The disinhibited effect in sequential blanking*

M. S. MAYZNER

New York University, New York, N.Y. 10453

About 15 years ago, Hartline & Ratliff proposed a disinhibition effect in *Limulus* and a number of recent studies have attempted to demonstrate such effects in the human visual system. The present study provides an analogue to the Hartline and Ratliff paradigm, for the human visual system, and the results obtained suggest that such disinhibition phenomena may be operative in man's visual system.

In Ratliff's (1965, p. 113) elegant summary of neural networks in the retina, he comments that, "When additional receptors are illuminated in the vicinity of several interacting elements—too far from one receptor to affect it directly, but near enough to the others to inhibit them—the frequency of discharge of the one increases as it is partially released from the inhibition exerted on it by the others [Hartline & Ratliff, 1954, 1957]." This disinhibition-type effect found in *Limulus* has recently come under study in the human visual system (Dember & Purcell, 1967; Mayzner, Tresselt, & Helfer, 1967b; Robinson, 1966, 1968; Schiller & Greenfield, 1969; Tresselt, Mayzner, Schoenberg, & Waxman, in press; Uttal¹). However, in all of these studies involving the human visual system, the experimental paradigms employed were not exact analogues of the Hartline & Ratliff (1954, 1957) paradigm in at least two important respects. First, with the human visual system studies, the inputs (i.e., the target, Mask 1, and Mask 2) were displayed successively, not simultaneously, and secondly, either the target, Mask 1, and Mask 2 occurred in essentially the same spatial location, (i.e., Robinson, 1966, 1968; Uttal¹) or the target and Mask 1 occurred in essentially the same spatial location, with Mask 2 enclosing Mask 1 spatially (i.e., Dember & Purcell, 1967; Schiller & Greenfield, 1969; Tresselt, Mayzner, Schoenberg, & Waxman, in press). The present study attempts to provide an analogue of the Hartline & Ratliff (1954, 1957) paradigm by employing an input sequence in which all three inputs (i.e., the target—Input 1; Mask 1—Input 2; and Mask 2—Input 3) occur in adjacent spatial locations, as in the studies of *Limulus*.

SUBJECTS

Ten male Ss were employed, selected randomly at the University Heights campus of New York University.

APPARATUS

The stimulus material was presented on

*This research was supported by Grant No. GB-8037 from the National Science Foundation.

two Fairchild cathode-ray tube (CRT) display consoles, slaved to a 340 Master Display, driven by a PDP-7 digital computer. A complete description of this hardware system and its associated computer programs (software) may be found in two earlier papers (Mayzner, 1968; Mayzner, Tresselt, & Helfer, 1967a).

PROCEDURE

Table 1 shows schematically, with numbers, the spatial and temporal ordering of the sequentially displayed inputs of each display sequence employed in the study. As may be seen in Table 1, numbers are shown in a particular spatial arrangement, which indicates the spatial ordering of the sequentially displayed inputs, i.e., Input 1 first, Input 2 second, and Input 3 third, for both the control and experimental conditions of the study. Ten different alphabetic characters were employed (i.e., B, D, E, G, H, L, M, S, T, and X); each display sequence always employed one of these 10 characters in all display locations.

In the control condition, for example, S might be shown two Bs, displayed simultaneously for 20 msec, corresponding to the spatial locations given by the number 1, followed 80 msec later by three Bs, displayed simultaneously for 20 msec, corresponding to the spatial locations given by the number 2. For the experimental condition, Inputs 1 and 2 (e.g., two Bs followed by three Bs) would in turn be followed 80 msec later by Input 3, i.e., six Bs displayed simultaneously for 20 msec, corresponding to the spatial locations given by the number 3 in Table 1. Thus, Inputs 1, 2, or 3 (i.e., two characters, three characters, or six characters displayed simultaneously) were each displayed for an on time of 20 msec with interdisplay or off time of 80 msec. These on and off times were selected on the basis of previous findings (Mayzner & Tresselt, in press; Mayzner, Tresselt, & Helfer, 1967b) known to produce strong sequential blanking effects.

