Backward masking in vision¹

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Abstract

Recognition accuracy for capital letters, A, T, and U was assessed when the exposure of a letter was either accompanied or followed at delays of 0 to 250 ms. by exposure of a ring stimulus that circumscribed the letter. Recognition impairment was found when the ring occurred concurrently with the letter and when delayed after the letter as long as 68 ms.

Problem

It has been reported and subsequently confirmed (Cheatham, 1952; Kolers & Rosner, 1960; Werner, 1935) that if a black disk stimulus is briefly exposed and subsequently followed by exposure of a black ring that circumscribes the disk, the perception of the disk is masked or impaired. Under certain conditions of luminance and contrast ratios masking effects are reported when the ring stimulus is delayed over 100 ms. Experiments on this phenomenon have used poor indicator methodology. Data from at least one study (Kolers & Rosner, 1960) suggest that reports of masking are markedly susceptible to the subjective criterion adopted by S. Also none of the experiments have reported the effect of simultaneous or concurrent occurrence of ring and disk upon perception of the disk. This latter oversight could be of major importance in the interpretation of the phenomenon. If perception is as impaired with concurrent presentation of stimulus and ring as it is at short delays of the ring, this would counterindicate an interpretation of the second (ring) stimulus erasing the preceding stimulus. Rather it would suggest that recognition impairment was due to the greater complexity of the stimulus for which exposure time was insufficient for recognition (Hake, 1957).

Method

A three field tachistoscope, previously described (Eriksen & Hoffman, 1963) was used to present the stimulus sequences. An adaptation field (.572 apparent ft candles) with a .2° H as a fixation point remained on throughout a trial and the stimulus exposures were superimposed upon the adaptation field luminance. Over several practice sessions an exposure duration was determined for each S where he could correctly indicate approximately 70% of the time which of the three alternative letters, A, T, or U had been presented. For these base level determinations only the letters were presented. The duration necessary for 70% accuracy was then used for the particular S for the exposure of the stimulus in the subsequent experimental trials. The ring had a constant exposure of 100 ms.

In Experiment 1 each of five practiced adult Ss (four males) was run for five experimental sessions with 108 trials per session. After each trial S reported whether

A, T, or U had occurred along with a rating of his subjective confidence on a three point scale. Each S made 90 judgments at each of five delay intervals (0, 68, 100, 130, and 250 ms.) and 90 for the concurrent condition. There were two kinds of trials for each delay interval as well as for the concurrent presentation. On half the trials, randomly selected, the letter was followed by the ring after the appropriate delay (ring present). On the other half, only the empty second field was flashed after the delay (ring absent). The letters and ring were black on a white ground (.200 apparent ft candles). The letters subtended .2° of angle and the ring .67° outer diameter and .3° inner diameter. The ring appeared spatially so as to center the letter.

After completion of Experiment 1 a second experiment was run with five additional practiced Ss (one male). Procedure was identical except the delay intervals were: concurrent, 0, 10, 25, 50, and 250 ms.

Results

In both experiments recognition accuracy was analyzed by a three-way analysis of variance (ring present vs. absent, delay interval, and Ss). In both experiments all three main effects were significant ($P < .01$) as was also the ring present-absent by delay interval interaction ($P < .025$). In neither experiment did the interactions with Ss approach significance.

In Fig. 1 recognition accuracy is shown as a function of the delay interval for the ring stimulus and for the control condition when the light only was flashed in the second field. The data from both experiments are shown and the curves have been fitted by eye. Maximum masking occurs when the ring stimulus occurs concurrently with a letter and becomes progressively less at longer delay intervals. The masking effect appears

Fig. 1. Percent correct letter recognitions as a function of delay and ring present and ring absent conditions.

to be eliminated by 100 ms. delay. There is no apparent effect of delay on recognition accuracy in the control condition where only light is flashed in the second stimulation.

Discussion

Superimposing a black ring stimulus around a form appreciably reduces recognition of the form, even when onset of the ring is delayed longer than 50 ms. after the form presentation has terminated. This result based upon improved and more sensitive methodology confirms previous findings. More important, the finding that masking appears maximal when form and ring are concurrent suggests that the masking is not attributable to an erasure process of the second stimulus upon the first. Rather it is more difficult to recognize letters that appear in the center of black rings than letters exposed on an uncluttered white ground. And at short delays of the ring the visual system reacts to the sequential stimulation as though it was concurrent. This may be due to a persistence of the first stimulus for a brief interval after stimulation has ceased or to a more rapid

perception of the stimulus that follows the preceding stimulus at a brief delay, perhaps due to a neural facilitation.

References

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Note

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Editorial Notes

The attention of our readers is called to *Information for Authors* found on the inside of the back cover. Several minor changes have been made. These are based on our experience thus far in editing the journal and are designed to simplify the preparation and handling of manuscripts. There is also a slight increase in the cost of reprints to authors; this too is based on our experience with costs.

The most important change noted in *Information for Authors* deserves some editorial explanation. With this issue, we are announcing that in the future we will publish pre-publication abstracts of articles awaiting publication in other journals with relatively long publication lags. This kind of publication was all along part of our plan for "increasing the speed of scientific communication." We did not announce it at the beginning because we wanted to gain experience with the publication of brief articles, which is our primary purpose, before we attempted to include pre-publication abstracts. Now that the work of publishing brief articles is going smoothly, we feel ready to add this second kind of quick and brief publication.

The purpose of the pre-publication abstracts is to put interested readers in contact with authors months or even a year or more before they might otherwise see articles of interest to them. We hope that many authors of such abstracts will have available pre-publication copies of their entire articles to send upon request. Since not every author is in a position to do this and something is gained simply by knowing of the existence of an

experiment, we have not made that a requirement. Quite possibly, with this innovation, we are opening up a Pandora's box, but if so, we will address the problem when it arises. In the meantime, we are striving to do what seems to be needed to reduce the lag in communicating the results of research in general experimental psychology.

While the editor is at it, he would like to call attention to the policy of publishing comments on articles. So far, only one comment has been received and published. Hopefully, this was all that was justified by the articles published so far. In any case, he has always felt that frank, objective comment published for all to see could be a self-corrective for flaws in articles that escape editorial detection in the pursuit of speed of publication. Readers are invited to write such comments when they seem enlightening.

It is noted with some pride that, except for the very first issue, our publication lag has been kept within the promised three to seven weeks. We compute this lag from the time an article is received in proper form for publication to the time the journal is mailed from our offices on the West Coast. We are now able to maintain this short lag and at the same time provide authors with a facsimile proof of each article as composed—something we did not think could be done when we started.

Readers are invited at any time to give us their candid views on any aspect of our editorial or publishing activities.

Clifford T. Morgan