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THE EFFECT OF WORD ASSOCIATIONS ON THE RECOGNITION OF FLASHED WORDS.

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DESCRIPTORS- *READING RESEARCH, *TACHISTOSCOPES, *COLLEGE STUDENTS, *PAIRED ASSOCIATE LEARNING, WORD RECOGNITION, WORD FREQUENCY, READING SPEED,

THE HYPOTHESIS THAT WHEN ASSOCIATED PAIRS OF WORDS ARE PRESENTED, SPEED OF RECOGNITION WILL BE FASTER THAN WHEN NONASSOCIATED WORD PAIRS ARE PRESENTED OR WHEN A TARGET WORD IS PRESENTED BY ITSELF WAS TESTED. TWENTY UNIVERSITY STUDENTS, INITIALLY SCREENED FOR VISION, WERE ASSIGNED RANDOMLY TO ROWS OF A 5 X 5 REPEATED-MEASURES LATIN SQUARE DESIGN. THE EXPERIMENTAL CONDITIONS WERE FACILITATION, INTERFERENCE, NEUTRAL, CONTROL 1, AND CONTROL 2. THE SUBJECTS RECOGNIZED WORDS UNDER THE FIVE TREATMENT CONDITIONS IN A COUNTER-BALANCED DESIGN. THE SUBJECTS' SPEED OF RECOGNITION WAS THE AVERAGE OF THE FIRST AND SECOND CORRECT REPORT. ANALYSIS OF VARIANCE WAS USED TO ANALYZE THE DATA. THERE WAS NO SIGNIFICANT DIFFERENCE AMONG THE GROUPS IN SPEED OF WORD RECOGNITION. NO TARGET WORDS WERE READ FASTER. THE TREATMENT EFFECT OF WORD ASSOCIATION ON THE SPEED OF RECOGNITION WAS HIGHLY SIGNIFICANT. A DISCUSSION OF FACTORS WHICH INFLUENCE SPEED OF READING WHEN READING MEANINGFUL CONNECTED PROSE IS PRESENTED. REFERENCES AND TABLES ARE INCLUDED. THIS PAPER WAS PRESENTED AT THE AMERICAN EDUCATIONAL RESEARCH ASSOCIATION CONFERENCE (CHICAGO, FEBRUARY 6-10, 1968). (BK)

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Abstract

When two words are presented in succession, what effect does reading the first word have on speed of recognition of the second word? It was hypothesized that when associated pairs of words were presented, speed of recognition would be faster than when non-associated word pairs were presented or when a target word was presented by itself. Twenty college subjects recognized words under five treatment conditions in a counter-balanced design. The results supported the hypotheses, and under certain conditions recognition was at "sub-threshold" speeds. A discussion of factors which influence speed of reading when reading meaningful connected prose is presented.

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When two words are presented in succession, what effect does reading the first word have on speed of recognition of the second word? This study investigated word recognition speed when words were tachistoscopically presented which either did or did not correspond to anticipated word associations.

Word associations have been shown to affect several aspects of reading performance. Samuels (1965) demonstrated that learning to read new words was facilitated when the sequence of words in the printed text matched the child's word associations. While this study examined the effect of word associations, a second study was done to determine the effect of associative strength between words in printed text on reading acquisition (Samuels and Wittrock, in preparation). The data indicated that reading acquisition was facilitated as much by word-pairs having low strength associative connections as by word-pairs having high strength associative connections. Furthermore, reading acquisition was facilitated with all treatments having some degree of associative strength between word-pairs compared to the control treatment which had none. Other aspects of reading strongly influenced by word associations are reading speed and recall (Samuels, in press). Elementary school and college subjects read a paragraph containing words with high-associative relationships significantly faster and with better recall than a group getting a similar paragraph containing words with low-associative

relationships. Although this study found that associative relationships between words affects reading speed, precisely how word associations affect speed of word recognition was not demonstrated in this study. By varying orders of approximation to English rather than the associative relationship between words, Morton (1964) demonstrated that time-wasting regressive eye movements increased in frequency when the subject read passages which increasingly departed from correct English syntax.

While the foregoing studies were concerned mainly with the effects of word associations on measures such as reading acquisition, reading speed, and recall, a different focus of psychological inquiry has been the effect of word associations on recognition of flashed words. O'Neil (1953), and Rouse and Vernis (1963) demonstrated that when associated words such as Table-Chair are tachistoscopically exposed in succession, recognizing the first word aids in recognizing the second word. In a similar study, Tulving and Gold (1963) reported that as the amount of information in a sentence containing a missing word increased, the time required to recognize the missing word decreased.

