Sequential blanking effects for two interleaved words*

JOSEPH NEWMARK
Staten Island Community College, Staten Island, N.Y. 10301

and

MARK S. MAYZNER
New York University, Bronx, N.Y. 10453

The present study, employing a computer-based CRT display system, extended and verified earlier findings concerned with display parameters that attenuate "sequential blanking" effects. It also revealed two additional parameters, namely word length and word orientation, which markedly affect the probability of word detection in such a sequential blanking paradigm.

For the past several years, we have been examining problems of visual information processing employing a computer-based cathode ray tube (CRT) display system [see Mayzner & Tresselt (1970) for an extensive review of this work]. In the course of this research program, a phenomenon we have called "sequential blanking" was discovered, in which it was found that if the letters of a word are presented sequentially at certain input display rates and with certain irregular input display orders, then certain letters will not be perceived (Mayzner, Tresselt, & Helfer, 1967a, b). More recently (Mayzner & Tresselt, 1970, p. 611), we discovered that if two 5-letter words are employed instead of just a single 10-letter word, and if the two 5-letter words are interleaved (e.g., "table" and "chair" are displayed letter by letter sequentially as "tcahbalier"), then in contrast to the sequential blanking effects found with a single 10-letter word, a marked attenuation of the blanking effect is found with the two interleaved words. The present study examines this effect in greater detail by varying word length, display on and off times, and whether the interleaved words are displayed horizontally, vertically, or obliquely.

METHOD

Subjects

Ten Ss were used in these experiments (five male and five female).

Apparatus

Display of the stimuli for these experiments was accomplished by using a PDP-8/E digital computer and a VR-14 display. A special program written for these experiments allowed the E to display alphanumeric characters at any desired rate, at any specific location, and at any display size required. Letters were formed by a series of dots of light displayed in appropriate and adjacent positions in a 5 by 7 dot matrix. For these experiments, Size 8 was used, i.e., eight dots of light per character (across). Luminance, as well as size, was the same for all displays and was approximately 1 mL. The individual letters were about 1/2 in. high and 3/8 in. wide.

*This research was supported by Grant No. GB-22785 from the National Science Foundation to the second author.

Materials

As this experiment was designed to determine the nature of the subroutines used by the visual system in processing inputs, and to determine if any hierarchical ordering of the subroutines existed, it was decided to present each S with two interleaved words and to see whether or not the second word could successfully blank the first word. Thus, for two seven-letter words, such as DESTROY and HIMSELF, the S would be shown the display DHEISMTSREOLYF. The display order was 1, 8, 2, 9, 3, 10, 4, 11, 5, 12, 6, 13, 7, 14. This means that the letter D appeared first, the E second, the S third, etc. For two typical three-letter words, such as ACT and WHO, Ss saw A W C H T O, where the display order was 1, 4, 2, 5, 3, 6. Similar displays were used for all the different word lengths.

All the words used were meaningful, simple, and familiar. The source of the words was the "AA" classification of the Thorndike-Lorge word list.

Procedure

The experimental design involved three crossed factors, configuration length, display time, and display position.

The most fundamental of these was word length, ranging from two simple 3-letter words to the more complicated two 7-letter interleaved words, i.e., configuration length appeared at five levels: 6 letters (two 3-letter words), 8 letters (two 4-letter words), 10 letters (two 5-letter words), 12 letters (two 6-letter words), and 14 letters (two 7-letter words).

However, for the sake of randomization, the display sequence was not 3-letter, 4-letter, 5-letter, 6-letter, and 7-letter words. It was, instead, decided to randomize configuration length also. Thus, Ss were first shown 6-letter words. Then they saw 3-letter, 4-letter, 7-letter, and 5-letter words.

