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LETTER TO THE EDITORS

PROPRIOCEPTIVE INFORMATION NEITHER IMPROVES FIXATION STABILITY NOR REDUCES AUTOKINESIS

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Recently, Lackner and Zabkar (1977) reported that proprioceptive information about the stability of a point of light reduced autokinetic movement. They also reported that when eye movements were measured concurrent with measurements of autokinesis, proprioceptive information reduced the number of large ($>1°$) eye movements preceding reports of autokinetic movement. These authors concluded that the improvement in fixation stability was brought about by availability of proprioceptive signals from the arm which provided information to the subjects that the fixation target was actually stationary, resulting in both improved fixation stability and reduced autokinesis.

We were concerned about the eye movement results reported by Lackner and Zabkar (1977) because subjects attempting to maintain fixation on a single point of light in darkness do not normally make eye movements "greater than 1°". We know this from almost three decades of experimentation in which eye movements during maintained fixation have been monitored with techniques (optical lever and magnetic field search coil) capable of resolving the miniature eye movements characteristic of fixation. The discrepancy between the Lackner and Zabkar (1977) report and the prior literature on the characteristics of maintained fixation prompted us to re-examine fixation under similar conditions.

METHOD

Three subjects participated in these experiments. Two (RS, HC) were experienced eye movement subjects and were familiar with the autokinetic illusion. The other subject (HS) was naive about the autokinetic illusion in the sense that he was unaware of the existence of the phenomenon. Eye movements were monitored by a search coil embedded in a soft limbus ring (Collewijn *et al.*, 1975). Head stability was maintained by tightly fitting forehead, temple and chin rests for subjects HC and HS and by a dental acrylic biteboard for subject RS.

The fixation target was a 4′ arc diameter photopically effective point of light seen in an otherwise dark room. A square acrylic rod ($2 \times 2 \times 30$ cm) was attached to the target. This arrangement was fixed rigidly to earth so that the point of light was straight ahead of the cyclopean eye. Both the point of light and the rod were at a distance (43 cm) which could be grasped comfortably with the left hand. The right hand manipulated a two-dimensional joystick mounted at the subjects right side, again comfortably within reach. The subjects were instructed to move the joystick in its forward–backward and leftward–rightward directions so as to mimic up–down and left–right autokinetic movements of the point of light when such movements were perceived.

Before the recording session, i.e. before the coil was inserted in the eye (right eye: subjects HC and HS, left eye: subject RS), each subject was allowed several practice trials in order to familiarize him with the use of the joystick and to be sure that the instructions for the two different tasks were understood. The instructions were the same as those used by Lackner and Zabkar (1977) which required the subject to assume one of two postures. In one the subject's hand rested in his lap (*L*). In the other the subject firmly grasped a rod attached to the light, holding his thumb near the light (*G*).

After the search coil had been inserted, 12 5-sec calibration trials were run, after which each subject ran 12 30-sec trials presented in a double alternating pattern, e.g. *GLLGGLLGGL*....

Two-dimensional eye movement and joystick analogs were recorded on FM instrumentation tape. For quantitative analyses, tape recorder analogs of the four variables were filtered at 50 Hz, digitized at 100 Hz and analyzed by minicomputer. Samples of horizontal and vertical eye position and horizontal and vertical joystick position were taken within the same millisecond. Data were digitized in 10 sec successive periods from within trials taking care not to include those portions of trials that contained blinks. Statistical analyses were based on equal numbers of these 10-sec periods for each condition.

RESULTS

Eye movements greater than 1° were never observed under either condition. The largest eye movements made by each of the subjects were 42-min arc for HC, 48-min arc for HS, and 34-min arc for RS.

Moreover, these large eye movements were always saccades. Slow drifts, often held responsible for the autokinetic phenomenon, were never more than 19′/sec. As expected, eye position stability in the present experiments was very similar to eye position stability generally observed during maintained fixation (e.g. Cornsweet, 1956; Nachmias, 1961; Steinman, 1965). Our results are summarized in Table 1 where it is clear that large eye movements ($>1°$) would be exceedingly rare during maintained fixation. Standard deviations of eye position only ranged from 3.31 to 7.67 min arc on the horizontal meridian and 2.26 to 7.48 on the vertical meridian. This result does not agree with the report of Lackner and Zabkar (1977). It is, however, consistent with prior measurements of maintained fixation made with sensitive instruments.

