Selective attention to "physical" vs "verbal" aspects of colored words*

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Ss who were asked to name the colors in which color words were printed named them more slowly than was the case for colors in which animal words were printed. When, however, they had to sort words into categories depending on whether the words or the colors they were printed in were the same or different, colors were sorted faster than words. It is argued that a distinction should be made between processing involving naming and processing involving simple recognition of physical features.

The Stroop effect, whereby a list of colored words is presented and S is shown to be slower in reading off the names of the ink colors when the words are color words than when they are not, has been the subject of intensive investigation with the view to establishing how far the effect reflects selective attention in naming and reading (see Jensen & Rohwer, 1966, for a review). Recently Treisman & Fearnley (1969) showed that when two words were displayed on a card and S had to sort cards according to whether the words on the cards were the same or the colors in which the words were printed were the same, matching two words or two colors was faster than was matching the word to the color of the second item (which in this case was a row of four Xs printed in a given color). The slowest sorting time was for the case where a colored word and a black word were presented: the S had to match the color of the first word with the name of the color represented by the second word. Uleman & Reeves (1971) and Lund (1927) have also shown that when an array of words or of color patches is presented, scanning for a given word is slower than is scanning for a given color. If we combine these findings, we may conclude that the perceptual act of selection of an item consists of two stages: a recognition of the color in which the word is printed or a recognition of the "shape" of a given word and, secondly, the naming act involved. The purpose of the present study is to show that these stages can be artificially separated: the Treisman and Fearnley experiment already goes a long way towards establishing this, insofar as same-different matches involving only the first stage were faster than were

same-different matches involving a comparison across sensory dimensions which necessarily included a naming act. In the work to be reported, we first show that the Stroop effect holds when the materials involve color and animal names; in the second part, it will be shown that when a same-different match has to be made between colors, such matching is faster than when the match has to be made between words. In the latter case, we also investigated the effects of varying the irrelevant dimension (colors or words) upon the speed of sorting. The first part of the experiment involves naming to a much greater degree than does the second part. Our ultimate aim was to show that words are named faster than colors but that colors can be processed faster than words when no naming is involved.

EXPERIMENT 1

General

The Ss were asked to read out the colors or the words of 81 words presented on a large sheet. The words were either color or animal words. The measure of efficiency of processing was the total time taken to read the whole set.

Materials

Nine color words and nine animal words were chosen as follows: blue, gray, pink, black, brown, green, orange, purple, yellow; bear, deer, lamb, horse, mouse, skunk, beaver, monkey, rabbit. It will be seen that in both series, there were three each of four-, five-, and six-letter words: these were chosen in order to control for any unwanted effects of word length upon speed of reading. Putting the two series together made a total of 81 possible combinations of colored words for each set of words, e.g., BEAR (or BLUE) could be printed in each of the nine colors, and so on for each of the other eight color or animal words. Four sheets of Bristol board were then printed with 81 words each (in three columns of 27) as follows: List 1—a randomly arranged list of

animal words printed in black (with nine occurrences of each word). List 2—a randomly arranged list of color words printed in black (with nine occurrences of each word). (These two lists served both for initial warmup and as controls for the rate at which such words could be read out when there was no need to be concerned about their printed colors). List 3—a randomly arranged list of animal words in which each occurrence of a word was printed in a color different from that of every other occurrence of that word. List 4—a randomly arranged list of color words in which each occurrence of a word was printed in a color different from that of every other occurrence of that word.

Procedure

The Ss first read instructions which familiarized them with the nine animal words and the nine color words and gave examples of the printed appearance of each of the nine colored inks which would occur. They were told that the general task was to read aloud the contents of an 81-item list as quickly and as accurately as possible and that their total reading time would be measured (by stopwatch). All Ss began by reading Lists 1 and 2 (half had List 1 first, half List 2). Then each S read Lists 3 and 4 twice each: once reading out the words they saw (color or animal), and once reading out the colors of the words. The 24 possible orders of these four tasks were counterbalanced across Ss.

