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A latency measure of metacontrast

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Perceived-order latencies were obtained with stimulus-onset asynchronies (SOAs) ranging from −200 (test preceding surround) to +200 msec. When the test stimulus preceded the surround, no appreciable change of latency was obtained; therefore, the results of the present study are in agreement with previous studies which found no effect of SOA on reaction time. Since effective brightness of a test stimulus is reduced maximally when the test stimulus precedes the masking stimulus by about 75 msec, the present study and previous reaction time studies indicate that mechanisms mediating latency are different from mechanisms mediating brightness.

Since reduction of test stimulus luminance increases perceptual latency (Alpern, 1954; Arden & Weale, 1954; Vaughan, Costa, & Gilden, 1966), it might be expected that reduction of test stimulus brightness by means other than reduction of luminance would increase perceptual latency. Under conditions of metacontrast, maximum reduction of effective test stimulus brightness occurs when the test stimulus precedes the masking stimulus (surround) by 50 to 125 msec (Alpern, 1953; Matteson, 1969; Schiller & Smith, 1966). Several studies using reaction time (RT) as a perceptual latency measure found no change of RT when the test stimulus preceded the masking stimulus (Fehrer & Raab, 1962; Fehrer & Smith, 1962; Harrison & Fox, 1966; Lappin & Eriksen, 1964). Schiller and Smith (1966) found increased RT when masking and test stimulus onsets were simultaneous, and they attributed this effect to stray light. Helson and Steger (1962) did obtain increased RT when the test stimulus preceded the masking stimulus, but Lappin and Eriksen (1964) argued that the verbal "ready signal" used by Helson and Steger might have biased their results. Breitmeyer and Ganz (in press) and Weisstein, Ozog, and Szoc (1975) hypothesized that maximum reduction of test stimulus brightness occurs when the test stimulus precedes the masking stimulus because the inhibitory effects of the masking stimulus are mediated by transient neural units, whereas test stimulus brightness is mediated by sustained units. Since transient units have shorter latencies than sustained units (Breitmeyer, 1975), maximum interference with test stimulus brightness would be predicted when the test stimulus precedes the masking stimulus. Since latency would be most apt to be mediated by transient units (which respond best to moving or flickering stimuli), the effect of a masking stimulus on latency would be expected to have a different time course than the effect of a masking stimulus on test stimulus brightness. Breitmeyer and Ganz (in press) and Weisstein (1972) both ascribe considerable theoretical importance to the finding that RT is unaffected under conditions of metacontrast.

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The present experiment was conducted to study the effects of SOA on latency with the perceived-order method. Perceived-order measures have some advantage over RT, because decision-time and motor components inherent to RT are absent. Since all previous studies of latency under conditions of metacontrast used RT, the possibility remains that latency increases might have been obscured by decision time or motor component effects.

METHOD

The two subjects, J. L. and T. F., were males aged 22 and 25 years. Both had at least 20 h of practice prior to testing. The three-channel Maxwellian-view optical system has been described previously (Matteson, 1969). The light source was a tungsten bulb, and timing was accomplished with a digital timer. Test and comparison stimuli were 30-min disks centered 1 deg 30 min above and below the fixation point, respectively. The surround was 33 min inner diam and 1 deg 30 min outer diam. Test and surround stimuli were presented concentrically to the right eye, and the comparison stimulus was presented to the left eye. The stimulus configuration was diagrammed in a previous paper (Flaherty & Matteson, 1971). Test stimulus luminance was 72,000 trolands (td) and comparison luminance was 52 td. Two surround luminances were used: 11,600 td and 104 td. Stimulus-onset asynchrony (SOA) was defined as test stimulus onset minus surround onset. For example, an SOA of +200 indicates that surround onset preceded test onset by 200 msec. Ten SOAs were used: nine values ranging from +200 to −200 msec and a no-surround control condition.

Points of subjective simultaneity were obtained with the perceived-order method, in which the interval between test and comparison stimuli is varied to make the occurrence of the two stimuli subjectively simultaneous (Alpern, 1954; Arden & Weale, 1954). Two intertwined staircase series were used, and the

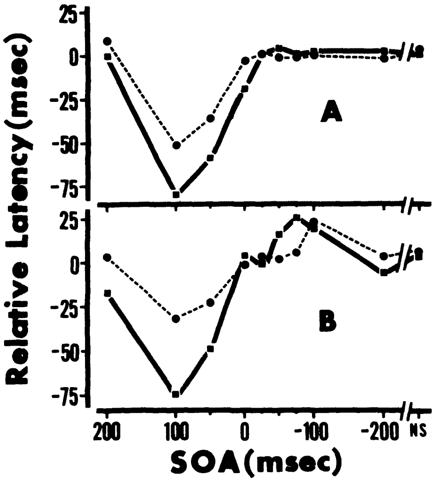

Figure 1. Mean relative latency as a function of stimulus-onset asynchrony (SOA) between test and surround stimuli with a 72,000-td surround (squares, solid line) and a 104-td surround (circles, dashed line) for J. L. (A) and T. F. (B).