Each S was given several sample displays before the main trials of the experiment to familiarize him with the display sequences and the response he was required to make to each of the 100-trial displays of the

experiment, i.e., 50 control trials, 5 trials with each of the 10 different alphabetic characters and 50 experimental trials, also consisting of 5 trials with each of the 10 different alphabetic characters. These 100 trials were presented in a different random order for each of the 10 Ss of the study.

For each of the 100 trials of the study, S was required to fill in the cells of a 3 by 5 matrix, with the letters he had observed on that trial. Each alphabetic character was 1/2 in. high and 3/8 in. wide. Display luminance of each character was approximately 1 mL, as measured with a Gamma Scientific photometric system (Model 2020EA). Room illumination was provided by one tensor lamp, placed about 10 ft behind the Fairchild display consoles, and in no way interfered with the quality of the image on the CRT display. S was positioned 2 ft from the display and he was told that the display sequences shown him would fall midway between two small black dots pasted to the CRT display surface. S's head was firmly positioned in a Bausch and Lomb head and chin rest.

RESULTS AND DISCUSSION

As shown in Table 1, S, when presented with each of the 100 display sequences of the study, was required to fill in the appropriate cells of a 3 by 5 matrix, in which he had observed alphabetic characters. Since the major objective of this study was to provide an experimental paradigm for the visual system in man that would constitute at least in some sense a spatial analogue of the Hartline and Ratliff (1954, 1957) work with *Limulus*, the control and experimental conditions of Table 1, it is believed, fulfill this objective. It follows, therefore, that if Input 2 inhibits Input 1 in the control condition, which is evident as shown by the results in Table 2, then Input 3 might be expected to inhibit Input 2 in the experimental condition and thus release Input 1 from the inhibition previously generated by Input 2. Table 2 very clearly shows that such is, in fact, the case, with all 10 Ss of the study supporting this prediction, and with $N = 10$, the sign test (Siegel, 1956) yields a $p < .001$.

The Ss also were tested on several additional supplementary control trials in which Inputs 2 and 3 were presented alone, in which blanking of Input 2 was almost always found, as one would expect, and on

Table 1
Spatial and Temporal Schematic Representation of the Display Sequences Employed in the Study

Control Condition					Experimental Condition				
					3	3	3		
2	1	2	1	2	2	1	2	1	2
					3	3	3		

Table 2
Number of Correct Responses* for Inputs 1 and 2 of the Control Condition and Inputs 1, 2, and 3 of the Experimental Condition

Subjects	Control Condition		Experimental Condition		
	Input 1	Input 2	Input 1	Input 2	Input 3
1	5	46	47	3	49
2	1	48	40	0	50
3	0	47	43	0	48
4	41	50	43	44	50
5	4	45	40	0	46
6	14	46	39	39	48
7	5	49	46	14	50
8	9	47	47	25	47
9	19	46	41	31	48
10	14	48	42	22	49

*Correct responses refer to S reporting correctly on the letters shown for Inputs 1, 2, or 3, with a score of 50 representing complete accuracy, i.e., on every one of 50 trials of each of the conditions of the experiment, S reported correctly on the letters being displayed. All values less than 50 represent the degree to which S failed to report letters being displayed, i.e., a score of 0 represents complete blanking on all 50 trials.

other control trials, in which Inputs 1 and 3 were presented alone, and where no blanking of Input 1 occurred, again results to be expected from our model's predictions (Mayzner & Tresselt, in press), because of the much longer time delay between Inputs 1 and 3 than would be found between Inputs 1 and 2 alone or between Inputs 2 and 3 alone. These results, particularly when contrasting the findings for Inputs 1 and 2 under the control and experimental conditions, would seem to demonstrate that the proper spatial and temporal configuration for Inputs 1, 2, and 3 can and do produce in the human visual system an analogue of the disinhibition effect found in *Limulus* (Hartline & Ratliff, 1954, 1957). The origin of this disinhibition effect would, however, have a central rather than a retinal or peripheral locus, as we have argued elsewhere (Mayzner & Tresselt, in press).

