# Autokinetic Movement: Selective Manipulation of Directional Components by Image Stabilization

Abstract. *With the retinal image of a 35-minute circular target stabilized against horizontal eye movements, horizontal autokinesis is markedly reduced. It is suggested that this result is consistent with an eye movement interpretation of autokinetic movement, and further, that the response patterns reported here are similar to those that might be expected from recent work describing cortical single unit movement detectors.*

In 1879 Hoppe (*1*) suggested that the autokinetic phenomenon, or the apparent movement of a fixated light in an otherwise dark field, was the result of fluctuations in the retinal location of the target image produced by involuntary eye movements. Since then, only two attempts at directly testing the eye movement interpretation have been reported (*2, 3*). In both studies, a search was made for a correlation between measurements of eye movements and autokinesis, but essentially opposite conclusions were reached. However, due largely to limitations in the techniques of measurement available at the times the studies were performed, both have numerous methodological inadequacies which make if difficult to accept the conclusions drawn from either of them. Even in experiments in which the methodological requirements for meaningful measurements are met, failure to find a correlation between measured eye movments and autokinesis may mean that the appropriate parameters of the eye movements were not chosen for comparison. On the other hand, any correlation that might be obtained would need to be further analyzed with regard to the alternative possibility that the appearance of subjective movement may result in pursuit eye movements.

A straightforward test of the eye movement interpretation of autokinesis would be performed if, independently of eye movements, one directional component of variation in retinal location could be removed. If the eye movement approach had any merit, the identical component of autokinetic movement ought also to be attenuated. This report describes such a test in which autokinesis viewed under conditions of image stabilization (*4*) is compared with autokinesis viewed normally.

Two subjects were used, each of whom wore an individually fitted scleral contact lens with a front-surfaced plane mirror embedded in its temporal margin; the mirror's normal was set at approximately 40 degrees to the subject's fixation axis and in the same horizontal plane. The subject saw in Maxwellian view a circular 35-minute target at optical infinity with luminance about 1 log unit above the dark-adapted foveal absolute threshold. Under the stabilized viewing condition a beam incident on the contact lens mirror was returned to the subject's pupil after passing through a telescopic system with slightly less than 0.5 angular magnification. The stabilized condition was thus arranged so that a horizontal eye movement of 1 degree resulted in a horizontal shift in the location of the retinal image of less than 1 minute; the effect of vertical eye movements was demagnified so that a 1-degree vertical movement resulted in a vertical shift in the location of the retinal image of about 15 minutes. The normal, unstabilized view of the same target could be instantaneously substituted by moving two mirrors into a position which deflected the incident beam through the same optical path without striking the contact lens mirror. For stabilized viewing these mirrors were rotated out of the way, permitting the incident beam to strike the contact lens mirror (*5*).

During experimental sessions the light source was electronically interrupted every 7 seconds for 0.5 second, and the subject reported the direction of the first autokinetic drift (*6*) which occurred during each period when the light was on by pressing one of a ring of eight switches which signalled north, northeast, east, southeast, south, southwest, west, or northwest; no movement was signalled with a ninth switch. In experiments (*a*), (*b*), and (*d*) (Fig. 1), a block of ten measurements in the stabilized condition was regularly alternated with a block of ten in the normal condition throughout each session; in experiment (*c*), random alternation of blocks of three measurements for each condition was employed.

Three features of the results shown in Fig. 1 are of significance here. (i) Both east and west responses were markedly reduced in frequency under stabilized viewing as compared to frequencies under normal viewing. (ii) The overall frequency of diagonal responses was reduced under stabilized viewing, although this was due mainly to reduction in northeast and northwest responses; southeast and southwest response frequencies either showed no marked change or increased under stabilization. (iii) The frequency of "no movement" responses increased under stabilization. These results strongly support the view that autokinesis is due to the occurrence of involuntary eye movements which continually shift the target image across the retina, and are consistent with the notion that local sign is involved in the perception of visual direction.

It might be expected from this interpretation that the normal and stabilized frequency distributions would be similar in each experiment, with the exception that (concurrent with the decrement in east and west frequencies) the "no movement" frequency for the stabilized condition be approximately equal to the sum of the east, west, and "no movement" frequencies for the corresponding normal viewing condition. Such is not the case, however. In each experiment in Fig. 1,

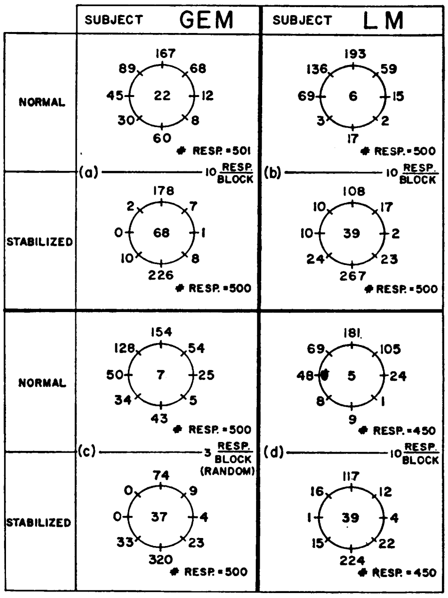


Fig. 1. Results of experiments comparing the frequencies of directional response under stabilized and normal viewing. Each number outside the circumference of a circle refers to the frequency of movement in a given direction, for example, in experiment (*a*) there were 167 north responses and 12 east responses in the normal viewing condition; frequency of "no movement" is given at the center of the circle. Experiment (*d*) was essentially a replication of (*b*) performed at a later date.

northerly responses predominated in the normal viewing condition and southerly responses predominated in the stabilized condition. This result has been analyzed and its basis established in several further experiments which are described elsewhere (*7*). It is also shown there that the result is consistent with the eye movement interpretation for autokinesis.

