The reality of cross-modal Stroop effects

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Cowan and Barron (1987) reported an experiment in which spoken color words interfered with the concurrent naming of visually presented colors. They also pointed out that this effect has important implications for theories of memory and attention. However, Miles, Madden, and Jones (1989) objected to this finding on the basis of several experiments of their own. Cowan (1989) laid these particular objections to rest by describing serious methodological shortcomings in the experiments conducted by Miles et al. Responding to these criticisms, Miles and Jones (1989) briefly described another experiment in which the method supposedly was very similar to that of Cowan and Barron (1987), but in which the cross-modal Stroop effect still was not replicated.

It is not clear why the studies have obtained different results. There might have been important differences between the subject samples of the two studies, unintended differences in method, or simply chance differences in examining a small effect. In any case, the present note is meant to reopen the issue by briefly describing another experiment in which cross-modal Stroop effects were examined more extensively and were obtained.

The method was somewhat different from that of Cowan and Barron (1987), because the experiment was the first step in an ongoing project (with A. Reeves and S. Jennings) to examine habituation and practice effects within cross-modal Stroop performance. The visual stimuli were index cards, each containing three rows of six colored dots. Each row of six dots included colors, arranged in a random order, that subjects had learned to label *lime*, *beige*, *crimson*, *turquoise*, *lavender*, and *sepia*.

Four audiotapes were constructed. One tape contained repetitions of the words *beige*, *turquoise*, and *lavender*, whereas a second tape contained repetitions of the words *lime*, *crimson*, and *sepia*. The other two tapes contained sets of color-neutral adjectives that were selected to match the color words as closely as possible in syllabic structure and word frequency (Carroll, Davies, & Richman, 1971). One such tape contained the words *dire*, *smothered*, and *changeable*, whereas the other tape contained the words *strict*, *lesser*, and *dastardly*. The words for each tape were randomly ordered within blocks of three, digitally recorded at the rate of 700 msec per word, and presented at 80 dB(A).

The subjects were 32 college students who received course credit. Each subject named the colors on a practice card until he/she could complete the card without error. Then the subject received a block of 10 consecutive trials with each audiotape, or 40 trials in all. The color and adjective tapes were used in an alternating order (i.e., the two color or the two adjective tapes never were used consecutively), and, across subjects, all 8 possible alternating orders of the four tapes were used.

On each trial, the subject was permitted to remove a blank cover sheet to reveal the visual stimulus card as soon as he/she heard the audiotape begin. Then the subject named the 18 colors on the card as quickly as possible. The time from the beginning of the subject's response to the completion of the last color on the card was recorded. Errors also were recorded. There was a 30-sec rest period between trials.

On the average, it took subjects 12.45 sec to name the 18 colors while listening to a color tape, but only 12.08 sec while listening to an adjective tape. This difference was significant [$F(1,31) = 5.50$, $MSe = 7.66$]. Moreover, the response speeds generally improved across the 10 trials in a block with a particular audiotape [$F(9,279) = 14.83$, $MSe = 2.79$]. For the 10 trials in a block, the mean speeds were 13.7, 12.5, 12.0, 12.5, 12.2, 12.0, 12.0, 11.9, 12.2, and 11.6 sec. However, the audiotape and trial effects did not interact; the cross-modal Stroop effect neither diminished nor increased significantly over trials. On the other hand, an examination of the data suggests that the cross-modal Stroop effect was much larger on the first few trials within the first trial block.

The error rate was 2.2% for color tapes and 1.8% for adjective tapes, but the difference was not significant. These error rates are somewhat higher than those obtained by Cowan and Barron (1987), probably because unusual color names were used.

In a second experiment that is only partly completed, the method is the same except that subjects listen and attend to one of the audiotapes in the period between trials. In the data collected thus far ($n=16$), the effect of this interim listening task seems small, and the cross-modal Stroop effect appears once more.

Miles and Jones (1989) also argued that it is untenable to account for a cross-modal Stroop effect with the same phonological buffer that Salamé and Baddeley (1982) used to account for the effects of irrelevant speech. This theoretical issue is unresolved, and one can find sufficient discussion of it in the articles cited above. More empirical work is needed before either the limiting conditions or the theoretical implications of the cross-modal Stroop effect will be clearly understood.

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