COMMENTARY

Contralateral Visual Masking May Be an Artifact*

George Fein and Fiona F. Brown
VA Medical Center and
University of California
San Francisco, CA

ABSTRACT

There are serious methodological problems in studies which report contralateral visual masking. Contralateral masking occurs when detection of a hemifield target stimulus is impaired by a pattern-masking stimulus presented to the opposite hemifield. We demonstrate that, in studies which used positive stimuli (i.e., black letters on a white field), contralateral masking may be an artifact. Although we observed contralateral masking when positive stimuli were presented, there was no evidence of masking with negative stimuli (i.e., white letters on a black field). A special masking stimulus with a positive mask contralateral to the target and a black hemifield ipsilateral to the target also failed to produce masking. Contralateral masking in this experiment was due to the flash of light in the field ipsilateral to the target; it was this ipsilateral stimulation, rather than contralateral interference, which impeded target recognition.

Visual masking occurs when a masking stimulus (mask) is presented in close temporal association with a target stimulus (target) such that the mask limits the viewer’s ability to identify the target (Felsten & Wasserman, 1980). In backward masking, the mask is presented after the target, whereas in forward masking it precedes the target. Dichoptic masking studies, in which target and mask are presented to different eyes, have established that masking can occur beyond the optic decussation. In most masking studies, the mask either overlaps the target in the visual field or is directly adjacent to it, the latter being known as metacontrast masking. In a recent study, Saccuzzo, Michael, & Rowe (1982) showed backward masking to occur when the target and mask were presented to opposite visual fields. They called this phenomenon “contralateral masking”. The targets and masks were neither overlapping nor adjacent, but projected to corresponding areas of different visual fields.

* This research was supported by NIA Grant No. 1-R01-AG03334 and by Veterans’ Administration General Medical Research Funds. Send requests for reprints to Dr. G. Fein, SFVAMC (116R), 4150 Clement Street, San Francisco, CA 94121, U.S.A.

Accepted for publication: January 16, 1986.
May Be an Artifact*

Fiona F. Brown
VA Medical Center
San Francisco, CA

studies which report contralateral en detection of a hemifield target ulus presented to the opposite used positive stimuli (i.e., black may be an artifact. Although we stimuli were presented, there was asalateral to the target and a dusted to produce masking. Contralaflash of light in the field ipsilateral rather than contralateral interfer-

us (mask) is presented in close ge) such that the mask limits the (Wasserman, 1980). In backward ars, in which target and mask are nt masking can occur beyond the mask either overlaps the target it, the latter being known as uzzo, Michael, & Rowe (1982) ara presented to non “contralateral masking”. ng nor adjacent, but projected to

METHODS

Subjects. Seven subjects were tested, 3 male and 4 female. All were right-handed by self-report. Ages ranged from 21.3 to 27.1, with a median age of 24.3.

Materials. An IBM PC-XT controlled all experimental procedures, including stimulus presentation, response recording, and EOG monitoring. Stimuli were projected onto a rear projection view screen using a Gerbrands (Model G1175) 3-field tachistoscope. A circular black fixation point subtending 0.4° of visual angle was affixed to the center of the viewing screen. The experimental room was illuminated with ceiling-mounted fluorescent lights throughout. EOG was recorded from gold-cup electrodes attached with EC2 electrode cream and amplified with a Grass (Model 7B) polygraph.
Three types of stimuli were used: (1) positive, (2) negative, and (3) a special set of contralateral masks with a positive mask in the hemifield contralateral to the target and a black hemifield ipsilateral to the target. (This special set of masks will be referred to as "positive/black"). The positive/black masks were designed so that they would not emit energy in the hemifield of the target when presented to the visual field contralateral to the target. The letters used as targets were "T" and "A". Masks were 9 "E"'s arranged in three rows of three letters each. Stimuli are displayed in Fig. 1.

