that it took significantly more time for the participants to perform condition 2 than condition 1 - indicate that there is a distinction between controlled and automatic processing. The average difference in time in seconds between the two performances was 5.1 seconds, which further demonstrates a significant difference. Additionally, the scores occurred fairly close to the mean, in that the standard deviations were small.

These results therefore highly support those of Stroop (1935). Morton and Chambers (1973) suggested the speed of processing model, in which it is assumed that we are able to read words faster than naming colours. It appears that our mind chooses to receive specific presented stimuli

before others. Due to this, when the word itself is a colour and the ink another colour it is harder to focus on only saying the colour of the ink, as the automatic process of reading takes over, and the two dimensions clash. However, this is not the case when the words are congruent. Thus, this assumption provides a strong possible explanation for the obtained results.

A major limitation in this experiment is that of order effects, as they cannot be entirely excluded, even by means of counterbalancing. Additionally, the methodology used may cause further limitations in that the participants were within a specific target population, which makes any generalisations problematic. In particular, the convenience sampling method used, further restrains the possibility of generalisation, as the people within the target population did not have an equal chance of being selected.

Nevertheless, replications of Stroop's experiment over the years suggest, that the effect investigated is fairly consistent, indicating that it is a universal cognitive process, and hereby suggesting that issues such as gender and culture do not interfere. In conclusion, automaticity of reading interferes with naming a word when the colour of the word is incongruent so that it takes longer time to name the word compared to a situation where the word is congruent.

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APPENDIX I - RAW DATA

PARTICIPANTS	GENDER	TIME (in seconds) CONGRUENT LIST	TIME (in seconds) INCONGRUENT LIST
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GROUP A – PRESENTED WITH CONDITION 1 FIRST. (Congruent wordlist)

participant		condition 1	condition 2
1	FEMALE	5.64	7.8
2	FEMALE	5.89	7.21
3	FEMALE	5.52	8.41
4	FEMALE	4.12	7.92
5	FEMALE	3.86	10.23
6	MALE	4.58	9.11
7	MALE	4.16	8.59
8	MALE	2.93	8.28
9	MALE	4.8	11.13
10	MALE		

GROUP B – PRESENTED WITH CONDITION 2 FIRST. (Incongruent wordlist)

Participant		Condition 2	Condition 1
11	FEMALE	5.66	15.03
12	FEMALE	6.34	13.02
13	FEMALE	4.27	11.91
14	FEMALE	4.7	7.03
15	FEMALE	6.52	11.44
16	MALE	5.32	10.35
17	MALE	3.28	11.86
18	MALE	4.25	8.14
19	MALE	5.7	9.57
20	MALE	4.23	10.27

APPENDIX II – STATISTICAL CALCULATIONS.

PARTICIPANTS	TIME (in seconds) FOR CONGRUENT WORDLIST	DEVIATION (d)	d²
1	5.64	0.48	0.23
2	5.89	1.09	1.19
3	5.52	0.72	0.52
4	4.12	-0.68	-0.46
5	3.86	-0.94	-0.88
6	4.58	-0.22	-0.48
7	4.16	-0.64	-0.41
8	2.93	-1.87	-3.5
9	4.8	0.00	0
10	3.5	-1.30	-1.69
11	5.66	0.86	0.74
12	6.34	1.54	2.37
13	4.27	-0.53	-0.28
14	4.7	-0.10	-0.01
15	6.52	1.72	2.96
16	5.32	0.52	0.27
17	3.28	-1.52	-2.31
18	4.25	-0.55	-0.30
19	5.7	0.90	0.81
20	4.23	-0.57	-0.32
N = 20	Mean: 4.8		∑d² = 19.73

