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Reaction times related to congruence in a Stroop test of undergraduate students

ABSTRACT

The 'Stroop effect', a measure of interference in a reaction time task, was investigated. Twenty undergraduate students of mixed age and gender were each presented with 48 coloured words in turn. These were divided into 16 of each of 3 levels of congruence. The time required to identify the colour of each stimulus was recorded, and related to whether the word presented identified, contrasted with or contained an unrelated meaning to the font colour it was displayed in. This data was collected and compared in order to assess the median time taken to correctly respond to each level of congruence. The results confirmed the effect of interference on the identification of colour when presented with contrasting semantic cues. However additional inferential statistics are required to assess the significance of the variance found between response times to words with meanings unrelated to, and those with meanings equivalent to their font colour. It is suggested that additional experiments be carried out to control for the possible effects of the relative position of input keys, and to determine whether prior learning or a language bias in the perception of semantic information explains the results.

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INTRODUCTION

Since its development in 1935, the Stroop task, a measure of the effect of interference on performance of a colour identification task, has been used to investigate aspects of such varied psychological disorders as Attention Deficit Hyperactivity Disorder (Savitz, & Jansen, 2003), Schizophrenia (Gruber, 2002), and Anorexia (Mendelwicz, Nef, & Simon, 2001). J. Ridley Stroop's original word colour identification test has additionally been modified to include numeric (Girelli, Sandrini, & Cappa, 2000) emotionally stimulating (Watts, Fraser, McKenna, Sharrock, Trezise, 1986) and auditory (Shor, 1993) variables.

In his classic experiment 'Studies of interference in serial verbal reactions' Stroop (1935) administered several variants of two main tests. Stroop (1935) referred to his tests as RCN, to stand for "Reading colour names", where participants were required to repeat the written meaning of words with differing coloured fonts; and NCW to stand for "Naming Coloured Words", in which participants were asked to verbally identify the font colour of each printed colour name. Additionally Stroop (1935) tested his participants at different stages of practise with each task, to account for the effects of association. Stroop (1935) identified an interference effect of prior learning on the time taken by participants to complete these tasks, an effect still pronounced despite continued practice at each task.

The current experiment attempted to verify whether the classic stroop effect would be displayed when the test was administered and participated in by undergraduate psychology students. It differed from Stroop's (1935) original experiment both by presenting each stimulus individually rather than in a group and by including words that contained the same semantic meaning as their font colour.

Students were presented with a series of words of varying font colour and semantic meaning, and their response times related to the congruence of the semantic and colour information for each stimulus were collated and contrasted with the group of students as a whole.

When each meaning did not match, and yet both contained contradictory information participants should have been momentarily confused by the interference of their learned tendency to give pre-eminence to the semantic meaning of written words, and thus have taken longer to correctly record the colour of the stimulus presented.

METHOD

Design

A repeated measures design was used. Each variable exhibited one of 3 levels of congruence. Congruent variables consisted of words which matched both in semantic meaning and font colour, Control variables had semantic meanings unrelated to their colour (for example the word "house" presented in blue), and incongruent variables had semantic meanings which contrasted with the colour in which they were displayed (for example the word "blue" displayed in the colour red). 16 variables of each type were presented to each of the 20 participants tested. Each level of congruence was randomly distributed throughout the test. Reaction times were measured for each participant for each stimulus, as related to the congruence of each stimulus responded to.

Participants

Twenty mixed gender undergraduate students from an introductory 'Practicals, Methodology and Statistics' course in Trinity Collage, participated as part of a laboratory practical. All participants were presented with the same stimuli, and each tested themselves and collated their own results. [Specific gender, age and nationality breakdowns are not available for this report, as trial data from a group other than this experimenters had to be used because errors were not removed from the original data.]

Apparatus

eMac Macintosh Personal computers running Mac OS9.2.2. Tests run on Superlab Pro 1.75 RT. Data analysed using SPSS.