As mentioned earlier, word associations affect reading speed, but precisely how they do has not been determined. It seems probable that when the associative connections between words in printed text is high (e.g., white-snow), reading the first word elicits from the reader the associate of that word. If the associate elicited from the reader matches the second word in the text, speed of word recognition should be facilitated. Moreover, when highly associated words appear sequentially in the text, after reading the first word the reader may correctly report the next word in the text without having to visually disciminate

that word. Conversely, if the sequence of words in the text does not conform to the word associations of the reader, then reading the first word may elicit an associate which does not match the next word in the text. When this occurs additional fixation time is required before the reader is able to correctly report the word printed in the text. To test these hypotheses regarding the effect of different kinds of word associations on speed of word recognition, subjects in this experiment were required to recognize tachistoscopically flashed words under the following five conditions: facilitating, neutral, interfering, and two control conditions. To further determine if in fact subjects could report "seeing" flashed words at speeds significantly below threshold, a separate control study was utilized to determine the threshold for speed of word recognition for the target words used in this study.

Control Study - Method

Subjects. Twenty juniors enrolled in introductory educational psychology were used. All subjects were given a screening examination with the tachistoscope to ensure they could see the flashed words. They were randomly assigned to rows of a 5x5 repeated-measures Latin square design.

Materials. A Scientific Prototype Three-Channel Tachistoscope was used. To prevent the possibility of after-image effects from the flashed presentation of the target words confounding the results regarding speed of recognition, an erasing image was flashed immediately following the presentation of the target words.

The word-pairs and single words used in the study met the following restrictions: (1) word-pairs formed adjective-noun grammatical units (the noun was the target word which was flashed to measure speed of recognition for all treatments), (2) each of the five treatments had

two target words, (3) all tachistoscopically presented words were typed in upper-case to reduce the possibility of using word-shape as a cue for word recognition, (4) the two target words used with each treatment started with the same letter to prevent use of first letter cues in word recognition, (5) word length for target words used in a treatment were as similar as possible, (6) in the neutral treatment, to prevent the possibility that subjects might have idiosyncratic associations between the first word of the pairs used with this treatment and any of the target words used in the study, a pool of four neutral stimulus words were selected for the treatment rather than two; these stimulus words had no known associative connections with any of the target words (each subject was tachistoscopically shown only two neutral stimulus words from the pool of four, the particular two were chosen randomly). The ten word-pairs were: BLUE-SKY (.25), SALTY-SEA (.08), DARK-NIGHT (.18), LOUD-NOISE (.23), BEAUTIFUL-GIRL (.16), GREEN-GRASS (.41), RED-COLOR (.07), SWEET-CANDY (.16), HEAVY-WEIGHT (.06), COLD-WINTER (.08). The decimal number next to each word-pair shows its associative strength for college subjects in the Palermo-Jenkins (1964) word-association norms. The four stimulus words used in the neutral treatment were: LONG, SOUR, THIRSTY, SMOOTH.

Design. To determine the effect of different kinds of word-associations on speed of word-recognition a 5x5 repeated-measures Latin square design was used. Each subject took all five treatments in succession but order of treatment presentation was randomized for each subject. In addition, the word-pairs used with the treatments were counterbalanced for each row of the design. See Table One for a paradigm of the design.

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Table One here
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Facilitation Treatment. This treatment provided data on speed of recognition for the target word when after reading the first word of a pair the subject anticipated the next word and the same word was flashed.

Interference and Neutral Treatments. These treatments provided data on speed of recognition when after reading the first word of a pair the subject anticipated the following word but a different word was flashed.

Control-1 Treatment. The subject was not familiarized beforehand with the word-associates which were tachistoscopically presented. Data from this treatment allowed comparisons to be made of word recognition speed between treatments in which word-associates were tachistoscopically presented but for which the subject had and had not been familiarized.

Control-2 Treatment. Data from this treatment provided information on recognition thresholds for just the target words. These words had been introduced during familiarization training.

Procedure. Because speed of tachistoscopic recognition is influenced by factors such as length of practice, knowing where to focus, and set, each subject read through a tachistoscopically presented practice list twice. The practice list was exposed at speeds of 100 and 50 milleseconds (ms.). The practice list was analogous to the test list in length, number of single words, and number of associated and non-associated word-pairs.

