Visual velocity discrimination: Effects of "blanking" the stimulus¹

Frank J. Mandriota
PRINCETON UNIVERSITY²

Abstract

Weber ratios were obtained for visual velocity discrimination under two stimulus conditions which differed only with regard to the presence of visible continuous motion.

Discrimination of velocity under normal conditions was compared with discrimination under "blanked" conditions. In the latter, Ss saw only the initial and final positions of a target separated in time by intervals comparable to the duration of the motions seen under the former condition.

Difference thresholds for blanked motion are approximately double those for continuous motion over a wide range of velocities.

Problem

When two stimulus velocities are compared by a human observer, the difference threshold is not a simple function of the values of distance and time of the respective stimulus movements. Stimulus size, shape and luminance; topographical features of the movement field; and the presence of correlated temporal or spatial cues all influence the difference threshold (Brown, 1961; Mandriota et al, 1962). The human observer need not see the entire path of motion to estimate velocity. He may interpolate or extrapolate on the basis of the velocity he has seen. No direct evidence seems to be available, however, concerning how well relative velocity discriminations might be performed when observers see nothing but the total spatial extent and duration of the displacement of an object. Such information may be valuable in specifying velocity discrimination baselines for the human observer.

The present study investigated the effects on velocity discrimination of "blanking" continuous motion. In other words, test stimuli were chosen bearing specific distance/time relationships to each other which were outside of the range of phi movement. Judgments were performed regarding the relative velocities of these stimuli. The precision of these judgments was then compared with judgments under identical conditions except for the inclusion of continuous motion (i.e., ordinary visible movement).

Method

Two female Ss with emmetropic vision viewed successive pairs of velocities generated by moving spots of light on a cathode ray tube. Ss reported whether the second member of the pair was "faster" or "slower" than the first. The stimuli were presented under two conditions referred to as "Heterodimensional" and "Heterodimensional-blanked."

Heterodimensional: At the beginning of a trial the S regarded a 1 in x 2 in area cut out of an opaque mask covering the CRT. This field subtended an area of 342.3 x 684.6 min. of visual angle at 10 in binocular viewing distance. The scale illumination of the oscilloscope provided a brightness of ~ 0.0057 ml. in the stimulus field. No fixation cross was present in the field during two-thirds of the total trials. Each S received 100 trials per standard stimulus which totaled 1200 binocular pursuit trials and 600 binocular fixation trials.

Two to 3 sec. following a warning buzzer a spot of light appeared in the left-hand half of the stimulus field, remained stationary for .75 sec., then moved at a constant velocity to a symmetrical position on the right-hand half of the field, whereupon it stopped for .75 sec. and disappeared. Within 4-5 sec. following presentation of the "standard" stimulus a comparison appeared and followed the same sequence of events. The comparison, however, appeared at one of five different predetermined positions, and moved at velocities different from the standard to the right-hand half of the screen. The different velocities and extents of traverse of the comparison stimuli were uncorrelated and randomly assigned.

Heterodimensional-blanked: This condition was identical in all respects to the heterodimensional condition except that from the time the stimulus appeared and remained fixed for .75 sec. to the time it stopped and remained fixed for .75 sec. it was blanked from the screen. The Ss compared the comparison with the standard and reported which was "faster."

Common to both conditions were: psychophysical method, constant stimuli; stimulus object, spot of light .030 in in diameter; stimulus brightness ~ 0.029 ml; velocities of the six standards, 20.06, 40.12, 80.25, 177.21, 256.35 and 512.71 min. of visual angle per second; and extents of traverse of the five comparison stimuli, 125, 150, 274, 500 and 600 min. of visual angle. For one-half of the trials the order of standard and comparison was reversed. Blocks of 25 trials under each of the two conditions were presented in counter-balanced order. Difference thresholds were calculated using an algebraic equivalent of the average Z score method (Woodworth & Schlosberg, 1954). They were converted to Weber ratios ($\Delta\omega/\omega$) and plotted as a function of angular velocity (Fig. 1).

Results

Figure 1 indicates that the Weber ratios for both Ss under the heterodimensional condition are

Fig. 1. Weber ratio functions for both subjects under heterodimensional and heterodimensional-blanked conditions.

within the range of previously reported values for velocity discrimination (Brown, 1961). When seen movement is blanked, however, velocity differences must be approximately doubled to be detected. It is also apparent that for both conditions the stimulus values selected fell within the range in which Weber's law is valid. Data from trials performed under binocular fixation are indicated by 'X's in Fig. 1. The presence or absence of gross pursuit movements does not seem to affect the results under either condition.

Discussion

Although the parameters of the two velocity displays used in this experiment are mathematically equivalent, blanking the stimulus motion results in considerably poorer velocity discrimination. The presence of a moving image on the retina between the discrete loci of initiation and termination of movement appears to make the difference in the discriminability of the two types of stimulus presentation. The Ss reported a great deal of difficulty in forming their relative velocity judg-

ments when they saw no actual movement. Their performance, however, indicates that they did, in fact, appropriately weigh both the perceived spatial and temporal features of each presentation in the blanked condition. Any other strategy such as systematically relying on either extent or duration cues would have resulted in 50% correct responses, i.e., indeterminate difference thresholds.

One interpretation of the facilitating effect of continuous motion is that it yields a series of momentary confirmations of the relationship between the elapsed time and extent of movement. Succeeding estimates may contribute to a weighted average which determines the overt response. Behavior exhibiting these characteristics has been observed in other contexts such as target detection (Lyman & Fogel, 1961).

It may be worth noting that although the level of behavior observed in this study is far removed from the neural substrate underlying it, the direction of the results agrees with electrophysiological studies demonstrating the considerable information processing occurring at the retinal level. Hartline (1940) and Lettvin (1959) have shown that in lower organisms neural correlates of image velocity can be recorded as close to the receptor as their third order neurones, i.e., the fibers of the optic nerve. In the absence of similar human electrophysiological data, psychophysical data such as those here reported serve to suggest that similar processes occur in the human visual system.

References

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Notes

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2. Present address: Neurology Department, College of Physicians and Surgeons, Columbia University, New York.