REFERENCES

- COHEN, B. H. Role of awareness in meaning established by classical conditioning. *Journal of Experimental Psychology*, 1964, 67, 373-378.
- DAS, J. P., & MITRA, A. K. Persistence of acquired meaning in semantic conditioning. *Psychonomic Science*, 1965, 3, 83-84.
- INSKO, C. A., & OAKES, W. F. Awareness and the "conditioning" of attitudes. *Journal of Personality & Social Psychology*, 1966, 4, 487-496.
- JENKINS, J. J., RUSSELL, W. A., & SUCI, G. J. An atlas of semantic profiles for 360 words. *American Journal of Psychology*, 1958, 71, 688-699.
- MILLER, A. W., JR. The dimensionality of awareness in verbal conditioning. *Journal of Psychology*, 1968, 70, 99-110.
- MILLER, A. W., JR., & BARSNESS, W. Extinction, stimulus generalization and partial reinforcement for higher-order meaning conditioning. *Psychological Reports*, in press.
- STAATS, A. W. *Learning, language and cognition*. New York: Holt, Rinehart & Winston, 1968.

SUBJECTS

A total of 53 Ss (29 male and 24 female) were tested. All were university students from various fields of study at levels ranging from freshmen to graduate students.

COLOR-WORD TEST

Three 9 x 12-in. cards were presented in the same sequence to all Ss, a word card (w), a color card (c), and a color-word card (cw).

The w card consisted of 80 color names (red, blue, green, yellow) printed in black, in 10 rows of 8. The words were randomly ordered with the restriction that no word could follow itself. The task for S was to read the names as rapidly as possible without pointing to the words and to correct all errors.

The c card consisted of 80 colored rectangular patches (.15 x .50 in.) of red, green, blue, or yellow ink. These were ordered randomly with the restriction that no color could follow itself in any row. The S was instructed to name the colors as rapidly as possible without pointing to the colors and to correct all errors.

The cw card consisted of the words red, blue, green, and yellow printed in colors different from that of the word; thus, the word "red" might appear in ink of either blue, green, or yellow. The order of the ink colors was identical to the order of the colors on the c card. The order of color names was the reverse order of the color names on the w card. The Ss were instructed to name the colors in which the words were printed as rapidly as possible without pointing to the word, squinting, or blurring the word. They were instructed to correct all errors.

PROCEDURE

Each S sat in a chair facing E seated 4 ft away. The S was asked to solve mental arithmetic problems such as $123/5 \times 4$, 18×5 , $136/6 \times 5$, 16×5 , etc. The E watched the right eye and recorded the initial lateral eye movement following the statement of the problem. If the first lateral movements for four consecutive questions went in the same direction S was classified as either a right or left mover. Generally, more than four questions had to be presented as some of the questions were not sufficiently complex to elicit an eye movement. If S shut his eyes or turned away from E, he was told to keep his eyes open and face E, though it was not necessary to stare at E while solving the problems.

After S had been classified as a right or left mover the color-word test was administered. Cards were presented and performance was timed in the following order: w card, c card, cw card.

RESULTS

Of the 53 Ss there were 49 who could be classified as either right or left movers. Of these, 28 were right movers and 21 were left movers. One was eliminated because of color

Lateral eye movement, reading speed, and visual attention

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An S, looking at the eyes of a questioner, will make a lateral eye movement, consistently right or left, as he begins to reflect on the answer to the question. To test the hypothesis that right movers do better at tasks requiring visual attention, the Stroop color-word interference test was administered to two groups, right and left movers. Right movers were subject to significantly less interference than left movers, thus confirming the hypothesis. Right movers were also found to read faster a list of color names printed in black on white. It is suggested that slower reading time on the color-word card is due in part to the covert response of reading the word, and that the better performance of right movers is due to their greater facility in the making of this covert reading response.