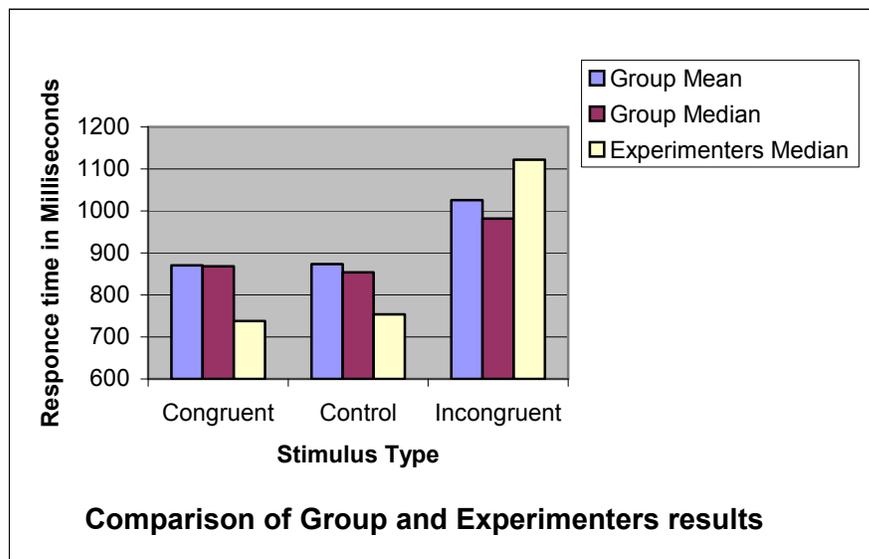
Procedure

Participants were tested individually, viewing instructions on screen before beginning the test at their own discretion. Each participant was presented with each of the 48 stimuli in turn, and asked to respond as quickly as possible; specifying through the pressing of a key on their computer the colour of the stimulus presented. Reaction times for each congruence coded variable were recorded.

RESULTS

Each participant collected their own reaction times, removing any erroneous responses, and calculated their own median response time for each of the 3 variables; reporting these figures to the postgraduates overseeing the experiment. The groups median response times for each type of stimulus (presented here to control for the effects of outliers) were 868ms for Congruent, 854ms for Control, and 982ms for Incongruent.

This experimenters median response times were 738ms for Congruent, 754ms for Control, and 1122ms for Incongruent.



In contrast to the group, which had a median reaction faster for Control stimuli than for Congruent, this experimenter had his lowest median reaction time to Congruent stimuli. However the group mean response time for Congruent (870.25ms) stimuli was higher than its mean response time to Control stimuli (873.35ms).

Both the group as a whole and this experimenter reacted most slowly to incongruent stimuli.

This experimenters results were more extreme than the group as a whole, with both significantly slower response times to Incongruent stimuli (+140ms), and significantly

faster response times to both Congruent (-130ms) and Control (-100ms) stimuli than the group medians.

DISCUSSION

A considerable variance in both the group and this testers median reaction times was found between Incongruent stimuli, and Control/Congruent stimuli. This can be viewed as a clear confirmation of the stroop effect. However the difference between Congruent and Control reaction times was negligible, with Control stimuli having a lower median response time, but a higher mean response time for the group. As the medians and means of the groups responses are based in turn on the medians of each participant, and the sample size is so small (20) it is possible that this is not a significant effect. Inferential statistics are required to assess the significance of this response difference.

During the experiment participants were forced to ignore the prior learning of written language, and attend instead to the font colour of each stimulus. If the stroop effect did not exist then participants could freely ignore the written information presented and attend to font colour. However in the case of Incongruent variables the effect of this contradiction in word meaning and font colour was to increase the time required to verify and report the correct answer. Since we assume the time required for the pressing of the requisite key did not significantly vary, this evidences a longer processing interval for such "contradictory" stimuli; demonstrating a bias towards either previously associated, or written information. Later experiments involving repeated measures could be used to attempt to quantify the effect of practice or association. Additional experiments could be performed to discovering the "weighting" of various interference stimuli, such as emotionally stimulating images, as compared to written information.

This experimenter found Congruent responses easy to rapidly respond to, eliciting a feeling of correctness. However both Incongruent and Control stimuli necessitated a conscious effort to perceive word colour. In the case of Control stimuli the unrelated word meaning proved a slight distraction, while Incongruent stimuli proved momentarily confusing, despite being expected. Additional time was required to 'double check' responses to Incongruent stimuli, to avoid producing erroneous responses.

Potential confounding variables in this implementation of Stroop's experiment include the method of input, as the potentially awkward positioning of the keys could have had an impact on the ease with which each was depressed (especially for non touch typists), an analysis of the experimental stimuli could ensure that each colour was presented a comparable number of times, and hence measure any effect of key position. A more reliable input method for future experiments would be one which required an equal amount of time/difficulty to reach each key and controlled for potential handedness bias. Alternately a spoken verification of each colour meaning could be recorded using voice recognition software. It is important to note that had participants utilised a specific strategy to attempt to compensate for the written language bias, for example attending only to the last letter of each word displayed, then the Stroop effect might not have been observed.

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APPENDIX 1

**Table of Group and Experimenters Response times in
Milliseconds**

	Congruent	Control	Incongruent
Group Results	671	709	810
	982	1338	1322
	911	794	850
	1102	1030	1270
	1006	782	918
	866	986	946
	1362	930	1138
	870	954	1034
	822	990	1522
	634	674	942
	786	666	914
	671	978	1129
	678	914	1009
	866	866	995
	883	819	987
	931	725	977
	878	790	770
	902	874	954
	862	806	1098
	722	842	930
Group Mean	870.25	873.35	1025.75
Group Median	868	854	982
Experimenters Median	738	754	1122

Appendix 2