Subjects

The Ss were 48 undergraduates from Queen's University, 24 males and 24 females.

Results

Table 1 shows the mean reading time per S under the six conditions of Experiment 1 (including Lists 1 and 2). Analysis of variance of the reading times for all Ss (excluding the data for Lists 1 and 2) showed that reading out words was significantly faster than reading out the colors of those words ($F = 1001.7$, $df = 1,47$, $p < .01$). But there was also a significant interaction between the nature of the words (animal or color) and the speed with

Table 1
Mean Reading Time Per S Under the Various Conditions of Experiment 1

	Color- Words (Sec)	Animal- Words (Sec)
<i>Lists 3 and 4</i>		
Reading the colors	79.4	64.7
Reading the words	32.4	31.8
<i>Lists 1 and 2</i>		
When words were all in black	30.7	32.4

*This work was carried out as an undergraduate project by J.M. and S.D. under the supervision of the first author. Expenses were borne by National Research Council of Canada Operating Grant APB-126 awarded to D.J.M.

Table 2
Mean Sorting Time (in Seconds) Per S Under the Various Conditions of Experiment 2

	Steady Background Characteristic			Variable Background Characteristic			
	Words Side by Side	Words One Above the Other	Mean	Words Side by Side	Words One Above the Other	Mean	
Sort for Words	80.6	86.3	83.4	82.3	92.3	87.3	85.37
Sort for Colors	77.7	86.1	81.9	76.3	87.0	82.65	81.77

which their colors could be read out—it was harder to read out the ink colors of color words than the ink colors of animal words ($F = 170.9$, $df = 1,47$, $p < .01$). Otherwise, there was no significant difference between the rate of reading color words and the rate of reading animal words, either when all were printed in black (Lists 1 and 2) or when their colors were variegated (Lists 3 and 4). It must be concluded that when one is set to analyze verbally the colors of words, one is more distracted if those words are color words than if they are animal words. This result, of course, essentially confirms that of Stroop (1935) and others.

EXPERIMENT 2

General

The Ss were given a deck of cards, on each of which were printed two colored words (either one above the other or side by side). Their task was to sort the cards into two piles: cards on which the two words (or the two colors) were the same and cards on which the two words (or the two colors) were different. It was also the case that when word identity had to be sorted for, sometimes the cards had both words in the same color ("steady background characteristic") and sometimes the cards had both words in different colors ("variable background characteristic"). Similarly, when colors had to be sorted for, sometimes the words were the same and sometimes they were different. Thus a total of eight sortings were undertaken, these being all the combinations for a 2 by 2 by 2 design in which the variables were: sorting for identity of colors or of words; steady or variable background characteristics; items printed one above the other or side by side. The measure of efficiency of processing was the total time taken to sort a whole deck of 90 cards.

Materials

The color words chosen for this experiment were those of Experiment 1. A total of 720 4 x 6 in. cards were made, on each of which were two words either identical (such as GREEN GREEN) or different (such as GREEN BLACK). However, each of the two words were always of the same length (four, five, or six letters).

Within each of the "same" or "different" sets, half had the words printed side by side (2 cm apart) and half had the words one above the other (2 cm between them). Then, within each of these sets, half the cards had the words printed in the same color and half had the words printed in different colors. All these cards were then appropriately intermixed so that eight new decks of 90 each were compiled: in any single deck, to be sorted into "same" or "different" with respect to words or colors, half the items were the "same" and half the items were "different." The eight sorting conditions were, therefore: (1) sort the colors, the actual words are the same, and they are side by side; (2) sort the colors, the actual words are the same, and they are vertically arranged; (3) sort the colors, the actual words are, incidentally, different, and they are side by side; (4) sort the colors, the actual words are, incidentally, different, and they are vertically arranged; (5) sort the words, the actual colors are the same, and the words are side by side; (6) sort the words, the actual colors are the same, and the words are vertically arranged; (7) sort the words, the actual colors are, incidentally, different, and the words are side by side; (8) sort the words, the actual colors are, incidentally, different, and the words are vertically arranged.