Another factor which was varied was that of display time. Depending upon word length, the letters of the blanking and blanked words were either displayed for equal on-times, or the on-time allowed for the characters of one word was always about twice what was allowed for the on-time of the other display. No matter what the on-time for each character of the blanked and blanking words used was, the off-time was the same for both. As

Table 1
Experimental Design for On-Off Time Values

	Display Time (in msec)			
	Per Letter of Blanked Word		Per Letter of Blanking Word	
	On	Off	On	Off
	23	16	11	16
6 Letters	16	16	16	16
	11	16	23	16
	8	14	15	14
8 Letters	12	12	12	12
	15	14	8	14
	15	10	5	10
10 Letters	10	10	10	10
	5	10	15	10
	12	8	6	8
12 Letters	8	8	8	8
	6	8	12	8
	10	7	5	7
14 Letters	7	7	7	7
	5	7	10	7

Table 2
Percent Correct Responses Under the Various Conditions for First Word – Second Word = Difference

		a_1 Three-Letter Word	a_2 Four-Letter Word	a_3 Five-Letter Word	a_4 Six-Letter Word	a_5 Seven-Letter Word
	b_1	80 – 37 = 43	50 – 52 = 7	69 – 40 = 29	67 – 21 = 46	63 – 33 = 30
c_1	b_2	73 – 46 = 27	73 – 37 = 36	59 – 38 = 21	51 – 15 = 36	44 – 17 = 27
	b_3	75 – 45 = 30	62 – 44 = 18	62 – 38 = 24	69 – 25 = 34	43 – 14 = 29
	b_1	50 – 33 = 17	33 – 9 = 24	26 – 4 = 22	22 – 6 = 16	9 – 4 = 5
c_2	b_2	43 – 26 = 17	40 – 6 = 34	24 – 5 = 19	19 – 1 = 18	15 – 6 = 9
	b_3	53 – 37 = 16	38 – 12 = 26	21 – 6 = 15	14 – 6 = 8	9 – 2 = 7
	b_1	61 – 20 = 41	40 – 10 = 30	36 – 7 = 29	47 – 10 = 37	20 – 6 = 14
c_3	b_2	61 – 37 = 24	50 – 14 = 36	30 – 8 = 22	23 – 0 = 23	19 – 4 = 15
	b_3	31 – 26 = 5	52 – 13 = 39	31 – 10 = 21	9 – 4 = 5	21 – 7 = 14

b_1 = on-off times *c_1 = horizontal display* *c_2 = vertical display* *c_3 = diagonal display*

it had already been shown that sequential blanking effects are maximized at about 200 msec of total display time (Mayzner & Tresselt, 1970), it was decided that no matter what work length was used, the total display time would be approximately 200 msec. Thus, depending upon word length, the scheme indicated in Table 1 was used.

Another factor manipulated was that of position. The characters were displayed in three different ways, horizontally, vertically, and diagonally.

In each case, the Ss were told when the display would be horizontal, vertical, or diagonal. They were also informed of the length of the words to be shown in advance, e.g., two 5-letter words, etc. Fixation was accomplished by enclosing the display area within a rectangular cardboard frame designed specifically for the varying word lengths and positions.

Each condition was repeated 10 times, but in a random order. There were 15 tapes in all, corresponding to the five different word lengths and the three different display positions. Each of the 15 tapes had 30 displays arranged randomly. Thus, for example, Tape 1 consisted of two 6-letter words interleaved and presented horizontally at the three different on-times, as listed in Table 1. A word used once was not repeated.

Ss were shown all the horizontal displays first. This was followed by the vertical and the diagonal displays. Thus, each S saw a total of 15 x 30, or 450, different displays.

RESULTS AND DISCUSSION

For this particular experiment, words were scored as "correct" only if they were properly recorded. This refers only to its accuracy, not to its order, i.e., which word came first. The results of the 10 Ss, i.e., the total number of correct answers, were pooled together to obtain the total number of correct answers for each of the 45 experimental conditions.

In order to extract meaningful conclusions from the data and to facilitate the analysis of variance, it was decided to divide the data into three categories: first word, second word, and difference (second word minus first word). Since the experimental research was conducted to determine if the second word displayed could blank the first word even when the words were interleaved, this "difference" analysis is extremely important. Thus, Table 2 gives the percent of correct detections for the second word minus the first word and the difference.

