Quantitative Determination of Autokinetic Movement: Rate, Direction, Extent, and Latency [1]

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THE DEVELOPMENT of precise methods for measuring subjective phenomena is both an enigma and a challenge in psychological research. It is basically an attempt to translate subjective experience into measurable behavior. Techniques for measuring the subjective movement of a stationary spot of light (autokinetic movement), for example, have been proposed by several researchers.

Guilford and Dallenbach (1928) employed a tracing method whereby *S* was instructed to trace the pattern of autokinesis with a pencil as he perceived the movement. Direction of apparent movement was readily obtained. The accuracy of this method for measuring the extent of autokinetic movement, however, was recently questioned by Bridges and Bitterman (1954). In addition, such autokinetic criteria as latency and rate of movement were not available with this technique.

Bridges and Bitterman (1954) reported a different approach to the problem. They attached the autokinetic stimulus to a lever, which permitted the spot of light to be moved in two dimensions on the frontal parallel plane. *S* was instructed to maintain the spot of light in its apparent starting position by lever-control movements. By recording lever displacements on a constant-speed kymograph, Bridges and Bitterman were able to obtain quantitative measures of rate, direction, extent, and latency of autokinetic movement. It was later pointed out, however, that this quantitative method confounded autokinesis with real movement, introducing error into the measures of rate and extent (Conklin, 1955). The Bridges and Bitterman apparatus, therefore, permitted only an approximate measure of apparent movement, particularly, since no attempt was made to train *S* in compensatory tracking before presenting the autokinetic situation.

The apparatus described here measures autokinetic movement by recording *S's* open-loop pursuit tracking response. This is preceded by training with real movement—developing skill in guiding tracking responses by kinesthetic feedback. The procedure is simple. *S* is trained to follow a moving spot of light with a control under conditions where autokinesis is absent. When ac-

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complished in this task, *S* is presented with the autokinetic situation. The tracking task is identical, and since *S* is not informed of the illusory nature of spot movement, precise measures of autokinetic criteria are attainable. (In checking the apparatus, *E* discovered that even individuals who are aware of the autokinetic phenomenon do a creditable job in tracking the apparent movement.)

Apparatus

Spot presentation, rate control, and exposure time. The autokinetic and training stimulus is projected from an oscilloscope (DuMont Oscillograph Type 340) by means of a projection lens (DuMont Oscillograph Projection Lens Type 2542) to a screen (Radiant Screen, Colorflect Model) located 100 inches away. This method of presentation is discussed in detail elsewhere (Conklin, Baldwin, and Brown, 1953). A slight modification of the wiring permits spot travel to be regulated separately in two dimensions. The rate of spot movement is controlled by condensor-resistor charging circuits as described in the earlier publication. The duration of stimulus presentation is controlled by cam-microswitch circuits (Eagle Multipulse Repeat Cycle Timer) furnishing intervals of ½, 1, 2, 4, 8, and 16 seconds. The oscilloscope is mounted on a platform above and behind *S*, adjusted and focused so that a clear spot of green light (½ inch in diameter) is projected on the exact center of the 40 by 40 inch screen.[2]

Two-dimensional control. A war-surplus gun-fire control sighting station, Model 2CSR386, has been modified for use in this apparatus (see Fig. 1). The vertical and horizontal Selsyn generators were replaced by "micropots" (high-precision linear potentiometers) and wired directly to a voltage source and a two-channel recording unit (Sanborne Twin Visa Recorder, Model 60-1300 utilizing DC General Purpose Amplifiers, Model 64-300). The sensitivity of the recorder has been adjusted so that 18.43° of control rotation (train and elevation) develop a 20-millimeter displacement of the recorder stylus. This represents a 20-inch displacement from center to any edge of the screen with the axis of control rotation located 60 inches away. The control has no influence on spot movement and can be pointed to any location on the projection screen.

Head-rest. The head-rest is anchored firmly to a concrete wall at a fixed height; locating *S's* eyes 72 inches from the center of the projection screen. An adjustable chair is used to take into account individual differences in trunk

[2] The projection screen is mounted by ½-inch plywood anchored to the concrete wall of the experimental room. Hinged to this is a second plywood square constructed to hold "satiation" figures drawn on 40-by-40-inch white cardboard. The main experiments are designed to investigate the effect of figural inspection on autokinetic movement and the lower rate threshold.