Procedure

Each S was instructed to sort each deck for either "sameness" or "difference" of words or of colors. No mention was made of the other differences between decks, such as the variability of the to-be-ignored characteristic, or of the layout of the words. Total sorting time per deck was measured by a stopwatch, following the E's saying "Go." The order of the eight conditions done by each S was determined by an 8 by 8 Latin square.

Subjects

The Ss were 24 undergraduates from Queen's University, 12 males and 12 females. The Latin square was applied three times across these 24 individuals.

Results

Table 2 shows the mean sorting

time per S for the eight conditions of sorting. Analysis of variance of the data for the 24 Ss revealed that side-by-side items were, in general, more rapidly sorted than were items printed one above the other ($F = 24.95$, $df = 1,23$, $p < .01$). However, this variable did not interact significantly either with the nature of the task (sorting for word sameness vs color sameness) or with the "steadiness" of the irrelevant word or color characteristic.

In general, sorting for color sameness was faster than sorting for word sameness ($F = 12.97$, $df = 1,23$, $p < .01$), but there was also an interaction between this variable and the steadiness of the background characteristic ($F = 5.28$, $df = 1,23$, $p < .05$). For color sorting, it made little difference whether the words on the cards happened to be the same or different; but word sorting was faster when the colors of the two words happened to be the same than when the colors happened to be different. No other factors or interactions were significant in the analysis. We might conclude, then, that when simple "same" vs "different" judgments have to be made on pairs of colored words, it is easier to compare colors in this respect than it is to compare words. There was also a hint that Ss were involuntarily distracted by color differences, even when they were sorting for words, and the colors should therefore have been irrelevant.

DISCUSSION

The finding that, with a steady background characteristic, colors were sorted slightly faster than were words is in agreement with the findings of Treisman and Fearnley for color-to-color matches and word-to-word matches, respectively. When the background characteristic varied, however, colors were matched faster than were words, much as if S had difficulty ignoring the colors in which the word was printed, even though the latter attribute was irrelevant. In Experiment 1, where a naming task was involved, just the inverse was found: naming colors was slower when the word name had to be ignored. It must, in general, be concluded that matching or scanning for the similarity of colors is faster than is the same task for words, whereas the naming of colors is slower than the naming of words. At the same time, interference between perceptual and naming tasks can occur, suggesting that, although it is worth making a theoretical distinction between recognition and naming, the two tasks are not necessarily completely independent in operation. The present results are also consistent with those of Uleman and Reeves insofar as

matching and scanning may be held to be similar in respect to the minimal amount of naming processing required. That matching and naming represent independent tasks is also justified in the work of Posner, Boies, Eichelman, & Taylor (1969), who showed that matching in terms of letter shapes is faster than is matching in terms of letter names.

REFERENCES

- JENSEN, A. R., & ROHWER, W. D., JR. The Stroop color-word test: A review. *Acta Psychologica*, 1966, 25, 36-93.
- LUND, R. H. The role of practice in the speed of association. *Journal of Experimental Psychology*, 1927, 10, 424-433.
- POSNER, M. I., BOIES, S. J., EICHELMAN, W. H., & TAYLOR, R. L. Retention of visual and name codes of single letters. *Journal of Experimental Psychology Monograph*, 1969, 79, 1-16.
- STROOP, J. R. Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 1935, 18, 643-662.
- TREISMAN, A., & FEARNLEY, S. The Stroop test: Selective attention to colours and words. *Nature*, 1969, 222, 437-439.
- ULEMAN, J. S., & REEVES, J. A reversal of the Stroop interference effect, through scanning. *Perception & Psychophysics*, 1971, 9, 293-295.