Hemiretinae and nonmonotonic masking functions with overlapping stimuli*

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Single-letter targets, followed at varying onset-onset intervals by a patterned mask, were presented for identification to the hemiretinae of both eyes. The target and mask stimuli were spatially overlapping; the mask could impede target perception dichoptically, and the energy of the target stimuli was twice that of the mask. Under these conditions, U-shaped monoptic masking functions were obtained which did not differ, as a function of hemiretina, in their overall shape or in their points of maximal masking.

Recent evidence indicates that U-shaped masking functions are not limited to conditions of metacontrast. Nonmonotonic functions relating degree of masking to stimulus-onset-asynchrony (SOA) for spatially overlapping targets and masks have been reported by Purcell & Stewart (1970), Weisstein (1971), and Turvey (1973). Turvey (1973) has hypothesized that nonmetacontrast U-shaped functions for monoptic masking should occur under the following conditions: when the energy of the target is greater than that of the mask and when the mask can effectively impede the perception of the target under conditions of dichoptic presentation, i.e., the mask is an effective central masker.

An explanation of the U-shaped function obtained when these conditions prevail can be stated quite generally in terms of a gradual shift with increasing SOA from masking of peripheral origin to masking of central origin (Turvey, 1973). It is proposed that at zero and at very brief SOAs the induced perceptual impairment is of peripheral origin. At brief intervals, the two stimuli, target and mask, engage common peripheral networks, and under conditions of peripheral interaction the stimulus of greater energy dominates. Thus, peripherally, a greater energy target will occlude a lower energy mask. At comparatively larger SOAs, it is proposed that the two stimuli do not interact peripherally but arrive centrally as separate events. The nature of central processing is such that, given the reception of two stimuli in close succession, the operations on the earlier stimulus are either terminated or distorted by the arrival of the later stimulus. Centrally the energy relation between the two stimuli is relatively unimportant; what matters is the order of arrival, with the advantage accruing to the later stimulus. Thus, centrally, the later-arriving mask can impede the perception of the greater-energy target. With further increments in SOA, the perceptual impairment of the target induced centrally by the aftercoming mask declines, because more time is allowed for the central processor to determine the target stimulus before the mask arrives.

These notions have received some support in a recent series of experiments reported by Turvey (1973). The present experiment was conducted as a further demonstration of nonmetacontrast U-shaped masking functions under the conditions described above. In addition, the experiment asked whether the overall shape and/or peak of the functions varied with the hemiretina to which the target and mask were presented.

METHOD

Two three-channel tachistoscopes (Scientific Prototype, Model GB) modified for dichoptic viewing, were used to present single-letter stimuli (A, H, M, T, U, V, W, X, Y) to one of the four hemiretinae. The viewing field of the tachistoscope subtended 6.5 horizontal by 3.5 vertical degrees of visual angle. The lines composing the letters were .15 deg thick, while the letters were .92 deg high and, on an average, .60 deg wide. The center of the letters was 1.15 deg of visual angle to the left or right of a centrally located point of fixation. The target letter was followed monoptically by a pattern mask which consisted of two identical composites of letter fragments, the centers of which were positioned 1.15 deg to the left and 1.15 deg to the right of the fixation point. The mask and a target letter are presented in Fig. 1. Pilot data had indicated that the mask could successfully impair target identification under conditions of dichoptic presentation, e.g., if a target was presented to the temporal hemiretina of the left eye and the mask to the right eye. Both the target and mask durations were set at 10 msec to preclude eye movements. Luminances of both stimuli were set initially at 34.3 cd/m^2, and a 50% (Kodak) neutral density filter was then used to reduce the mask luminance. Thus, the energy of the target stimuli was twice that of the mask.

A completely within-Ss design was used, each S receiving 10 targets to each hemiretina at each of 10 SOAs (0, 10, 20, 40, 50, 60, 80, 100, 150, and 200 msec). For half the Ss, SOAs increased across trials, and for the others, they decreased across trials. The 40 trials at each SOA were randomly divided among the four hemiretinae, with the restriction that each hemiretina receive 10 presentations. On a particular trial, S knew neither to which eye nor to which side of a constantly illuminated fixation point the stimulus was to appear.

Eight Yale University undergraduates, naive about tachistoscopic viewing, were paid to serve as Ss. They were

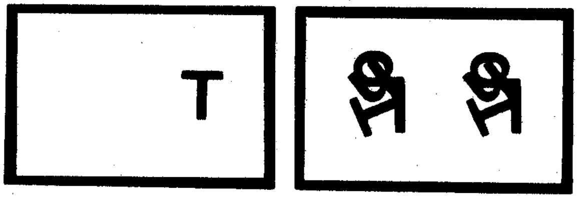

Fig. 1. The mask stimulus (right) and an example of the target stimuli. (The internal border represents the edge of the viewing field.)

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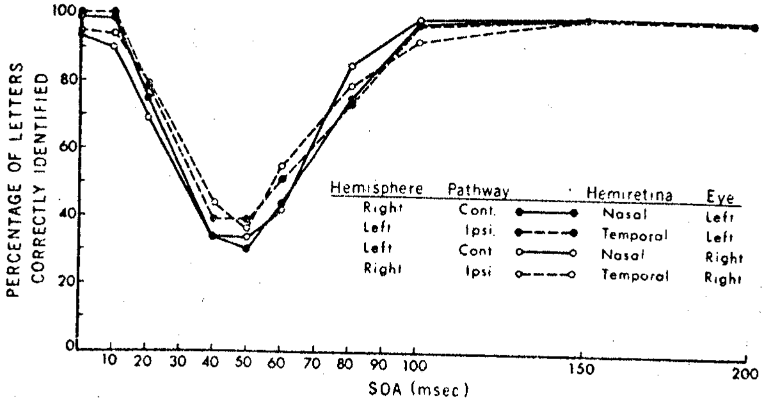

Fig. 2. Percentage of letters correctly identified as a function of SOA and hemiretina.

instructed to identify the letter and to guess if unsure. The entire procedure took about 40 min, including a 5-min rest at the halfway point.

RESULTS AND DISCUSSION

The number of letters correctly identified at each SOA was averaged across Ss for each hemiretina. These results are presented in Fig. 2. An Eye by Pathway Type (contralateral vs ipsilateral) by SOA by Ss analysis of variance revealed that only SOA was significant, $F(9,63) = 16.6$, $p < .001$. All Ss demonstrated maximal masking at SOAs of either 40 or 50 msec. Examination of Fig. 2 clearly shows U-shaped functions for each hemiretina, but obviously neither the minima of these functions nor their ascending and descending components differed.

According to the hypotheses advanced earlier, two types of masking occurred. In peripheral processing, energy was the critical variable, and at brief SOAs, the higher energy target masked the aftercoming mask; that is, the target won out in the competition for peripheral networks at longer SOAs, the mask escaped peripheral impairment by the target, and the rules of central processing took effect—namely, the mask had the advantage of being a second event and, as such, could disrupt the central processing of the target. On this account, the present results indicate that *central* masking did not differ as a function of the hemiretina to which the target and mask were delivered.

Another variable needs examination in the present context. Degree of eccentricity from the fixation point has been found to be a determinant of vocal reaction time (McKeever & Gill, 1972) and degree of metacontrast (Stewart & Purcell, 1970). We might suspect that degree of eccentricity affects peripheral and/or central masking. This possibility awaits investigation.

Finally, the existence of U-shaped functions in the present experiment reinforces the notion that they are not unique to the metacontrast situation as some have supposed (cf. Bridgeman, 1971).

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