A neurophysiological basis for our results is suggested by recent work in which electrical recordings were made from single units in the striate cortex of cats (*8*). This work shows that some cortical cells are differentially sensitive to different directions of movement of a pattern across their receptive fields. Thus, for example, some units which are stimulated most effectively by movement in either direction along a given retinal meridian do not respond at all to movement along the meridian perpendicular to the given one and yield small responses to movement along intermediate meridians. A unit of this type may be most sensitive to vertical movement, horizontal movement, or movement along a particular diagonal meridian. Further, some units may be least sensitive to movement at 180 degrees from the direction of movement to which they are most sensitive (see also *9*).

The reduction of horizontal movement during our stabilized viewing condition may be related to the fact that those neural units sensitive to horizontal movement are not being adequately stimulated, while those sensitive to movements in other meridians are still being stimulated. The response of the group sensitive to diagonal movement would be expected to be attenuated, however, since its stimulation now results mainly from vertical movements rather than from movement in those directions to which it is most sensitive. This interpretation of our results, of course, depends on the existence, as yet undemonstrated, of single unit movement detectors in the human visual system, similar to those in cats, and also on the requirement that the output of such detectors be coded in perception so as to retain direction-specific information in the sense of a modern version of specific nerve energies.

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**References and Notes**

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5. Preliminary work showed that two alignment criteria were essential: (i) it was necessary that the stablized view be foveally centered; (ii) when the stablized view was substituted for the normal view, it was necessary that no shift of target location be observed by the subject. These criteria will be discussed more fully in a paper by L. Matin, G. E. MacKinnon, and D. Pearce, in preparation.
6. The autokinetic movements we observed could, without difficulty, be separated into (i) small, short-lasting, jerky, or oscillatory movements which appeared to be of considerably lesser magnitude than the diameter of the fixation target, and (ii) prolonged, slower drifts of larger apparent magnitude. We did not attempt to obtain information on the first type—when such movements do occur, changes in direction are too rapid for the subject to record. The data reported here concern the drifts.
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10. This work was supported by grants G-18120 and GB-944 from the National Science Foundation.

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## Speech Durations of Astronaut and Ground Communicator

Abstract. *Laboratory studies suggest that an interviewer can influence the speech duration of an interviewee by modifications in his own speech duration. What appears to be a related association between the speech duration of communicators on the ground and an astronaut in orbital flight was found.*

In a recent paper (*1*) we reported that an interviewer apparently can influence the duration of interviewee speech by changes in the duration of his own speaking times. The results of the three experiments done in that study are summarized graphically in Fig. 1. In the experiment shown at the top of this figure, an interviewer conducted individually a 45-minute nondirective employment interview with each of 20 normal interviewees. Unknown to the interviewee, the interviewer, while appearing to carry out a straightforward interview, modified his own speaking time per speech unit by limiting each of his comments to 5 seconds for the first 15 minutes, then switching to 10-second comments in the second 15-minute period, and finally returning to 5-second speech durations each time he spoke in the last 15-minute period. The interviewer did not attempt to control the content of the 45-minute interview. Rather, the content of the interview was allowed to flow spontaneously into a number of categories with each interviewee. The results in Fig. 1 show that as the interviewer's mean speech durations in the three periods of the interview averaged 5.3, 9.9, and 6.1 seconds ($p = .001$) as he aimed for 5, 10, and 5 seconds, the corresponding mean speech durations of the 20 interviewees were 24.3, 46.9, and 26.6 seconds ($p = .01$). Durations of single speech units for interviewer and interviewee were recorded on a Chapple Interaction Chronograph (*2*) by an observer watching the live interview through a one-way mirror.

To further establish that interviewee speech durations were amenable to influence by the interviewer, we conducted a second study, utilizing 20 additional interviewees and an interviewer speech sequence of 10, 5, and 10 seconds. The results are shown in Fig. 1 (middle) and indicate that as the interviewer's mean speech durations averaged 9.5, 4.9, and 9.5 seconds ($p = .001$), the corresponding interviewee speech durations were 41.1, 22.8, and 48.2 seconds ($p = .001$). A third group of 20 subjects, not previously reported, served as a control group and the means are shown at the bottom of Fig. 1: 5.0, 5.2, and 5.2 seconds ($p$ not significant) and 30.0, 30.5, and 28.1 seconds ($p$ not significant). In a fourth group of 20 subjects, also not previously reported, the interviewer aimed for 5, 15, and 5 seconds duration for his individual speech units in the three periods of the interview. The results, not shown in Fig. 1, were as follows for interviewer and interviewee, respectively: 5.0, 15.2, and 5.5 seconds ($p = .001$) and 30.9, 64.5, and 31.9 seconds ($p = .001$).

A question that we have raised (*1*, pp. 455–456) about the results shown in Fig. 1 is whether they are, in fact, due to an increase in the duration of the interviewer's own speech, or whether they are the result of some methodological artifact. The evidence so far indicates they are not an artifact. The results in Fig. 1 also could be a function of the observer's error (or bias), or the interviewer's error (or bias). That is, the interviewer could remain si-