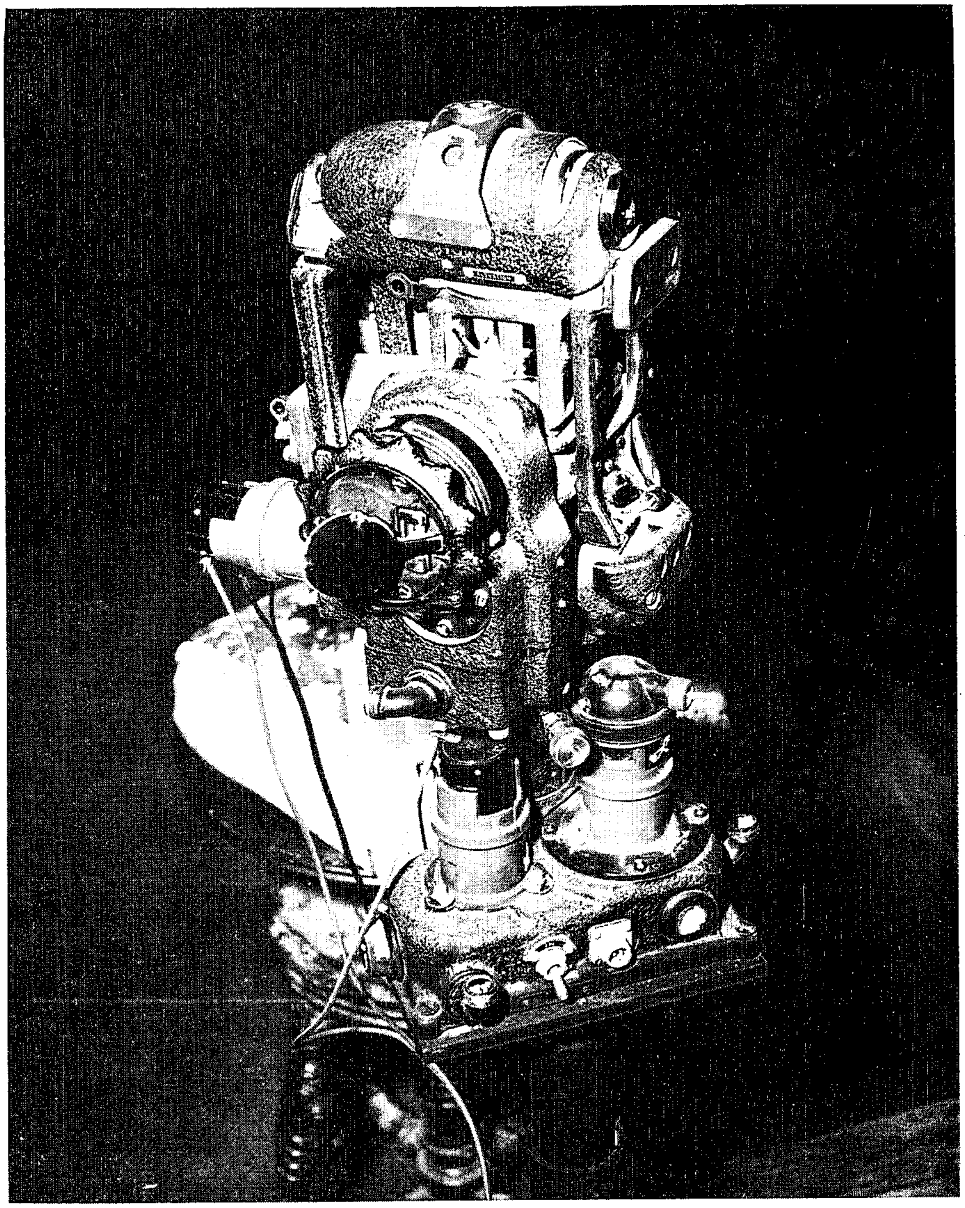

Figure 1. Two-dimensional control for tracking autokinetic movement.

length. The head-rest permits head rotation in the horizontal plane, calibrated in degrees from the straight-ahead position.