Table 1. Inverse fixation stability, inverse autokinetic stability and the Pearson product moment correlation coefficient for each spatial meridian (*Horizontal*, *Vertical*) under two conditions: when the fixation rod was grasped (*G*) and when the hand was in the lap (*L*)

		Horizontal		*Vertical*		
	Subject	*G*	*L*	*G*	*L*	*N*
Eye position:						
	HS	6.9 (1.8)	7.6 (2.3)	4.5 (3.0)	4.4 (1.6)	17
	HC	5.8 (3.6)	6.2 (3.7)	7.2 (3.1)	7.5 (2.9)	10
	RS	3.3 (1.5)	3.9 (1.7)	2.3 (0.6)	2.8 (0.8)	9
Autokinesis:						
	HS	19.3 (10.1)	11.9 (10.5)	49.0 (44.1)	21.3 (22.2)	17
	HC	22.9 (9.8)	6.5 (6.4)	33.2 (23.6)	25.1 (12.4)	10
	RS	51.6 (25.8)	33.4 (15.7)	65.1 (21.3)	79.1 (71.8)	9
Pearson:						
	HS	−0.095	0.104	−0.017	0.257	17
	HC	0.056	0.273	−0.070	−0.025	10
	RS	0.008	−0.233	−0.151	0.202	9

Inverse stabilities are summarized as mean standard deviation of 10 sec measurement intervals in minutes of arc for eye position and in arbitrary units for autokinetic position. Pearson product moment correlation coefficients were computed from matched pairs of eye position standard deviations and autokinetic position standard deviations for each subject, meridian and condition. The number (*N*) of 10-sec intervals used in these computations is also shown.

We were also unable to support the Lackner and Zabkar finding that the eye was more stable when the rod was grasped than when the hand was in the lap. We found that the eye was equally stable under both conditions.

Although, in all cases but one, mean standard deviations were less in the grasp condition (*G*) than in the lap condition (*L*), an analysis of variance showed that the small difference in variability between the two conditions was statistically unreliable ($F = 1.15$, df = 138,1). These differences, in addition to being unreliable, were very small, that is, the largest difference was less than 1-min arc. Thus, it appears that proprioceptive information about the stability of the fixation target does not influence fixation stability.

Autokinesis as measured by the joystick was reliably different under the two conditions ($F = 7.6$; df = 138,1; $p < 0.01$). *But*, the direction of the reduction was opposite to expectations based on the results reported by Lackner and Zabkar (1977). In our experiments, joystick position tended to be *less* variable when the hand was in the lap than when the hand grasped the rod.

This led us to examine the correlation coefficient between standard deviations of eye position and standard deviations of joystick position. These were computed for each subject, condition and meridian of movement using measures of variability obtained within each 10 sec measured interval. These results are summarized in Table 1. The correlations showed no systematic tendencies. The mean product moment correlation coefficient was 0.025.

DISCUSSION

Lackner and Zabkar reported observing eye movements "greater than 1°" in amplitude during maintained fixation of a point target. We found no such eye movements in our records and can only speculate as to the origin of theirs. An examination of our records revealed occasional deflections of eye position which were quite large, sometimes as large as several degrees. However, these movements were easily identified as the characteristic eye movements that accompany blinks. Lackner and Zabkar instructed their subjects to avoid blinking but did not make records of eye movements accompanying blinks and remove such events from their analyses. Several blinks would be expected during trials as long as theirs (60 sec), and we suspect that their eye movement data may be contaminated by blink artifacts. In addition to being unable to observe the large eye movements reported by Lackner and Zabkar, we were also unable to support their conclusion that fixation is less stable when subjects do not grasp an object attached near the fixation target. Also, we could not support their conclusion that autokineses depends on fixation stability.

Our result is not surprising. Even though there is prior evidence that fixation eye movements are associated with autokinesis (e.g. Barlow, 1952; Matin and McKinnon, 1964; Crone and Verduyn Lunel, 1969), the details of the relationship between eye movements and autokinesis remains obscure. It is clear from our present results and from investigations prior to Lackner and Zabkar (1977) that *large* eye movements are not necessary for the perception of autokinetic movement. In fact we are sure that all experienced eye movement subjects have been startled at the lack of large eye movements recorded during periods they have perceived dramatic autokinetic movements. It is clear that a little bit of eye movement can go a long way perceptually. If this were not the case, perhaps the origin of autokinesis would be better understood.

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