PARTICIPANTS	TIME (in seconds) FOR INCONGRUENT WORDLIST	DEVIATION (d)	d²
1	7.8	-2.10	4.41
2	7.21	-2.69	7.23
3	8.41	-1.49	2.22
4	7.92	-1.98	3.92
5	10.23	0.33	0.11
6	9.11	-0.79	0.62
7	8.59	-1.31	1.72
8	8.28	-1.62	2.62
9	11.13	1.23	1.51
10	10.7	0.80	0.64
11	15.03	5.13	26.32
12	13.02	3.12	9.73
13	11.91	2.01	4.04
14	7.03	-2.87	8.24
15	11.44	1.54	2.37
16	10.35	0.45	0.20
17	11.86	1.96	3.84
18	8.14	-1.76	4.00

19	9.27	-0.63	0.40
20	10.27	0.37	0.14
N = 20	Mean: 9.9		$\sum d^2 = 84.28$

APPENDIX III – CALCULATIONS.

MEAN: USING THE FORMULA $\frac{\sum x}{n}$

CONGRUENT WORDLIST:

$$(5.64 + 5.89 + 5.52 + 4.12 + 3.86 + 4.58 + 4.16 + 2.93 + 4.8 + 3.5 + 5.66 + 6.34 + 4.27 + 4.7 + 6.52 + 5.32 + 3.28 + 4.25 + 5.7 + 4.23) / 20 = \underline{\underline{4.8}}$$

INCONGRUENT WORDLIST:

$$(7.8 + 7.21 + 8.41 + 7.92 + 10.23 + 9.11 + 8.59 + 8.28 + 11.13 + 10.7 + 15.03 + 13.02 + 11.91 + 7.03 + 11.44 + 10.35 + 11.86 + 8.14 + 9.57 + 10.27) = \underline{\underline{9.9}}$$

DIFFERENCE BETWEEN MEANS:

$$(9.9 - 4.8) = \underline{\underline{5.1}}$$

VARIATION: USING THE FORMULA $s^2 = \frac{\sum (x-x)^2}{N}$

$$\underline{\underline{CONGRUENT WORDLIST:}} = \frac{19.73}{20} = \underline{\underline{0.99}}$$

$$\underline{\underline{INCONGRUENT WORDLIST:}} = \frac{84.28}{20} = \underline{\underline{4.21}}$$

STANDARD DEVIATION: USING THE FORMULA: $s = \sqrt{\frac{\sum (x-x)^2}{N}}$

$$\underline{\underline{CONGRUENT WORDLIST:}} = \sqrt{0.99} = \underline{\underline{0.99}}$$

$$\underline{\underline{INCONGRUENT WORDLIST:}} = \sqrt{4.21} = \underline{\underline{2.05}}$$

APPENDIX IV – WORDLISTS.

CONGRUENT WORDLIST

RED
GREEN
YELLOW
RED
BLUE
GREEN
RED
YELLOW
BLUE
BLUE

INCONGRUENT WORDLIST

YELLOW
RED
BLUE
GREEN
RED
BLUE
GREEN
YELLOW
RED
BLUE

APPENDIX V – BRIEFING AND DEBRIEFING INSTRUCTIONS.

Standardized Briefing Instructions.

You will be presented with two lists of words. Your task for this experiment is to state the colour of ink in which each word is presented regardless of the word. You will need to start naming the colours starting at the top of the list, and ending at the bottom. Your performance on each list will be timed. Please remember that if at any time during the proceedings of this experiment you wish to withdraw, you have the right to do so. If you have any questions, please ask them now. I will give you the first list now. Please turn it over when I instruct you to.

Standardized Debriefing Instructions.

The experiment is now over. We want to thank you for your corporation. If you would like the results of the experiment or to read the final reports on it, you are welcome to do so at the completion of them. If you have any further questions please do not hesitate to ask them. Thank you again.

APPENDIX VI – CONSENT FORM.

Consent Form

- I have been informed satisfactorily about the experiment
- I know that I have the right to withdraw from the experiment at any time, and that any information/data about me will remain confidential
- My anonymity will be protected.
- The experiment will be conducted so that the participants are not harmed in any way.
- I have the right to ask questions.
- I will be debriefed at the end, and have the opportunity to find out the results if I wish to do that.

I agree to participate in this experiment

NAME and date _____

Contact number _____