Dark room. Within the experimental room, a dark room has been constructed having the inside dimensions of 65 by 140 by 93 inches in width, length, and height, respectively. A solid framework composed of 2 by 4 inch boards is anchored by two sides to the concrete walls of the research room. Two layers of heavy black material cover this frame, constituting an extremely dark environment when the overhead lights are shut off. The control panel is located behind the framework illuminated by a 10-watt incandescent lamp. During the training procedures, the curtains are parted on one side of the dark room and the overhead lights turned on—permitting sufficient structure of the visual field to prevent apparent movement.

Procedure

Training procedure. *S* is immediately informed that the experiment is concerned with how well an individual can follow a moving spot of light in total darkness by the "feel of the control." He is installed in the head-rest and advised on the operation of the control, located in front of him but below the line of sight. In addition, *S* is instructed that he will be given practice in following horizontal and vertical spot movements in dim illumination before the main experiment. *S* is cautioned to avoid looking at the control position during practice in order to insure that his tracking responses are guided only by kinesthetic feedback.

Practice consists of training *S* to follow rates of spot movement ranging from 0.5° to 4.0° of visual angle per second. Before the first trial, *S* is instructed to move the control to the right until it points to the edge of the screen. By observing this response on the recorder, *E* gives immediate knowledge of results and corrects any over- or undershooting of the edge. *E* then instructs *S* to return the control to center, and then point it to a position that is halfway between the center and the edge of the screen. These procedures are similar for control movements to the left, up, and down. *S* is constantly reminded to try to get the "feel of the control" in order to guide his tracking movements. The learning of this task is relatively simple.

Practice sessions in open-loop tracking are then given for horizontal motions of the spot at time exposures of 4, 8, and 16 seconds. The rate of spot movement is determined for each time interval so that the spot moves from center to the edge of the screen, or to a point halfway between the edge and center. Thus for time intervals of 4, 8, and 16 seconds the target rates employed are 2.0 and 4.0, 1.0 and 2.0, 0.5 and 1.0 degrees of visual angle per second, respectively. Practice is continued for each rate of spot movement (to the right and left) until *S* tracks perfectly as indicated by his response on the recorder. These procedures are identical for the vertical dimension.

Autokinetic procedure. Following the practice sessions, *S* is permitted a five-minute rest period in dim illumination (illumination from a 15-watt lamp mounted above *S's* head and spotted on the screen automatically between trials). During the rest period, *S* is instructed that his tracking performance will be tested in the darkness with different head orientations in the horizontal plane. Before the autokinetic stimulus is presented, *S* is instructed to move his control to the horizontal and vertical edges of the screen and back to center to see if he still retains the "feel of the control."

Eight autokinetic trials are then recorded for five head orientations, viz., 40° and 20° to the right and left, and one to the center. The order of head orientations is determined by a table of random numbers. The autokinetic stimulus is presented for 16 seconds while the control movements are recorded for train and elevation. After each trial, *S* is instructed to return his control to the center position—minor corrections verbally initiated by *E.* The next autokinetic trial begins immediately following a "ready" signal.

Subjects. Eight male and eight female undergraduates at Montana State College served as *Ss* for this illustrative experiment. They gave no indication that they were aware of the autokinetic illusion, or that they had been tracking an apparent movement.

Results

Autokinetic records of four *Ss* (chosen at random) are reproduced in Figure 2 for different head orientations. These tracings of control variations in elevation and train denote the travels of apparent movement. The data to be reported are concerned solely with the horizontal dimension. Measures of latency, direction, maximum displacement, and average rate of autokinetic movement are readily obtained from these recordings.

Observations reveal that the apparent movement was entirely absent on a few trials. Occasionally, it was perceived entirely in one dimension, e.g., vertically. Figure 3 shows the percentage of trials where horizontal autokinetic movement was seen going to the left, right, or entirely absent as a function of head orientation. The null hypothesis that left and right movements should occur an equal number of times was rejected at the 1-per-cent level of confidence for all head orientations except for the straight-ahead position. These data confirmed the results of Bridges and Bitterman, viz., that the direction of autokinetic movement is significantly and directly related to the orientation of the eyes in the socket.