Following tachistoscopic practice, the subject was given familiarization training with the single words and word-associates as shown in Table One. Since there is no way of knowing a priori if the word-associates as shown in the Palermo-Jenkins (1964) word-association norms

are part of a particular subject's associative structure, each subject was familiarized with the word-associates and individual words appropriate for the row of the design to which he was assigned. Familiarization consisted of reading through a thirty card list three times. The thirty card list contained ten different cards repeated in three random orders. Each of the ten cards contained one of the words or word-associates as shown in the paradigm of the design under familiarization training. Thus, six of the cards had adjective-noun pairs and the other four cards had only nouns.

Following familiarization, the subject looked again into the tachistoscope. The test list was then presented. The first word of a pair was shown for 1-sec; the subject read it aloud, and this was followed immediately by the exposure of the target word. The subject then reported the target word, if he could. No feedback was given. Following this, the next word-pair or individual word was shown. The entire test list was shown starting at 20-ms. exposures of the target word and increasing in duration of exposure by 10-ms. The entire list continued to be shown until the subject correctly reported each target word two times. When just the target word was flashed, as in the Control-2 Treatment, first a dot appeared and then the target word was flashed. The average of the first and second correct report of the word was used as the subject's speed of recognition.

Results

The analysis of variance for the 5:5 repeated-measures Latin square design indicated that: (1) there was no significant difference among the five groups (rows in the design) of randomly assigned subjects in

speed of word recognition ($F = < 1$, 4/15 df), (2) none of the target words (nouns) were read faster than the others ($F = < 1$, 4/60 df), (3) the interaction effect was not significant ($F = < 1$, 12/60), but (4) the treatment effect of word-associations on speed of recognition was highly significant ($F = 19.82$, 4/60 df, $p < .001$).

The means and standard deviations for each of the five treatments are shown in Table Two.

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Table Two here
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To determine for which treatments mean speeds of recognition were significantly different from each other, Newman-Keuls Tests were run. The results are shown in Table Three.

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Table Three here
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Method

Subjects. Twenty juniors enrolled in introductory educational psychology were used. All were screened to ensure they could read the flashed words.

Materials. The tachistoscope with erasing image described earlier was used. The ten target words used in the main study were presented.

Procedure. The subject was first given practice recognizing flashed words using a practice list consisting of nouns which were similar to those used in the test list. The practice list was presented at speeds of 100-ms. and 50-ms. After practice, the ten target words from the test list were presented starting at exposure durations of 20-ms. Exposure duration was increased by 10-ms. each time the list was repeated. With each repetition of the list the target words were shown in a different sequence. No feedback was given, and the entire list was repeated

until the subject reported each word correctly twice.

Results

As seen in Table Two, the mean recognition speed for the Control Study was 61.37-ms., which represents the longest exposure required for recognition. Recognition speed for the Control-2 Treatment, in which familiarized target words were shown, was significantly faster than was recognition speed for the Control Study ($t = 4.02$, $df = 38$, $p < .01$).

Discussion

The purpose of this study was to determine the effect of associative connections between words on speed of word recognition. It was hypothesized that when the word-associations of the reader matched the associative connections between visually presented word-pairs, speed of recognition would be facilitated. Conversely, when the word-associations of the reader did not match the associative connections between visually presented word pairs, speed of recognition would be retarded. The third question under investigation was, could subjects recognize words at sub-threshold speeds, and if so, under what conditions.

As predicted, word-recognition speed was facilitated when associative connections between words in the text matched the word-associations of the reader. Furthermore, no significant difference in recognition speed was found between the Facilitation and the Control-1 Treatment. In the Facilitation Treatment the subject was familiarized with the word-associates before they were visually presented whereas in the Control-1 Treatment the subject was not familiarized with the word-associates beforehand. Thus, when comparing the two treatments in which

associated word-pairs were visually presented with the three treatments in which associated word-pairs were not presented, it was found that speed of recognition was significantly faster for the two treatments in which target words were preceded by their associates.

Another hypothesis supported by the data was that recognition speed would be significantly retarded if the target word was preceded by a non-associate. Speed of recognition for the Neutral and Interference Treatments, in which non-associated word-pairs were presented, was significantly slower than it was for the Control-2 Treatment, in which just target words were shown. Neither the Neutral nor the Interference Treatments were significantly different from each other in recognition speed.

Finally, it was found that recognition speed in the Facilitation and Control-1 Treatments was at sub-threshold, using the Control-2 Treatment as a baseline, whereas Control-2 was at sub-threshold using the Control Study as a baseline. In the latter study, subjects had no prior knowledge of what words were to be presented. Since the same subjects were used for all treatments in the Main Study, and since they recognized words at sub-threshold speeds in some treatments but not in others, sub-threshold recognition can be assumed to be influenced by word-associations and knowledge of the domain from which target words were drawn.