For the first six subjects, the viewing distance was 127 cm. At this distance, the center of each stimulus was displaced either 0.3, 0.6, or 1.2 degrees of visual angle from the central fixation point. Targets subtended 0.2° vertically and 0.1 or 0.2° horizontally. Each mask subtended 1.2° vertically and 0.5° horizontally. The last two subjects, one of whom had also been in the first group, were positioned 80 cm from the viewing screen. In this arrangement, the center of each stimulus was displaced either 0.5, 1.0 or 2.0° from the central fixation point. Targets subtended 0.4° vertically and 0.3 or 0.4° horizontally. Masks subtended 1.9° vertically and 0.7° horizontally. When the subjects were 80 cm from the screen, the angles subtended by the stimuli replicated those in the Saccuzzo et al. (1982) experiment. The luminance of the experimental room was 9.6 cd/m², measured from the position of the subject's eyes in the direction of the fixation point. The luminance of positive targets and masks was 2.4 cd/m² greater than the room luminance; luminance of negative targets and masks was indistinguishable from room luminance. Luminance of the positive/black mask was 1.4 cd/m² greater than room luminance.

Procedure. Two eye-movement electrodes and a ground were positioned before the experiment began. One eye-movement electrode was placed above the outer canthus of the left eye; the second was positioned below the outer canthus of the right eye.

![Figure 1. Examples of the experimental stimuli: (a) Positive target. (b) Positive mask. (c) Positive/black mask. (d) Negative target. (e) Negative mask.](image)

Calibration criteria were set such that eye movements were recorded only if the eye was within 2.0° (80 cm distance) of visual angle would be recorded. EOG was monitored from 200 ms pretarget through the end of the trial.

The experiment encompassed four combinations of target and mask. Masks were presented contralateral to the target (ipsilateral) or to the opposite hemifield: (1) positive targets with contralateral positive hemifield; (2) negative targets with positive contralateral masks; (3) negative targets with positive contralateral masks; (4) positive targets with positive/black masks. The order of presentation varied across subjects. Target duration was 40 ms. Within a block only one level of displacement of the targets was used. Each trial consisted of 24 trials, or presentations of each target letter, six to the right of center, six to the left of center, six to the right of center, and six to the left of center. Each condition was composed of nine blocks of trials, with each block consisting of 24 trials, or presentations of each target letter, six to the right of center, six to the left of center, six to the right of center, and six to the left of center. These blocks were randomly varied across subjects. Target duration was 40 ms.

On three occasions during the experiment, the subject was asked to correct an error in self-reporting. These occasions were: (1) as an initial exposure to the negative targets, and (2) at the end of each block of trials. These blocks were randomly varied across subjects. Target duration was 40 ms. The technician stressed the importance of each block of trials to ensure that the subject was able to correct his responses. Use of positive, contralateral masks was allowed at 0 ms SOA, but not at 20 ms. These blocks were randomly varied across subjects. Target duration was 40 ms. The technician stressed the importance of each block of trials to ensure that the subject was able to correct his responses. Use of positive, contralateral masks was allowed at 0 ms SOA, but not at 20 ms. These blocks were randomly varied across subjects. Target duration was 40 ms. The technician stressed the importance of each block of trials to ensure that the subject was able to correct his responses. Use of positive, contralateral masks was allowed at 0 ms SOA, but not at 20 ms. These blocks were randomly varied across subjects. Target duration was 40 ms. The technician stressed the importance of each block of trials to ensure that the subject was able to correct his responses. Use of positive, contralateral masks was allowed at 0 ms SOA, but not at 20 ms. These blocks were randomly varied across subjects. Target duration was 40 ms. The technician stressed the importance of each block of trials to ensure that the subject was able to correct his responses. Use of positive, contralateral masks was allowed at 0 ms SOA, but not at 20 ms. These blocks were randomly varied across subjects. Target duration was 40 ms. The technician stressed the importance of each block of trials to ensure that the subject was able to correct his responses. Use of positive, contralateral masks was allowed at 0 ms SOA, but not at 20 ms. These blocks were randomly varied across subjects. Target duration was 40 ms.
Contralateral Masking

(A. F. Brown)

(1) Positive target. (b) Positive mask. (c) Negative target. (d) Negative mask. (e) Negative mask.

(2) negative, and (3) a special set of contralateral to the target and a special set of masks will be referred to as designed so that they would not emit to the visual field contralateral to the "A". Masks were 9 "E"'s arranged in a grid.