two series were one half step size apart. The only procedural difference from an earlier study (Matteson, 1970) was that additional trials with SOAs other than the one being measured were included. The additional trials were randomly interspersed with test trials in an attempt to force the subject to attend only to the test stimulus. Additional trials were limited to 100 msec on either side of the SOA being measured and were multiples of 50 msec from the SOA. For example, during determinations with an SOA of −75 msec, the surround was also presented at asynchronies of +25, −25, −125, and −175 msec. There were half as many additional trials as test trials under a given experimental condition. Subjects were dark adapted for 20 min prior to observations, and 2-min rests were given after blocks of 15 trials. Two determinations were made under each combination of experimental conditions. Determinations were made at two randomly chosen SOAs in a single session.

RESULTS AND DISCUSSION

The main effect of SOA was statistically significant for both subjects ($p < .01$), but appreciable changes of latency occurred only when the surround preceded the test stimulus (see Figure 1). With an SOA of +100 msec, latency was 75 msec shorter than when no surround was presented (i.e., the comparison had to be presented 75 msec earlier when the surround preceded the test stimulus by 100 msec.) The latency reduction at positive SOAs was greater with the high-luminance surround. The main effect of surround luminance was significant at the .01 level for both subjects. The interaction of SOA by Surround Luminance was statistically significant for T. F. ($p < .01$), but it was not significant for J. L. ($p > .05$).

The reduction of latency when the surround preceded the test stimulus is opposite to what would be predicted from the psychological refractory period (Herman & Kantowitz, 1970). Psychological refractory period studies involve choice RT, and increased RT obtained in these studies when another stimulus is presented prior to the test stimulus is usually explained in terms of competing response tendencies. Since the subjects did not have to choose more than one response in this experiment, an obvious explanation for shorter latencies when the surround preceded the test is that the subjects were responding to the surround rather than to the test stimulus. Previous RT studies dealt only with negative SOAs (test preceding surround).

Changes in latency at negative SOAs (test preceding surround) were negligible. J. L. showed no change of latency from −25 to −200 msec (Figure 1A), and these values were all very close to his latency value with no surround. With the high luminance (11,600-td) surround, J. L.'s latency was shorter when the surround was presented simultaneously with the test stimulus than with no surround. T. F. showed some increase of latencies at negative SOAs (Figure 1B); however, this increase was almost as large with the low luminance (104-td) surround as with the high luminance surround. With brightness-matching measures, there is no metacontrast when surround luminance is lower than test stimulus luminance (Alpern, 1953; Matteson, 1969). Thus, the small increase of latency obtained from only one subject has nothing in common with metacontrast. Perhaps it resulted from a tendency for T. F. to respond to the surround even when the test stimulus preceded the surround. Both subjects showed appreciable metacontrast with a suprathreshold brightness-matching procedure in which the luminance of the test stimulus is varied to maintain constant brightness (Flaherty & Matteson, 1971), and these brightness measures were made over the same period of time as the latency measures reported in this paper. Flaherty and Matteson also obtained measures with a comparison stimulus adjusted to match the brightness of a constant-luminance test stimulus. These measures were highly variable and showed no evidence of metacontrast; however, the problem might well have been glare from the comparison stimulus at those SOAs where metacontrast was minimal (Growney, Weisstein, & Cox, 1975). A low luminance comparison stimulus was used in the present experiment. Since the present study was conducted with the perceived-order method, which does not involve decision time and motor components inherent to RT, the results of the present study add generality to the conclusion that latency is unaffected under conditions of metacontrast, which is based on earlier RT studies (Fehrer & Raab, 1962; Fehrer & Smith, 1962; Harrison & Fox, 1966; Lappin & Eriksen, 1964). In terms of a recent theoretical approach to masking (Breitmeyer & Ganz, in press; Weisstein, Ozog, & Szoc, 1975), reduction of test stimulus brightness involves inhibition of slow-responding sustained cells by fast-responding transient cells, whereas masking of latency would involve inhibition of transient cells by transient cells. Thus, any increase of latency would be predicted to be maximal when test and masking stimuli are presented simultaneously (Schiller & Smith, 1966).

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