Facilitation of visual backward masking by increasing target duration: A methodological extension[1]

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Two separate experiments confirmed the previously reported finding that, within limits, increasing the duration of a visual target facilitates backward masking. Increasing the target duration has one of two unavoidable results: It decreases the interstimulus interval separating the target from the mask, or it increases the time period from target onset to mask onset. While both manipulations have been reported to facilitate masking, the data of the present two experiments cannot be explained directly by reference to either the interstimulus interval or the target-onset/mask-onset interval.

The presentation of two visual stimuli, closely in time, to the same or adjacent retinal areas can result in one stimulus interfering with the perception of the other. When the second stimulus interferes with the perception of the first, the effect is called "visual backward masking." Purcell, Stewart, & Dember (1969) have found that the amount of backward masking can be increased by increasing the luminance or duration of the target field. The present paper is concerned specifically with the finding that the detection of a black disc target, followed by a black ring mask, can be reduced by increasing the target duration. Of special interest is the paradigm used by Purcell, Stewart, & Dember (1969) to investigate the effect of stimulus duration on target detection. Two target durations, 5 and 10 msec, were studied; the interstimulus interval (ISI) was the same for both conditions of target duration. As a result, the interval from the onset of the target to the onset of the mask ($-\Delta t$) was lengthened 5 msec when the target duration was increased to 10 msec. Purcell, Stewart, and Dember argued that the reduction in target detection resulted from an increase in target duration. It has been reported, however, that increases in $-\Delta t$, up to some point, have resulted in decreased target detection (Averback & Coriell, 1961; Weisstein, 1966; Weisstein & Haber, 1965). It may be argued, then, that Purcell, Stewart, and Dember confounded an increase in target duration with an increase in $-\Delta t$. Because of this confounding, it is difficult to assess the meaning of their results.

METHODOLOGY

Two visual backward-masking experiments were designed in an attempt to clarify the issue of whether visual backward masking is facilitated through increasing target duration or through increasing $-\Delta t$. Experiment 1 was designed to study the effect of increased target duration on detection when $-\Delta t$ is held constant (see Fig. 1a). Experiment 2 was designed to study the effect of increasing $-\Delta t$ while holding target duration constant and then comparing its effect with the result of increasing $-\Delta t$ by increasing target duration (see Fig. 1b). The measure of backward masking in both experiments was taken as the per cent of trials that a S correctly detected in which one of two possible spatial positions the target was presented. The target was a black disk, subtending 24 min of arc, and in both experiments was presented in a 180-min square white field. The target was followed, after a suitable delay, by a 180-min square masking field. The luminance of the target field was 30 ft-L; the duration of the target disk and its field was either 5 or 10 msec, as conditions required. The masking field contained two black masking rings (inner diam, 24 min of arc; outer diam, 48 min of arc) oriented to the left and right of the center of the field (57.6 min of arc center-to-center). In both experiments, the luminance of the masking field was 40 ft-L, and its duration was 75 msec; during both the ISI and the intertrial interval, the viewing field was dark except for four peripheral pinpoint red lights that served to guide fixation. The presentation of stimuli was via a Scientific Prototype tachistoscope (Model GB). Ss were dark adapted for 10 min prior to the experiment. All viewing was monoptic, right eye. On each trial, the disk was placed to appear in the center of one of the rings according to a random sequence. The S's task on each trial was to indicate, through verbal report, in which of the two masking rings the target disk appeared. Ss were instructed to guess when it was not clear to them in which ring the disk appeared. Each trial was initiated by S after a ready signal was given by E.

EXPERIMENT 1

Fifteen Ss were run under both of the two experimental conditions, 50 trials per condition in blocks of 10, with blocks randomized. The ISI was individually selected for each S in a pretest with a 5-msec target to yield 60% to 70% correct detection, corrected for guessing. The point of this procedure was to provide an ISI for each S at which both increases or decreases in detection could be manifested as target duration was increased. The mean ISI obtained was 30 msec. Under Condition 1, the duration of the target was 5 msec. Under Condition 2, each S was run using the same $-\Delta t$ values used under Condition 1, but target duration was 10 msec. In effect, the ISI in Condition 2 was 5 msec shorter than the ISI in Condition 1 (see Fig. 1a).

In Experiment 1, Condition 1 yielded 63.46% correct detection, corrected for guessing and averaged across Ss. The corresponding value for Condition 2 was 40.80% [$t(14) = 2.65$, $p < .02$]. In this experiment, however, increasing the target duration had the effect of decreasing the ISI. A number of experiments have shown that decreasing ISI can result in a decrease in target detection (see Weisstein, 1968). Because of this, it is impossible to tell if the reduction in target detection in Condition 2 was the result of increased target duration or decreased ISI.

EXPERIMENT 2

Experiment 2 consisted of three conditions and was designed to clarify the results of Experiment 1. Twenty naive Ss were run under all three conditions, 50 trials per condition in blocks of 10, with blocks randomized. The duration of the target in Condition 1 was 5 msec. As in Experiment 1, the ISI associated with this condition was selected to yield 60% to 70% correct detection, corrected for guessing. The mean ISI obtained was 24 msec. Condition 2 consisted of a 10-msec target with the same ISI as in Condition 1. This resulted in $-\Delta t$ being increased by 5 msec over $-\Delta t$ in Condition 1. Conditions 1 and 2 are a replication of Purcell, Stewart, &

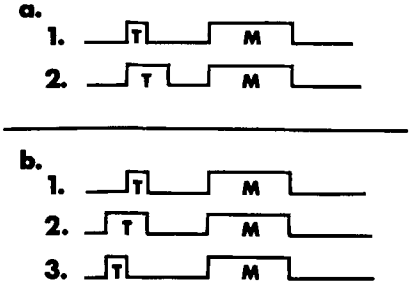

Fig. 1. (a) Schematic showing temporal relationship of the target (T) to the mask (M) in Experiment 1. T = 5 msec in Condition 1, T = 10 msec in Condition 2. (b) Schematic showing temporal relationship of T to M in Experiment 2. T = 5 msec in Condition 1, T = 10 msec in Condition 2, and T = 5 msec in Condition 3.