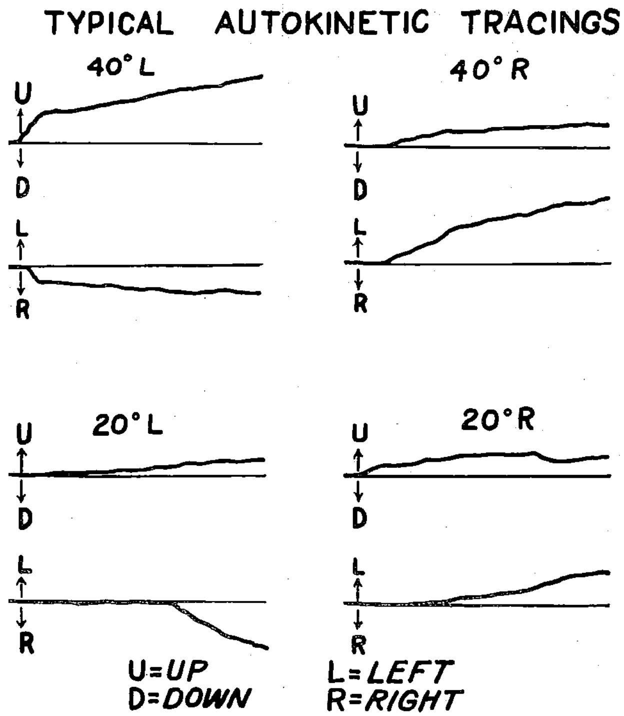

Figure 2. Sample of autokinetic records obtained with four head orientations. (Each tracing represents a different S chosen at random.)

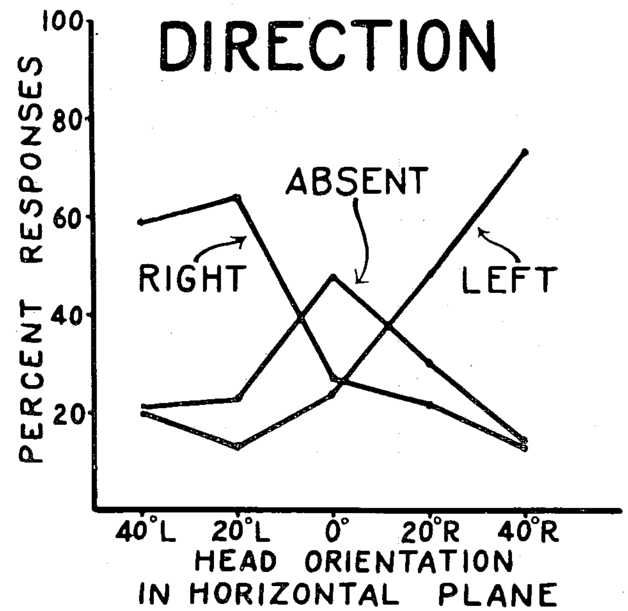

Figure 3. Direction of autokinetic movement as a function of head orientation.

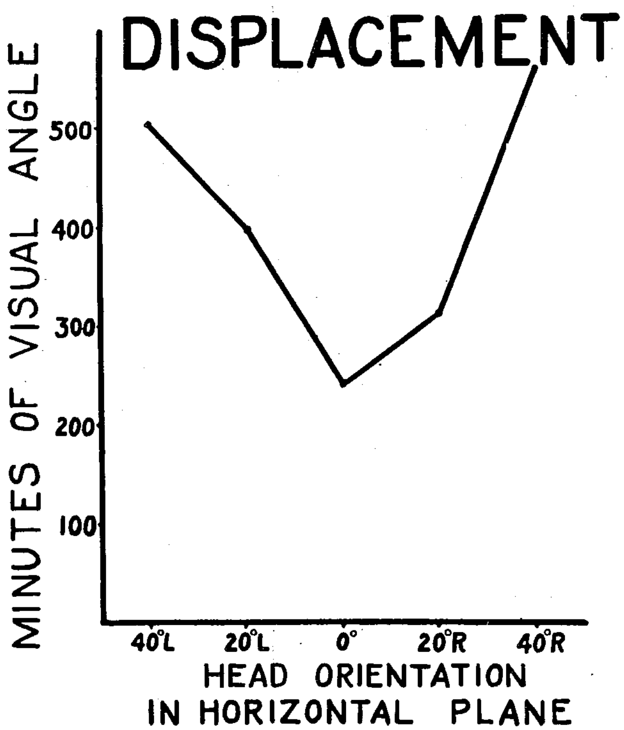

Figure 4. Maximum displacement of autokinetic movement as a function of head orientation.