As shown in Fig. 1, was 127 cm. At this distance, the center was 1.2 degrees of visual angle from the vertically and 0.1 or 0.2° horizontally. The last two subjects, one of whom was placed either 0.5, 1.0 or 2.0° from the vertically and 0.3 or 0.4° horizontally. When the subjects were 80 cm from the viewing screen, in the upper right corner of the right eye.

A ground were positioned before the was placed above the outer canthus of the outer canthus of the right eye.

Calibration criteria were set such that eye movements greater than 1.4° (127 cm distance) or 2.0° (80 cm distance) of visual angle would result in rejection of the trial. For each trial, EOG was monitored from 200 ms pretarget onset to 800 ms posttarget onset.

The experiment encompassed four conditions, each condition testing a different combination of target and mask. Masks were presented either to the same hemifield as the target (ipsilateral) or to the opposite hemifield (contralateral). The conditions were: (1) positive targets with contralateral positive masks; (2) negative targets with contralateral negative masks; (3) negative targets with ipsilateral negative masks, and (4) positive targets with positive/black masks. The order of presentation of these conditions was varied across subjects. Target duration was 6 ms and mask duration was 20 ms throughout.

Each condition was composed of nine blocks of trials. The nine blocks represented all combinations of stimulus displacement and stimulus onset asynchrony (SOA) (0, 20, or 40 ms). Within a block only one level of displacement and SOA were used. Each block consisted of 24 trials, or presentations of target and mask. Twelve trials were allotted for each target letter, six to the right of center and six to the left. Target letter and hemifield of presentation were randomly varied across trials. The subject's verbal report of either "A" or "T" was entered at the computer keyboard by the technician. A response of "No", indicating "no idea of which target was presented", was entered as a letter other than A or T. A minimum of 2.25 s elapsed between the onset of one target and the onset of the next.

On three occasions during the experiment, targets were shown without masks to ensure that the subject was able to correctly identify the target at the specified target duration. These occasions were: (1) as an initial exposure to the positive targets, (2) as an initial exposure to the negative targets, and (3) at the end of the experiment. When targets were presented without masks, subjects had 100% target recognition. Throughout the experiment the technician stressed the importance of looking at the fixation point without blinking during each block of trials. Subjects were allowed approximately 2 min break between blocks of trials and about 5 min between conditions.

Results

Use of positive, contralateral masks with positive targets produced almost total masking at 0 ms SOA, but not at either 20 or 40 ms. This was true at all displacements and for all subjects, with the exception of one subject whose performance at the 20-ms level indicated some masking (see Figure 2). This finding replicates Saccuzzo et al. (1982).

Negative, contralateral masks paired with negative targets elicited no masking response from any of the six subjects at any SOA or displacement level (see Figure 3). When negative masks were presented ipsilateral to the negative targets, however, masking occurred at all SOA levels and displacements in each subject (see Figure 4).

When the positive/black masks were presented contralateral to positive targets, no masking occurred (see Figure 5). This result was similar to that occurring when negative, contralateral masks were used with negative targets.

Eye movements resulted in the rejection of between 5 and 25% of trials across
Figures 2-5. Mean number of correct responses at each stimulus onset asynchrony level (0, 20 and 40 ms). Data are shown for eight subject runs (six runs with subjects seated 127 cm from screen and two with subjects seated 80 cm from the screen). Data are averaged across direction and degree of stimulus displacement. Contralateral = masks presented to hemifield contralateral to targets; ipsilateral = masks presented to hemifield ipsilateral to targets. Maximum possible number correct = 12.

![Figure 3. Negative targets; contralateral positive masks.](image)

![Figure 4. Negative targets; ipsilateral positive masks.](image)

DISCUSSION

In this paper we provide compelling evidence that paradigms which use positive target and mask stimuli to measure contralateral masking are seriously flawed. In each of seven subjects we showed that contralateral backward masking only occurs when a flash of light is presented to the hemifield ipsilateral to the target and thus cannot be attributed to the pattern mask presented contralateral to the target. The light flash reduces the target contrast and makes the target more difficult to detect. We know that the pattern-masking stimuli we used are...
Results at each stimulus onset asynchrony level are shown for eight subject runs (six runs with six runs with eight subjects seated 80 cm from each other), across direction and degree of stimulus presented to hemifield contralateral to targets. Two eye runs, with at each stimulus onset asynchrony level were run for eight subject runs (six runs with eight subjects seated 80 cm from each other), across direction and degree of stimulus presented to hemifield contralateral to targets. Two eye runs, with one subject run with a stimulus presented contralateral to the target.