Dember (1969). A third condition was run to determine if an increase in $-\Delta t$, without increasing target duration, would result in a decrease in target detectability with these luminance and ISI values. Condition 3 consisted of a 5-msec target with the same $-\Delta t$ as in Condition 2 (see Fig. 1b).

The mean per cent correct, corrected for guessing, obtained under each condition was: Condition 1, 66.20%; Condition 2, 57.00%; Condition 3, 75.80% [$F(2,28) = 8.38$, $p < .01$]. A Duncan's range test demonstrated that both Conditions 1 and 3 were statistically different from Condition 2 ($p < .01$).

DISCUSSION

Experiment 1 demonstrated that it is possible to reduce the detection (i.e., increase masking) of a black disk target by increasing its duration while holding $-\Delta t$ constant. This suggests that the previous finding that target detection was reduced by increasing target duration is not simply an artifact of increasing $-\Delta t$ (Purcell, Stewart, & Dember, 1969).

In Experiment 2, comparison of the results of Conditions 1 and 2 replicates the previous finding that increasing target duration while holding ISI constant can decrease target detectability (Purcell, Stewart, & Dember, 1969). The finding that Condition 2 yielded less detection than did Condition 3 replicates the results of Experiment 1 in this paper. The finding that Condition 1 did not yield more detection than did Condition 3 indicates that, with the parameters used in this study, increases in $-\Delta t$ alone do not decrease target detection. The finding that Condition 3 gave more correct detections than did Condition 1 indicates that the results of Experiment 1 may be the result of decreased ISI. However, the finding that Condition 2 gave fewer correct detections than did Condition 1 indicates that increased target duration served to reduce target detections even further than simply decreasing ISI. Purcell, Stewart, & Dember (1968) have used the concept of lateral inhibition in explaining visual backward masking, and these results support the interpretation they have proposed.

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NOTE

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Schematic concept formation in relationship to mental ability in adolescents

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The relationship between schematic concept formation (SCF) and intelligence was studied with adolescent Ss. Sixty Ss (mean age 16 years) performed a two-schema discrimination task using stimuli generated by the VARGUS 9 computer system. Intelligence quotients of Ss ranged between 70 and 140, as measured by the California Test of Mental Maturity. Positive correlations were found between the SCF test and the CTMM total score ($r = .36$), CTMM language score ($r = .28$), and the CTMM nonlanguage score ($r = .42$). No relationship between SCF and sex was found. Potential utility of the SCF task in studies of individual differences in learning are discussed.

Schema theory proposes that humans abstract and use the redundant aspects of the environment to reduce information processing and storage requirements. Evans (1967a) proposed schematic concept formation (SCF) to account for schema learning under environmental conditions in which humans are confronted with instances of various schema families mixed together. According to this theory, humans develop the ability to assign objects to their corresponding schema families on the basis of the information derived from perceiving the objects, without any other external source of information regarding the appropriate categorization and without prior familiarization with the relevant schemata. The basis for this process is assumed to be the overdetermination of the categories or, in other words, the redundant information associated with the categories.

Many of the significant learning situations involve concept formation, and yet knowledge of this important process is limited. The process of SCF has been demonstrated and related to stimulus and task variables in a number of studies (Brown, Walker, & Evans, 1968; Edmonds & Mueller, 1967b; Rosser, 1967; Evans & Edmonds, 1966). The present study investigated the relationship between SCF and intelligence, as measured by the California Test of Mental Maturity (CTMM).

It was hypothesized that a positive correlation would be found between scores on the CTMM and scores on a SCF test for adolescent Ss. Because SCF does not involve language, a significantly higher correlation was expected between the SCF test and the nonlanguage subtest of the CTMM than between the SCF test and the language subtest. Also, on the basis of observations made during previous SCF research, it was hypothesized that a significant difference would be found between the male and female Ss on their SCF test scores.

SUBJECTS

Sixty adolescent children (mean age, 16 years) were selected on the basis of CTMM total IQ scores. Ten male and 10 female Ss were selected from the following three IQ groups: subnormal, IQ range from 70 to 85 (mean = 77); average, IQ range from 90 to 109 (mean = 100); and superior, IQ range from 120 to 140 (mean = 129).

STIMULI

The VARGUS 9 system (Evans & Mueller, 1966) produces patterns of numbers randomly sampled from a defined population having specifiable information or redundancy characteristics. The sequence of numbers may be mapped into proportional column heights, resulting in patterns described as histoforms, or the numbers may be plotted like a line graph, as illustrated by Rankin & Evans (1968). The stimuli used by Rankin and Evans were also used in this study. The stimuli represented examples of two schema families at 70% redundancy.

PROCEDURE

The SCF task described by Rankin & Evans (1968) was used as a measure of SCF