Since word length appeared at five levels, configuration position at three levels, and display time at three levels, the analysis of variance involved a 5 by 3 by 3 ANOVA design (Winer, 1962). As percent correct "scores" was employed as the dependent response measure, an inverse sine transformation was applied to the raw scores as recommended by Edwards (1968, p. 109).

The results shown in Table 2 clearly demonstrate that, for all values of the parameters examined, sequential blanking effects are attenuated by interleaving two words rather than employing a single word, as all past work with single words or letter arrays (Mayzner & Tresselt, 1970; Mayzner, Tresselt, & Helfer, 1967a, b) have shown massive blanking effects. In contrast, in Table 2, all 45 difference scores are positive and almost all conditions yield appreciable positive percent correct detections for the first word displayed, whereas such scores would have been essentially zero if large blanking effects had occurred. As to the other major parameters of the study, namely, word length, on-off time, and orientation, only word length and orientation yielded signficant F values with the ANOVA for the first- and second-word percent correct scores both highly significant as main effects (i.e., first word, $F = 8.7, 19.4$; $df = 4/449, 2/449$; $p < .001$, $p < .001$, respectively; second word, $F = 9.3, 30.3$, $df = 4/449, 2/449$; $p < .001$, $p < .001$, respectively). All interactions, as well as the main effect of on-off times, were insignificant.

In brief, this study has again shown, over a much wider range of parameter variation than studied previously (Mayzner & Tresselt, 1970), that sequential blanking effects can be greatly attenuated by word meaning. Further, two ancillary findings deserving more study seem indicated. First, increasing the length of the two interleaved words very significantly reduces the probability of their detection, and second, changing the display orientation from horizontal to vertical or oblique also reduces their probability of detection. Both of these new findings are currently under investigation.

REFERENCES

Edwards, A. L. *Experimental design in psychological research.*

(3rd ed.) New York: Holt, Rinehart & Winston, 1968.
Mayzner, M. S., & Tresselt, M. E. Visual information processing with sequential inputs: A general model for sequential blanking, displacement, and overprinting phenomena. Annals of the New York Academy of Sciences, 1970, 169, 599-618.
Mayzner, M. S., Tresselt, M. E., & Helfer, M. S. A research strategy for studying certain effects of very fast sequential input rates on the visual system. Psychonomic Monograph Supplements, 1967a, 2(5, Whole No. 21), 73-81.
Mayzner, M. S., Tresselt, M. E., & Helfer, M. S. A provisional model of visual information processing with sequential inputs. Psychonomic Monograph Supplements, 1967b, 2(7, Whole No. 23), 91-108.
Winer, B. J. *Statistical principles in experimental design.* New York: McGraw-Hill, 1962.

(Received for publication May 9, 1973.)

Olfactory thresholds and level of anxiety*

CAROLYN K. ROVEE, SANDRA L. HARRIS
and
RITA YOPP
Douglass College, Rutgers–The State University
New Brunswick, N.J. 08903

Absolute and difference thresholds of n-octanol were determined for 30 college students scoring at extremes of the Taylor Manifest Anxiety Scale. High-anxious Ss produced significantly higher absolute thresholds and more reversals than low-anxious Ss. In the difference threshold task, high-anxious Ss responded within a narrower area of uncertainty, but points of subjective equality did not differentiate the groups. Also, the number of low-anxious reversals increased in the second task to a level similar to that of high-anxious Ss. Absolute and difference thresholds were not correlated, and response latencies were comparable across groups and tasks. Results were discussed in terms of predictions derived from Hull's multiplicative drive theory (Brown, 1961).

*This research was supported by Grant 07-2268 from the Rutgers University Research Council to the senior author. We thank Linda Ciricillo and Albert Goss for assistance in data collection and analysis, respectively. Reprint requests should be sent to the senior author, Department of Psychology, Douglass College, Rutgers University, New Brunswick, N.J. 08903.

The role of motivational variables in perceptual behavior has generally been neglected both in theory and research. Although Brown (1961) attempted to extend Hull's postulates to predict psychophysical relations for simple stimulus events, his data did not permit clear statements as to whether observed differences were due to changes in performance or in associative factors.