Search time and color coding⁷

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Abstract

In an attempt to determine the effect of color coding on search time, six groups of 10 S's each were asked to respond to 10 different displays containing 60 symbols, some of which were color coded. Comparisons among conditions revealed that there was a significant difference in search times only between a "color" and a "no color" condition.

Problem

Recently, attention has been drawn to the use of color as a coding dimension in visual displays. Although such coding is redundant in that S's do not need it in order to find particular targets, it does enable S to find the target much quicker.

Among the pioneering work in this area, Green & Anderson (1956) explored the use of color in reducing search times with respect to the number of symbols of each color and the number of different colors used. Their results indicated that, "search times are slightly longer for multicolored displays than for comparable single-colored displays."

Smith (1962), in exploring this result further, was able to verify the fact that S's were able to search for targets of one color code "almost as quickly in the presence of differently colored targets as when they were presented alone." Smith concluded that, "if more and more different colors were added to a display, one would expect that there would be diminishing improvement followed by eventual degradation of visual separability based on this coding dimension."

In an attempt to explore this statement further, the present experimental study was conducted. Using displays somewhat like those of Smith (1963), the effectiveness of a number of color codes was measured by the reduction in search times when the codes were used.

Method

Six groups of 10 S's each were employed in the study. Each S was exposed to 10 different displays which were coded according to the condition in which S participated. (i.e. S in the first group was shown displays with no color, S in the second group saw one color, and so on.) The display colors used for each category and their Munsell notation are shown in Table 1.

Table 1. Display Colors used for each Category and their Munsell Notation

Group No.	Display Color	Munsell Notation	Item Category
0	No Color		
1	Red	5 R 4/14	H
2	Yellow	5 Y 8/10	F
3	Green	5 G 5/10	I
4	Blue	5 B 4/8	S
5	Violet	5 V 4/10	M

Fig. 1. Average Search Times as a Function of the Number of Colors Employed.

Each display was composed of 50 items randomly placed in a matrix which could be thought of as having 14 rows and columns, allowing for 196 possible positions. The items were types using an IBM Electric Typewriter and consisted of a letter (either H, S, F, I, or M) followed by a three digit number (000-999) selected from a random number table. Care was taken to insure that each of the five letters appeared 10 times and no number appeared more than once.

The displays were made up on 8 1/2 x 11 in bond paper mounted on chipboard, and were shown to S from a distance of about 18 in. Normal room illumination was utilized.

In their instructions, S's were told to search for and write down as quickly as possible the 10 items beginning with the letter "H." For each of the five conditions in which color was employed, S's were told that all items with "H" would have a red rectangular bar approximately 1/4 x 3/32 in beneath them. For each condition in which an additional color was used, S's were told beforehand the letter and color associated with it. (i.e. when three colors were used S was told that H's had a red bar beneath them, F's had yellow, and I's had green.) A stop watch was used to record the time which S required to correctly identify all "H" items.

Results and Discussion

Figure 1 presents the average search times as a function of the number of colors employed. The results of an analysis of variance for a randomized groups design yielded a $p < .001$ for the F-value of 40.03. Further analysis using Duncan's New Multiple Range Test revealed that a significant difference existed

between the "no color" condition and each of the other experimental conditions.

The overall results of the present study tend to suggest that increasing the number of colors on a display from one to five will not significantly affect S's search time for a particular item, provided he is told beforehand the item and the color to search for. The failure to disclose any difference among the multiple color conditions per se appears to generalize Smith's (1962) statement that, "...neither the particular target color used, nor the display background, nor any interaction term including these variables, had any statistically significant effect."

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Note

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Comment

Analysis vs. Experiment:

"On the Inferred Independence of Paired Watchkeepers"

1. If one assumes that two independent observers each have an average probability of detecting a target of .7, a very simple calculation shows that the probability of one or the other or both of the observers seeing the target (of the target being detected) is .91. The value .91 is terribly like the value .906 obtained by Morgan & Alluisi (1965) from pairs of Ss in a detection task.

2. If, once the 24 Ss have been run and the data are available, one were to pair data randomly from Ss in the non-paired condition, the irrelevance of significance testing to the experimental question would be obvious.

3. Pirenne (1943) did essentially the same experiment more cheaply. He used two eyes of the same S, and some analysis.

Sometimes experiments are unnecessary. Sometimes experiments ask the wrong questions. Sometimes they have been done before and more cheaply.

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Reply

Analysis and Experiment: A Reply to B. R. Wolin

Sometimes two eyes act independently (Pirenne, 1943; Woodworth & Schlosberg, 1954, pp. 398-399), but sometimes they do not (Casperperson & Schlosberg, 1950; reviews of binocular depth perception, e.g., Woodworth & Schlosberg, 1954, pp. 455-491). Sometimes paired Ss keep watch independently (Morgan & Alluisi, 1965), but sometimes they do not (Wiener, 1964). We know these things now (hindsight) by analysis and experiment; we did not know them before.

With regard to Wolin's specific comments:

1. He does understand our results. We prefer our statement (Morgan & Alluisi, 1965, p. 162) as being more nearly precise, but we do not object to his re-statement, especially if it helps him understand and remember our study.

2. Had we known prior to our study that paired Ss would keep watch independently, Wolin's comment would be pertinent. It is irrelevant, however, to the extent that hindsight does not imply foresight; nor prediction, verification.

3. Like Pirenne (1943) we conducted both experiment and analysis; he dealt with the two eyes of one S on a question of the binocular summation of brightnesses in the peripheral retinas—a within-S question that required use of two eyes per S. We dealt with the two Ss of one pair on a question of the independence of paired watchkeepers—a within-pair question that required use of two Ss per pair.

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