THE STROOP TEST IN EVALUATING PERFORMANCE EFFECTS OF NAVY DIVING TASKS.

I. STIMULUS EXPOSURE DURATION EFFECTS

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SUMMARY PAGE

THE PROBLEM

To estimate the suitability of the Stroop test for measuring performance effects of Navy diving tasks and to determine if varying the exposure duration of the test items is an effective means of manipulating "task stress."

FINDINGS

Number of response errors was significantly greater with a shorter item exposure duration. There was no significant decrease in number of errors with repeated presentation of the stimuli. The overall results suggest that, under brief item exposure duration, the Stroop task is inherently disruptive and stressful.

APPLICATION

A variation of this task will be included in a battery of tests designed to examine performance on stressful tasks under the adverse environmental conditions encountered in Navy diving situations.

ADMINISTRATIVE INFORMATION

This investigation was conducted under Bureau of Medicine and Surgery Research Work Unit M4306.03-1020D - Development of Effective Performance Measures for Use in Diving Research and American Institute of Biological Science, Nonr Contract No. 4526(05). The present report is the first under the above BuMed Work Unit, and also on the Nonr contract. It was approved for publication on 24 June 1970 and designated as Submarine Medical Research Laboratory Report No. 632.

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ABSTRACT

The items in the Stroop color-word test are color names printed in an incongruous color (e.g., the word "red" in the color blue). Twenty-four Submarine School volunteers viewed a set of 36 Stroop items presented serially at speeds of either 1 or 2 sec. duration. Interference in color naming was examined over six repeated presentations of the list. The results indicated that interference effects were significantly greater ($p < .001$) under the 1 sec. condition. The data are consistent with a competing response interpretation.

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I. STIMULUS EXPOSURE DURATION EFFECTS[1]

INTRODUCTION

This experiment is part of a project designed to identify objective behavioral tests which can be used to evaluate an individual's ability to perform an inherently disruptive task under environmental stress (i.e., a situation involving threat to the individual's safety such as performing diving tasks). The task selected for investigation here was a modified version of a color-word interference test introduced by Stroop (1935). An excellent review of the literature on the test has been provided by Jensen and Rohwer (1966).

In the typical experimental procedure, S is presented with a color-word (e.g., red) printed in an incongruous color (e.g., blue). The S's task is to name the color of the ink in which the word is printed. The significant feature of this test, for the present purpose, is that it involves interference between two response tendencies: the well-learned tendency to read the printed word, and the less dominant tendency to name the color in which the word is printed.

It was the purpose of this study to examine the effect of item exposure duration on interference in the color naming of Stroop stimuli. This experiment constitutes a partial replication of two recent studies (Hochman, 1967, 1969) which show that Ss perform significantly better with longer exposure times. Furthermore, this investigation provided an opportunity to evaluate the effects of repeated practice with the same set of items on color-word interference.

METHOD

Subjects.

The Ss were 24 Submarine School volunteers from the U.S. Naval Submarine Base, Groton, Connecticut, ranging in age from 18 to 22 years. The modal age was 19. All Ss were given the Ishihara Color Test to rule out visual color deficiencies.

Materials and Procedure.

The stimulus items were four color names (red, blue, yellow, black), each printed in the three incongruous colors (e.g., the word "red" was printed in blue, yellow, black, etc.). Each of the twelve items appeared three times in a random order to make up the test list of 36 Stroop items. Items were randomized with the restriction that no color appeared more than twice in immediate succession.

The 24 Ss were randomly assigned to two experimental conditions. For Ss in one group (n=12), stimuli were

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exposed for 2 sec.; for the remaining 12 Ss, the stimulus exposure duration was 1 sec.

Ss were seated in a dimly lighted room, approximately three feet from a rear-projection screen. Room illumination was maintained at a level at which Ss could discriminate color. The set of thirty-six 35mm color slides was presented automatically on the screen by means of a Kodak Carousel slide projector. On each of the six trials, the same random order of items was repeated. The inter-trial interval was approximately 20 seconds.

Prior to the first trial, Ss were given the following instructions:

> You will be viewing a series of slides on which are printed the names of colors. Your task is to name the color of the ink in which each word is printed. Remember, respond only with the name of the color of what you see on each slide. It will be either red, blue, yellow or black. Are there any questions?