Figure 3. Negative targets; contralateral negative masks.

Figure 4. Negative targets; ipsilateral negative masks.

Discussion

It is clear that paradigms which use positive lateral masking are seriously flawed. Contralateral backward masking only the hemifield ipsilateral to the target mask presented contralateral to the target contrast and makes the target more difficult to detect. Pattern-masking stimuli we used are
adequate for masking since we demonstrate masking when negative targets and masks are presented to the same hemifield.

The differential effects of homogeneous light, random noise, and pattern masks have been studied extensively and are reviewed in Felsten and Wasserman (1980). Masking by homogeneous light or by random noise is dependent on the ratio of target energy to mask energy, while pattern masking is relatively insensitive to target and mask energy. Homogeneous light and random noise masks are effective only at relatively short SOAs, while pattern masks are effective over a wider range of SOAs. Our findings, that the positive contralateral mask was effective only over very short SOAs while the negative ipsilateral mask was effective over the entire range of SOAs, are consistent with masking by homogeneous light with positive contralateral masks and pattern masking with negative ipsilateral masks.

Braff and Saccuzzo (1985) have recently reported further evidence of contralateral masking. Their masks, displaced less than 1.5° from the central fixation point, were presented to a fixed hemifield within each block of 120 trials. Neither eye movement nor eye position were monitored. They used polarized filters to present positive targets and masks dichoptically. The hemifield of the target varied randomly within each block. They found contralateral masking to be less effective than ipsilateral masking and to persist over longer SOAs than had been reported by Saccuzzo et al. (1982).

There are two methodological problems with study. First, since the position of the may have developed a strategy for target from the central fixation point, possibility to the same hemifield. In the absence of movement, it is essential to randomize the study utilized positive stimuli in luminance by 75%. It was not stated whether luminance was necessary for contralateral pattern were the source of the masking minimal, since pattern masking is relatively energy. However, if contralateral mask target luminance, it would more likely light field ipsilateral to the target than target. In order to firmly establish the contralateral pattern mask rather than negative targets and masks should be used.

Until more compelling evidence presented, one must assume on the basis opinion, it would be surprising if cor to envision what neurophysiological postulates that backward masking occur out the sustained detailed image masking of information in one hemif field would probably not be use.
There are two methodological problems with the Braff and Saccuzzo (1985) study. First, since the position of the mask could be anticipated, the subjects may have developed a strategy for target detection which involved fixation away from the central fixation point, possibly resulting in target and mask presentation to the same hemifield. In the absence of monitoring of eye position and eye movement, it is essential to randomize both target and mask hemifield. Second, the study utilized positive stimuli in which mask luminance exceeded target luminance by 75%. It was not stated whether this difference in mask and target luminance was necessary for contralateral masking to occur. If the contralateral pattern were the source of the masking, the influence of mask energy should be minimal, since pattern masking is relatively independent of target and mask energy. However, if contralateral masking only occurs with greater mask than target luminance, it would more likely be due to masking by the homogeneous light field ipsilateral to the target than by the pattern mask contralateral to the target. In order to firmly establish that an observed masking effect is due to the contralateral pattern mask rather than to ipsilateral homogeneous light, negative targets and masks should be used.

Until more compelling evidence for contralateral backward masking is presented, one must assume on the basis of our results that it does not occur. In our opinion, it would be surprising if contralateral masking did occur; it is difficult to envision what neurophysiological function it might serve. Breitmeyer (1980) postulates that backward masking could serve binocular foveal vision by blanking out the sustained detailed images when fixation is shifted. In this context, masking of information in one hemifield by subsequent information in the other hemifield would probably not be useful.

REFERENCES