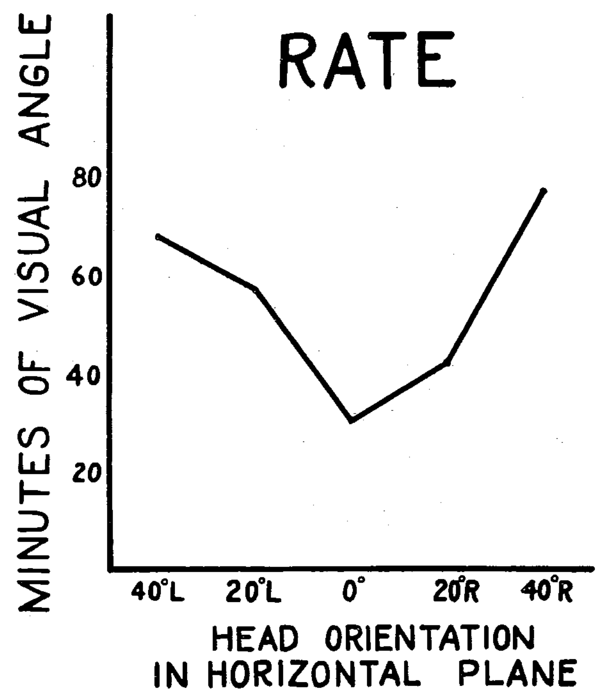

Figure 5. Rate of autokinetic movement as a function of head orientation.

Table 1 contains summary data for the 16 *Ss* regarding the three remaining autokinetic measurements, i.e., latency, maximum displacement, and rate

TABLE 1. MEAN VALUES OF THREE QUANTITATIVE AUTOKINETIC CRITERIA

	Head Orientation				
	40° Left	20° Left	Center	20° Right	40° Right
Latency (sec.)	3.00	5.22	4.08	4.82	3.83
Displacement (min. of arc)	503.07	400.22	241.21	313.81	560.54
Rate (min./sec.)	68.07	57.56	30.53	42.06	77.18

of movement. Apparent displacement and rate consistently decreases and then increases as the head is oriented from 40° left to 40° right—minimum values occurring in the straight-ahead position (see Figs. 4 and 5). Latency, however, does not appear to vary systematically with the experimental variable.

TABLE 2. MEAN DIFFERENCES AND THEIR STATISTICAL SIGNIFICANCE

	Head Orientation					
	40°L-20°L	40°L-0°	20°L-0°	0°-20°R	0°-40°R	20°R-40°R
Latency (sec.)	−2.22**	−1.08*	1.14*	−0.74	0.25	0.99
Displacement (min. of arc)	102.85	261.86*	159.01	−72.60	−319.33**	−246.73**
Rate (min./sec.)	10.51	37.54**	27.03**	−11.53**	−46.65**	−35.12**

* Significant at the 5-per-cent level of confidence.
** Significant at the 1-per-cent level of confidence.

As shown in Table 2, tests of significance were made separately for mean differences. Although the displacement criterion looks promising, the rate of autokinetic movement proves to have a highly significant relation to head orientation. All rate differences between 0° and right or left head positions are significant at the 1-per-cent level of confidence. From the results of this illustrative experiment, it can be concluded that the technique (described above) for obtaining quantitative measures of autokinetic movement is verified.

Literature Cited

Bridges, C. C., and M. E. Bitterman. 1954. The measurements of autokinetic movement. Amer. Jour. Psychol., 67: 525-529.

Conklin, J. E., A. Baldwin, and R. H. Brown. 1953. Apparatus for measuring the threshold for the visual discrimination of direction of movement. Amer. Jour. Psychol., 66: 289-294.

Conklin, J. E. 1955. A note on the measurement of autokinetic movement. Amer. Jour. Psychol., 68: 144-145.

Guilford, J. P., and K. M. Dallenbach. 1928. A study of the autokinetic sensation. Amer. Jour. Psychol., 40: 83-91.

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