Overall, the findings of this study are in good agreement with our own previous results (Tresselt, Mayzner, Schoenberg, & Waxman, in press) and those of others (e.g., Dember & Purcell, 1967; Robinson, 1966, 1968; Schiller & Greenfield, 1969). However, these findings do not correspond with a recent study of Uttal's,¹ but as we have suggested earlier (Tresselt, Mayzner, Schoenberg, & Waxman, in press), Uttal's failure to find a disinhibition effect is a result, we believe, of the particular experimental paradigm he employed, rather than total absence of the phenomena to occur in man's visual system.

REFERENCES

- DEMBER, W. N., & PURCELL, D. G. Recovery of masked visual targets by inhibition of the masking stimulus. *Science*, 1967, 157, 1335-1336.
- HARTLINE, H. K., & RATLIFF, F. Spatial summation of inhibitory influences in the eye of *Limulus*. *Science*, 1954, 120, 781.
- HARTLINE, H. K., & RATLIFF, F. Inhibitory interaction of receptor units in the eye of *Limulus*. *Journal of General Physiology*, 1957, 40, 357-376.
- MAYZNER, M. S. The research potential of a computer-based cathode-ray tube display system. *Behavior Research Methods & Instrumentation*, 1968, 1, 41-43.
- 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*, in press.
- 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.
- RATLIFF, F. *Mach bands: Quantitative studies on neural networks in the retina*. San Francisco: Holden Day, 1965.
- ROBINSON, D. N. Disinhibition of visually masked stimuli. *Science*, 1966, 154, 157-158.
- ROBINSON, D. N. Visual disinhibition with binocular and interocular presentations. *Journal of the Optical Society of America*, 1968, 58, 254-257.
- SCHILLER, P. H., & GREENFIELD, A. Visual masking and the recovery phenomena. *Perception & Psychophysics*, 1969, 6, 182-184.
- SIEGEL, S. *Nonparametric statistics for the behavioral sciences*. New York: McGraw-Hill, 1956.
- TRESSELT, M. E., MAYZNER, M. S., SCHOENBERG, K. N., & WAXMAN, J. A study of sequential blanking and overprinting combined. *Perception & Psychophysics*, in press.

NOTE

1. Uttal, W. R. On the physiological basis of masking with dotted visual noise. Unpublished manuscript, 1969.

Linguistic operations in the analysis of pairs of class-membership statements*

WILLIAM J. KROSSNER

Vassar College, Poughkeepsie, N.Y. 12601

The ordering of solution times and error rates in a task comprising the comparison of statements that were logically equivalent but linguistically different was successfully predicted by a model involving two operations capable of transforming the linguistically differing forms into each other.

The binary universal class-membership relation expressed as "All As are Bs" may also be asserted by three other logically equivalent linguistic forms; Fig. 1 shows the forms in a particular arrangement labeled a logical diamond. In addition, the negation or logical contrary of each form may be expressed in two ways; thus, the negation of the statement "All cats are mammals" may be expressed either as "No cats are mammals" or as "All cats are nonmammals."

The first type of negation involves a change in the universal or operator word, in this instance from "All" to "No." The second type of negation involves an operation in the predicate of the assertion, the placement of a "non" in front of the predicate class name.

A glance at Fig. 1 shows that these two kinds of operations are also involved in changing one logically equivalent form to another. In one case, as with the transitions from Form 1 to Form 2 or from Form 3 to Form 4, the operator word is changed and

nons are added or deleted as necessary to keep logical equivalence. This total operation is called, for simplicity, an operator change. In the other case, the predicate is acted upon, with the predicate and subject class names being interchanged and with the insertion or deletion of nons from the class names as required by the operator word. This second type of operation is called, in its totality, a subject-predicate interchange.

With these two operations thus defined, it is possible to convert any of the forms of Fig. 1 to any of the others by using either an operator change or a subject-predicate interchange, or both; the 1-3, 3-1, 2-4, and 4-2 transitions are the cases where both operations are required.

If Ss actually use these operations to analyze class-membership statements, then, by the simplest model, were Ss to be presented with pairs of equivalent statements, the time necessary for Ss to determine the status of the pair should vary in proportion to the number of operations required to convert one member of the pair to the other.

A second assumption would be that the likelihood of making an error is correlated

*Project done while the author was a postdoctoral fellow at the Harvard University Center for Cognitive Studies and supported by various grants to that agency.