

References and Notes

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Aftereffect of Seen Motion with a Stabilized Retinal Image

Abstract. *Prolonged inspection of uniformly moving contours affects differentially the luminance threshold for the detection of test contours as a function of the direction of motion of the test contours. This finding supports a new explanation of the well-known aftereffect.*

If one views a train of contours moving steadily across the visual field and then turns to a nonmoving scene, the stationary scene appears to be in motion. The direction of the movement aftereffect is opposite to the movement of the contours that was initially seen. This widely known and easily observed phenomenon has never been satisfactorily explained (1).

Recently, Hubel and Wiesel (2) have reported neural cells in the visual cortex of the cat which respond to stimuli moving in a single direction within the visual field. Such a finding offers a new basis of explanation of the movement aftereffect. It may be that extended viewing of stimuli moving in one direction can produce differential adaptation at the cortex, affecting only cells sensitive to movement in that direction. Such an explanation has been proposed by Sutherland (3): "the direction in which something is seen to move might depend upon the ratios of firing in cells sensitive to movement in different directions, and after prolonged movement in one direction a stationary image would produce less firing in the cells which had just been stimulated than normally, hence apparent movement in the opposite direction would be seen to occur." If the perception of motion depends upon the action of these direction-specific cells, it follows that prolonged viewing of a stimulus moving in one direction will elevate the threshold for the subsequent detection of stimulus patterns moving in that direction. We made a study (4) to find whether a threshold elevation exists and,

if it does, whether it is related to movement aftereffect. According to the theory, magnitude of the movement aftereffect and magnitude of threshold elevation should be covariant.

To obtain maximal differential adaption to motion it is necessary to present a subject with a stimulus having truly unidirectional motion. This is ordinarily impossible, since involuntary movements of the eye, present even during "steady" fixation, superimpose a random spectrum of eye motions upon the motion of the physical stimulus (5). We eliminated the effect of involuntary eye movements and rendered our stimulus unidirectional by presenting the targets as stabilized retinal images. This technique optically "locks" a stimulus onto one retinal area (6).

The subject focused upon a black point on a luminous circular field subtending a visual angle of 4°30' (luminance 1.19 millilambert). The stabilized target, a rectangle with sides subtending visual angles of 2°14' and 1°35', respectively, was centered within this field. It comprised bright vertical stripes, 6 minutes of arc wide, separated by areas of background field 32 minarcs wide. These stripes could be made to move either to the right or to the left within the rectangle. The stimulus was presented in a 15-second repeating cycle with three phases. (i) Inspection: for 5.0 second the subject viewed the moving stripes (stripe luminance, 1.48 mlam). (ii) Interval: for 2.8 seconds the subject viewed the circular background field; no stripes were presented. (iii) Test: for 7.2 seconds the subject "tracked" his threshold for stripe detection. "Tracking" is a psychophysical procedure in which the subject diminishes the intensity of the stimulus when he detects the target and increases the intensity when he does not detect it (7). During the test phase the subject kept the intensity of the stimulus just above or just below his luminance threshold for stripe detection. Key presses on either of two keys moved a photometric wedge interposed in the optical path of the stimulus so as to modulate intensity either up or down. Recording equipment provided a record of the intensity of the stimulus as a function of time. Catch trials, in which no stripe target was presented, were interspersed during the test phase.

Luminance thresholds for the detection of moving stripes were measured under two conditions. In the "reverse" (R) condition, the direction of motion

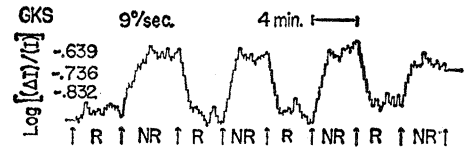


Fig. 1. A continuous record of luminance threshold values during one session. Changes of condition, between R and NR, are shown at the bottom of the record.

during the inspection phase was opposite to that during the test phase; in the "nonreverse" (NR) condition, the direction of motion during the inspection and test phases was the same. According to the prediction, the luminance threshold would be higher in the NR than in the R condition. Threshold elevation was determined in three subjects for various velocities of the stripes. The velocity ranged from 10°50" visual angle per second, where motion is just perceptible, to 15° per second, where the observer reports a blur in which the individual stripes are not discernible. A typical session required 32 minutes of observations. Blocks of tests under conditions R and NR were presented alternately in a balanced design. The same velocities were used for the inspection and the test phases.

For velocities between 4° and 9° visual angle per second, the luminance

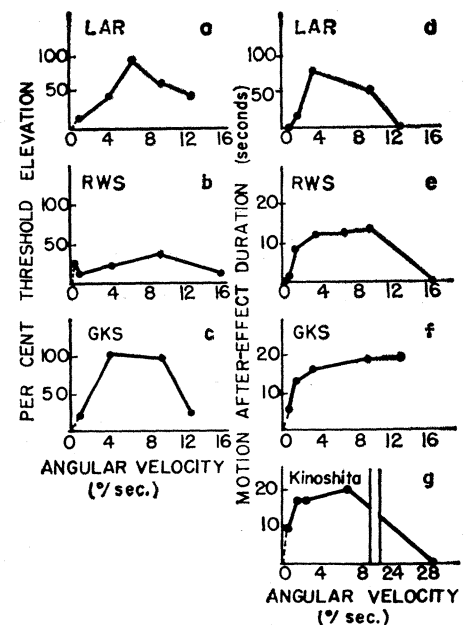


Fig. 2. (a-c) Threshold elevation, 100 [(NR-R)/R], as a function of stimulus velocity. Each point is based on the mean of 170 to 300 measurements. (d-f) Duration of motion aftereffect as a function of stimulus velocity for the three subjects of a-c. (g) Comparable data of Kinoshita on the duration of motion aftereffect, for one subject.