Day (1964) has described a lateral eye movement response which occurs when an individual shifts his attention from an external to an internal focus. If a person's visual attention is directed toward your face while you ask him a question requiring reflection, the eye movement occurs when you finish talking and he begins to think of an answer. It can be observed by watching one or both eyes as he shifts from external to internal attention in his search for an answer to the question. The movement is characteristic in direction for most individuals on repeated observations (Day, 1964; Duke,

1968). The lateral eye movement is most likely to occur in response to complex or reflective questions; simple factual questions are less likely to elicit the movement.

Day (1964, 1967a, b) has made a number of clinical observations and speculations about the phenomenon suggesting that the direction of lateral movement should have correlates in a variety of personality, cognitive, and physiological variables. On the basis of his observations Day suggests that "in general the right mover shows an externalized actively responsive distribution of attention emphasizing the visual-haptic modes," whereas "the left mover shows an internalized, subjective . . . distribution of attention in which he is more reactive to auditory and subjective visceral experience [Day, 1967a]."

This study was designed to test the hypothesis that Ss who make right lateral eye movements will perform better than those who make left lateral eye movements in a task requiring a high degree of visual attention. Right and left movers were compared for performance on the Stroop color-word test (Stroop, 1935, 1938). In this test, S is presented with color words (e.g., red, blue, yellow, green) printed in conflicting ink colors. Thus, the word "red" is printed in green ink and the correct response is saying the word "green." This test has been used as a measure of visual attentiveness or resistance to distraction (Agnew & Agnew, 1963; Bakan & Alperson, 1967; Klein, 1964; Lazarus, Baker, Broverman, & Moyer, 1957). The literature on the test has been reviewed by Jensen (1965) and Jensen & Rohwer (1966).

Table 1
Time Scores

Direction		Score (seconds)			
		Word (w)	Color (c)	Color-word (cw)	(cw-c)
Right	Mean	30.25	41.92	75.72	33.80
	SD	4.57	6.21	12.48	10.40
Left	Mean	34.52	43.00	84.83	41.83
	SD	6.22	5.83	19.87	15.10
Right-Left		2.72 (.01)	.61 (NS)	1.93 (.10)	2.22 (.025)

blindness and three because they could not be classified as right or left movers by the criterion used.

The mean reading time scores for each of the three cards, w, c, and cw, are shown in Table 1 for right and left movers. In addition, there is a derived score, the cw-c score, which is a measure of the extent to which the words interfere with the naming of colors. It represents the additional time required to say the colors presented as conflicting words rather than as color patches.

The w card yields a measure of the time to read a card of color names printed in black on a white ground. On this measure of reading speed right movers read faster than left movers and the difference is significant at the .01 level.

The c card yields a measure of the time it takes to call the colors of 80 color patches. On this measure there is a very small nonsignificant difference between right and left movers, a difference of about 1 sec favoring the right movers.

For both the right mover group and the left mover group the w card is read faster than the c card. This difference of about 10 sec in reading time is highly significant ($p = .001$). Every S but one read the w card faster than the c card. This result suggests that word reading is easier than color naming.

The cw card is clearly the most difficult since it reflects the interfering effect of the conflicting color words on color-naming. It takes almost twice as long to call the colors on the cw card as it does to call them on the c card. On the cw card the right movers do better than the left movers with the difference significant at the .10 level. This is suggestive of greater interference for the left movers.

A more sensitive measure of interference is the cw-c score, since this partials out color-saying time and gives a purer measure of interference produced by the words. The performance of right movers on the cw-c score is significantly better than that of left movers. This difference is significant at the .025 level and confirms the hypothesis that right movers do better on a visual attention task.

DISCUSSION

The results of this experiment support the

hypothesis that right movers do better in a task requiring visual attention. This has been shown in the Stroop color-word test where S has to attend to ink colors rather than to the names of colors (e.g., the word "red" is printed in yellow ink and the correct response is "yellow").