The results of this study suggest how speed of word recognition is facilitated or retarded. If a target word is presented without prior knowledge of what the word might be, more cues are required for recognition than if the subject has prior knowledge or can anticipate the word. While the reports of Cattell (1885) stated that short, familiar

words were responded to as a whole, the same studies demonstrated that as words become less familiar, recognition required letter-by-letter discrimination. In this study, when associated word-pairs were presented, reading the first word provided information about the following word. If the subject perceived a single letter of group of letters when the target word was flashed, and if these cues matched the word he anticipated, there was a high probability that his anticipation was correct. Thus, in the Facilitation Treatment, the subject was able to recognize the target word at sub-threshold speeds when he perceived only partial cues. An interesting question arises as to why recognition speed for non-familiarized word-associates (Control-1 Treatment) was about as fast as it was for familiarized word-associates (Facilitation Treatment). Rouse and Vernis (1962) suggested that low strength word-associates are recognized as fast as high strength word-associates because of three processes: set (i.e., the strategy of guessing associates), the activation of a hierarchy of associations to the first word of the pair, and verification of guesses by partial perceptions.

The same three processes which explain sub-threshold recognition when associated word-pairs were presented can explain slower speed of recognition when non-associated pairs were presented. In the Interference Treatment, when word-pairs were tachistoscopically presented, recognizing the first word activated a hierarchy of word-associates. For example, if SALTY-SKY had been flashed, after reading "SALTY" the subject would probably have anticipated "SEA". A partial perception of the target word might have been only to letter "S". Since the perception of a single letter matched part of the word which the subject anticipated, he probably would have reported the wrong word, if he were willing to base

his report on partial perceptions. The subject would then have continued to give the wrong word until he perceived enough letters to realize that he was incorrect. Thus, the set to respond associatively and partial perception may interfere with accurate recognition. The willingness to report a word based on partial information is negatively correlated with age, and is part of an individual's reflective-impulsive style (Kagan, 1965).

In the Neutral Treatment, if a partial perception from the target word matched one of the word-associates activated by reading the first word of a pair, then the interaction of set and partial perception might have led the subject to report the wrong word. If a partial perception did not match one of the word-associates which were activated, then recognition had to await the perception of enough cues to provide a basis for accurate responding.

The same processes which influenced speed of word recognition in this study can explain how reading speed is influenced in reading meaningful connected prose. Various cues, for example, from context as well as from syntagmatic word-associations, help the reader anticipate what the following words will be. If the reader's partial perceptions match the words he anticipates, he can read rapidly, never having to discriminate all the letters. The utilization of partial cues can continue until the anticipations and partial perceptions no longer support each other or until the reader realizes that what he is reading is no longer meaningful. To the extent that the syntax and word associations in a passage are familiar will the reader be able to read rapidly. When syntax and word sequence in the text are unfamiliar, reading time will be slower because more of the letters would have to be discriminated

in order to recognize the word. Eye movement photography has shown that reading time can be separated into fixations, inter-fixations, and regressions. Fixations can be further separated into stabilization time, seeing time, and central-processing time. It would appear that when words in the text match the words which the reader anticipates, seeing time, time wasting regressions, and also, possibly, central-processing time would be reduced.

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Table One

Paradigm of Experimental Design

Experimental condition	Words used in familiarization training	Words presented with tachistoscope for test of recognition speed
Facilitation (F)	LOUD-NOISE DARK-NIGHT	LOUD-NOISE DARK-NIGHT
Interference (I)	BLUE-SKY SALTY-SEA	BLUE-SEA SALTY-SKY
Neutral (N)	BEAUTIFUL-GIRL GREEN-GRASS	SOUR-GIRL SMOOTH-GRASS
Control$_1$ (C_1)	_____COLOR _____CANDY	RED-COLOR SWEET-CANDY
Control$_2$ (C_2)	_____WINTER _____WEIGHT	WINTER WEIGHT

Table Two

Mean Recognition Speed in Milleseconds and Standard Deviations for Target Words for Main Study and Control Study

Treatment	Mean Recognition Speed	Standard Deviation
Facilitation	35.00	5.57
Control-1	40.00	11.00
Control-2	47.55	13.04
Interference	56.65	14.76
Neutral	60.35	13.27
Control Study	61.37	7.42

Table Three

Newman-Keuls Tests Indicating for Which Treatments Mean Recognition Speeds were Significantly Different from Each Other

	F	C_1	C_2	I	N
F		NS	**	**	**
C_1			NS	**	**
C_2				*	**
I					NS

** P < .01
* P < .05