threshold under the *NR* condition was, in every determination, higher than that under the *R* condition. Figure 1 is a record showing the variations in threshold for seen motion through one session. At each introduction of the *NR* condition the threshold rose abruptly. At lower and higher speeds the same effect occurred, though less markedly. Figure 2 (*a-c*) shows the percentage of threshold elevation, $100[(NR-\bar{R})/\bar{R}]$, as a function of velocity for the three subjects. Since conditions *R* and *NR* are indistinguishable at angular velocity of 0° per second, we can assume the absence of threshold elevation at that point. The relationship between velocity and percentage of rise in threshold is curvilinear, with a maximum in the 4- to 9-degree region. In addition, we found, as did other investigators (8), the luminance threshold to be an increasing function of the velocity of the stripes.

To assess the relationship between threshold elevation and motion aftereffect, a measure of motion-aftereffect strength was obtained. The subject viewed the stripes in motion, retinally stabilized, for 1 minute. He then shifted his focus to a stationary textured field (at luminance of 39 mlam) and reported when he no longer saw motion. The field was at the same distance for the inspection and test phases. There was a period of 2 minutes between trials. A number of tests for motion aftereffect were made with the three subjects of the earlier tests, and at a number of velocities.

Figure 2 (*d-f*) depicts the mean duration of motion aftereffect at the velocities studied. Figure 2g shows comparable data from the work of Kinoshita (9). Motion aftereffect occurs

over a broad range of velocities; the relationship is approximately curvilinear, not unlike the threshold-elevation function shown in Fig. 2 (*a-c*). Inter- and intraindividual variability in motion aftereffect makes it necessary to view this last conclusion with caution.

Our results definitely support an explanation of motion aftereffect on the basis of direction-specific cortical adaptation, such as Sutherland has proposed. In accordance with this explanation, it has been shown that the threshold for motion perception changes as a function of the direction of motion. The change in threshold shows peaking and curvilinearity with velocity, much like the motion aftereffect itself.

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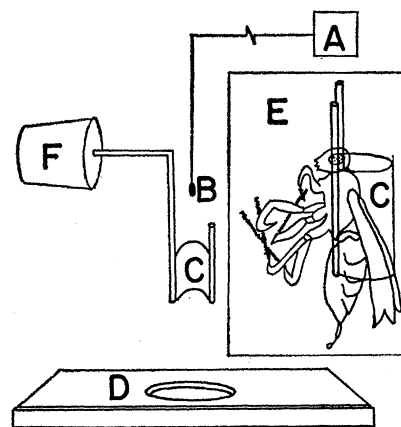


Fig. 1. Procuring venom from a wasp. A, Spark coil with 6-volt d-c power supply; B, nichrome wire; C, brass mesh half-cylinder; D, microscope well-slide; E, insert showing insect mounted in half-cylinder before being wrapped with aluminum ribbon; F, rubber stopper.

bound in place with a $\frac{1}{4}$ -inch ribbon of aluminum foil which is twisted behind the half-cylinder. The mounted insect is supported by a clamp directly beneath a nichrome wire lead from a spark coil (about 10,000 volts) (3). A microscope well-slide is placed under the insect in such a manner that only the sting lancet reaches into the well. The well-slide can be filled with agar or agarose gel for microdiffusion studies of venom antigens or the empty well can be used for collecting the venom. As the insect begins to revive, it is excited by a brief high voltage shock, controlled by a key switch, until venom is secreted. The venom on the slides may be dried in a vacuum over phosphorus pentoxide. The dried venom may be stored at 0°C for several months without loss of activity. With this apparatus, two or three insects can be "milked" each minute with no apparent effect on the insect except pronounced hunger and thirst.

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3. Obtained from the Central Scientific Co., Chicago.

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Hymenoptera: Pure Venom from Bees, Wasps, and Hornets

Abstract. Pure venom can be obtained from bees, wasps, and hornets by electrical stimulation with inexpensive apparatus.

The methods which have been described for obtaining bee venom by electrical excitation (1) are not applicable to certain wasps and hornets because of insufficient excitation voltage or because of the danger of fighting among these insects.

The method described here (2) has been found adequate for obtaining pure venom from one to several hundred individual bees, wasps, or hornets. The insects suffer no apparent damage and

many may often be used for repeated venom extractions. Samples obtained are readily prepared for microanalyses or immunologic studies.

The apparatus (Fig. 1) consists of a small (about $\frac{1}{4}$ -inch diameter) half-cylinder of fine brass mesh about $\frac{1}{2}$ -inch long soldered to the end of a 2-inch length of rigid iron wire which is bent for insertion into a rubber stopper. The insect is anesthetized with carbon dioxide, placed in the half-cylinder, and