Clarity and recognition of masked and degraded stimuli

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Three Ss viewed arrays of four letters which were either varied in duration or followed by visual noise. On half of the trials they rated the clarity of the letters; on the other half they attempted to recognize all of the letters. The results showed that while both clarity and recognition increased in parallel as duration was increased, clarity exceeded recognition accuracy when visual noise followed the array. Thus, Ss said the letters were clear even though they did not have enough time to process them for recognition. These results were interpreted as supporting an information processing model of the effects of visual noise, as compared to a sensory or temporal summation explanation.

If a visual patterned mask exerts its effect on a prior stimulus by acting backward to block or to alter the neural representation of a stimulus, then all indices of the perception of that stimulus should be altered together. Specifically, an S's rating of the clarity of the stimulus should be highly correlated with the number of items of information he can process from the representation. This position is similar to one held by Neisser (1967), Kahneman (1968), and Eriksen (1967), among others. Each has argued that a mask, such as visual noise, following a stimulus within about 100 msec of its offset, combines in some way with the stimulus so that its acuity, brightness, contrast, or clarity never reaches the level it would have achieved in the absence of the mask. This position will be referred to as a "sensory" interpretation of backward masking by visual noise since it stresses sensory and neural alterations of the stimulus representation before it can be acted upon at higher levels.

Another position, referred to as an "information processing" interpretation (Haber, in press; Sperling, 1967; Liss, 1968) assumes that the processing of the stimulus begins from its representation as soon as the representation develops. If a mask follows the stimulus after some delay, processing is assumed to have occurred during that delay, but is terminated or interfered with by the mask, probably in part because the neural representation is *then* altered. Thus, the mask has no "backward" effect but rather only serves to interrupt the processing that began with the initial registration of the stimulus. Therefore, an index of perception that measures the initial registration (e.g., S's rating of the clarity of his percept of the stimulus) should not be affected by visual noise once the representation is formed, whereas visual noise should affect an index that measures the processing of information (e.g., report the items in the stimulus), especially if insufficient time was allowed for the processing (see Haber, in preparation, for a more detailed description of these positions).

The present experiment poses a test between these two theoretical positions. Four-letter stimuli are presented under two conditions and with two response indicators. The first condition varies the duration of the stimulus from well below to well above threshold. Both theories would predict that both clarity and the number of letters reported would increase monotonically and in parallel, since increasing the energy (duration) should increase the adequacy of initial registration and thereby both improve the clarity rating and the processing of information. The second condition holds energy constant but follows the stimulus presentation with a visual noise field after a varying delay. Here the two theories make different predictions—the former still predicting a high correlation between the two indices as the mask is delayed, while the information processing position argues that the clarity rating would increase more rapidly than the accuracy of reporting letters.

METHOD

Subjects

Three observers with normal vision served as Ss. They were unaware of any experimental hypotheses. Three hours of prior practice were given and then 10 h of data collection constituted the experiment for each S.

Apparatus

The stimuli were presented in a three-channel tachistoscope (Scientific Prototype Model GA). All fields, including the noise field when used, were set at 10 ml. as measured from the eye piece. The test stimuli were four-letter arrays, drawn by random selection from all letters except "I" and "Q." The letters were drawn in black on white cardboard which had a reflectance of 90%. Letter size was 5 mm high x 3 mm or less wide. The vertical visual angle for each letter was 16 min. The array size was 2.1 x 2.1 cm. Viewing distance was 110 cm. A central fixation point was provided in the background channel at all times. For the visual noise condition a visual noise field, copied from Sperling (1963), was used in the second channel. In the no-mask condition the second channel was not used.

Procedure

Each session was a complete replication of the entire design. In half of each session, a mask followed the stimulus. In the other half no mask was used, but the stimulus was degraded by varying its duration. The order of the masked and degraded halves was counterbalanced between sessions. Within each half session, six alternating blocks of 10 clarity rating and 10 letter reporting trials were run. Each block of 10 trials used a different ISI (to mask) or stimulus duration (to degrade). The order of the blocks was counterbalanced. Thus, over the 10 sessions, 100 trials were run for each duration, for each ISI, and for each of the two types of reports required from the S.

The array durations used for the degraded condition were 10, 15, 20, 30, 40, and 50 msec. For the masked condition,

Fig. 1. Changes in mean clarity ratings and mean number of letters reported as a function of degraded (left side) and masked (right side) presentations. Each data point represents the mean of 100 responses for each of three Ss combined.

Fig. 2. Data from Fig. 1 replotted to show the number of letters reported as a function of clarity ratings for both degraded and masked presentations.

the array duration was set at a value corresponding to 75% correct without a mask for each S. For the three Ss this duration, determined during the practice sessions, was 37, 40, and 52 msec. The mask duration was 500 msec and it followed the array after 0, 10, 25, 50, 100, or 200 msec.

Response Indices

For the clarity rating, S was trained to use a five-point scale, in which the values were as follows: 1—zero clarity (nothing seen); 2—some very faint pattern seen; 3—fragments of contour seen; 4—moderately sharp outline emerges but still below normal clarity (normal clarity taken as that of a 50 msec presentation which is not masked); and 5—clarity approximately equal to normal (defined as in Category 4 above). The S was instructed to rate clarity solely on the basis of sharpness or blackness of the contours in the array taken as a whole and not to consider how many letters were seen or recognized. Procedures recommended by Natsoulas (1967) were followed.

With the letter reports, the S was required to report all four letters even if he had to guess. He was not required to indicate their positions nor to report them in any specified order.

RESULTS

Figure 1 presents the results for each condition separately. Figure 2 replots these to show more fully the relationship of the clarity ratings to the number of letters reported. The six points on each curve of Fig. 2 represent the six levels of interstimulus interval and the six durations, respectively. It is clear from Fig. 2 that, under the masked presentations, clarity rating exceeds letter reporting, as compared to those of the degraded presentations. This is supported by an analysis of variance for the clarity ratings, employing the number of letters correctly reported as a covariable, which shows that rated clarity was significantly higher for masked than for degraded conditions. Clarity ratings also differed significantly between Ss and between sessions. This latter practice effect represented a slight decrease in the rated clarity for both masked and degraded stimuli during the course of the study.

CONCLUSIONS

The study indicates that masking by visual noise and degrading by duration reduction are both effective in limiting the number of letters correctly reported from an array. These two procedures are not equivalent, however, in that the clarity of the array, for any given level of letter reporting, is higher under the masked as compared to the degraded presentations. The effect is not strikingly large, but it is consistent for each S and statistically reliable. It is largest for delays between 10 and 100 msec. Presumably for delays shorter than 10 msec, the mask prevents even the representation of the stimulus from being formed. For delays longer than 100 msec, sufficient time is apparently provided to process the items, so the mask is no longer producing any differential effect.

These results closely parallel those found by Liss (1968). He also had Ss rate the clarity of letters as well as attempt to report them. He found several indications to suggest that with masked presentations, Ss rate the clarity as high even though they cannot process very many letters. His Ss commented that "despite the high contrast of the letters presented under backward masking, they typically appeared for such brief duration that there was not much time to identify them before the mask appeared" (1968).

Therefore, this experiment, together with Liss', provides some support for the information processing interpretation of masking by visual noise. That is, even with a mask, the clarity of the representation of the stimulus reaches a higher level than would be expected by S's ability to process items in the stimulus. This suggests, then, that the factors that control the initial registration or representation of the stimulus in the nervous system are independent in part from those factors which control processing or extraction of information from that representation.

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NOTE

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