Before discussing this finding it is necessary to consider the result with the w card. Performance on the w card was significantly better for right movers than for left movers. The w card is not influenced by color-word interference, but seems to be simply a measure of reading speed. The result suggests that reading speed is a correlate of the direction of the lateral eye movement response described by Day. This relationship will require further exploration. It may mean that the right mover finds it easier and more natural to make the left-to-right movements required in reading English and that the relationship would be reversed for readers of languages that go from right to left as in Hebrew or Yiddish, or in mirror reading. The observed relationship between reading speed and lateral eye movement also suggests the possibility that reading difficulties may be related to direction of lateral eye movements. Reading ability may be at least in part a manifestation of the superiority of visual attentiveness which Day attributes to right movers. In this connection it should be pointed out that in the perceptual color-naming task of the color c card where there are no words but only color patches there is no difference in speed between the right and left movers. The difference found in reading words is not found in naming colors.

Turning now to the difference between right and left movers on the cw card and on the cw-c score, it is possible to account for this difference in terms of the difference between the groups in reading speed. The stimuli in the cw card may elicit a tendency to make two incompatible motor-linguistic responses, reading a word and identifying a color. There is evidence that the reading response is the easier and dominant response (Stroop, 1938; Klein, 1964). This was also true for the present study, where all but one S completed the w card in less time than the c card. It is likely that an important cause of the slowdown in responding to the cw card is

the covert reading of the word which may take place before the overt response of saying the color. This suggests a two-stage process, a covert reading of the word followed by an overt report of the color. If this is the case then one would expect that Ss who read the color words faster would get through the first stage in less time and would then call the color. This analysis is supported by the data of Klein (1964) who found that interference was reduced when S was instructed to say the word first and then say the color. Ss found this easier than the standard condition, and despite the fact that two overt responses were made instead of one it took no longer. It seems that Ss will make both responses, word and color, whether E instructs them to or not. The difference is that in the standard condition for the cw card the word response is covert rather than overt. This argument also is supported by the fact that the reading time for the cw standard condition is about the same as the time for the c card plus the time for the w card (see Table 1). From the evidence available we conclude that the better performance of the right movers is due to their ability to read the interfering words faster before naming the color.

REFERENCES

- AGNEW, N., & AGNEW, M. Drive level effects on tasks of narrow and broad attention. *Quarterly Journal of Experimental Psychology*, 1963, 15, 58-62.
- BAKAN, P., & ALPERSON, B. Pronounceability, attentivity, and interference in the color-word test. *American Journal of Psychology*, 1967, 80, 416-420.
- DAY, M. E. An eye-movement phenomenon relating to attention, thought and anxiety. *Perceptual & Motor Skills*, 1964, 19, 443-446.
- DAY, M. E. An eye-movement indicator of type and level of anxiety: Some clinical observations. *Journal of Clinical Psychology*, 1967a, 23, 438-441.
- DAY, M. E. An eye-movement indicator of individual differences in the physiological organization of attentional processes and anxiety. *The Journal of Psychology*, 1967b, 66, 51-62.
- DUKE, J. D. Lateral eye movement behavior. *Journal of General Psychology*, 1968, 78, 189-195.
- JENSEN, A. R. Scoring the Stroop test. *Acta Psychologica*, 1965, 24, 398-408.
- JENSEN, A. R., & ROHWER, W. D. The Stroop color-word test: A review. *Acta Psychologica*, 1966, 25, 36-93.
- KLEIN, G. S. Semantic power measured through interference of words with color-naming. *American Journal of Psychology*, 1964, 77, 576-588.
- LAZARUS, R. S., BAKER, R. W., BROVERMAN, D. M., & MOYER, J. Personality and psychological stress. *Journal of Personality*, 1957, 25, 559-577.
- STROOP, J. R. Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 1935, 18, 643-662.
- STROOP, J. R. Factors affecting speed in serial verbal reactions. *Psychological Monographs: General & Applied*, 1938, 50, No. 5, 38-48.