All responses were recorded on tape and analyzed for type of error (e.g., naming word rather than color, inappropriate color naming, omissions, inarticulate utterances, etc.).

RESULTS AND DISCUSSION

Mean number of errors for the two exposure conditions over the six trials is shown in Fig. 1. Analysis of variance on these data revealed a significant effect due to exposure duration, $F(1, 22) = 20.25$, $p < .001$, and a reliable trials effect, $F(5, 110) = 3.05$ $p < .05$. The interaction, however, was not significant ($F < 1.00$). The finding that performance was inferior with a briefer exposure duration is congruent with Hochman's (1967, 1969) data. These results are consistent with a response competition interpretation of Stroop performance, as Ss in the short duration condition presumably have less opportunity to inhibit the dominant response tendency (i.e., reading the word).

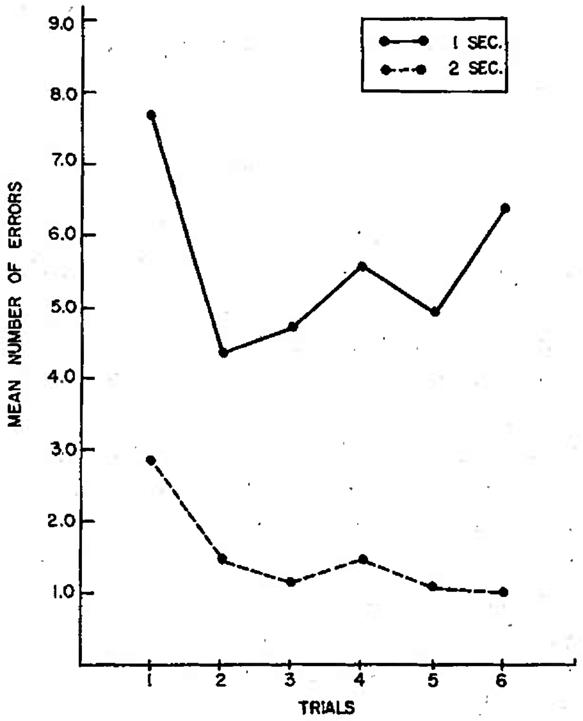

Fig. 1. Mean number of errors over 6 trials for the 1 and 2 sec. exposure conditions.

The experimental procedure, which involved presentation of stimuli in the same random order on all trials, is one which might normally be expected to maximize sequential practice effects. Although there is a significant decrease in errors ($t(11) = 2.51$, $p < .05$) from Trial 1 to Trial 2 for Ss in the 1 sec. condition, it is evident that repeated practice on the same set of stimuli over the subsequent four trials does not result in any further improvement in performance. In fact, with the exception of Trial 5, there is a progressive *increase* in the mean number of errors over Trials 2 to 6. The difference in performance between Trials 2 and 6, however, was not statistically reliable (*t*(11) = 1.29). This raises the general question as to whether or not interference effects are independent of the order of presentation of items. Any further investigation of this problem should, of course, involve comparisons of repeated measures of performance under the same and randomized sets of items.

The extraneous behavior (e.g., laughing, pointing, sighing, fidgeting, etc.) often observed in *Ss* performing on the Stroop test was again evident here, and much more pronounced in the 1 sec. condition. This finding supports the conclusion that when exposure duration is brief, the task is inherently disruptive and stressful. Under longer exposure duration, however, Ss presumably have an opportunity to "cue" themselves to suppress the dominant tendency, and give the correct response.

Overall, the present results provide support for the usefulness of the Stroop technique as a method for manipulating task stressfulness.

REFERENCES

Hochman, S.H. The effects of stress on Stroop color-word performance. *Psychonomic Science*, 1967, *9*, 475-476.

Hochman, S.H. Stress and response competition in children's color-word performance. *Perceptual and Motor Skills*, 1969, *28*, 115-118.

Jensen, A. H., and Rohwer, W.D. The Stroop color-word test: A review. *Acta Psychologica*, 1966, *25*, 36-93.

Stroop, J.R. Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 1935, *18*, 643-662.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Task stress						
Stroop test						
Color-word interference						
Diving						
Performance measurement						

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