Comments on Brosgole¹

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In a recent report, Brosgole (1968) suggests that an eye-movement interpretation of autokinesis is inappropriate. The report neglects, we feel, certain current eye-movement-related interpretations of autokinesis and does not sufficiently integrate previous work in the area. First, it should be noted that there are several eye-movement-related interpretations of autokinesis, all of which would predict (within certain limitations) Brosgole's experimental results.

For reasons of brevity we discuss only one type of eye-movement-related theory of autokinesis: the retinal shift type, the type which Brosgole considered. [It should be noted, however, that another type of eye-movement theory is concerned with the central monitoring of the extraocular muscle innervation (Gregory, 1963; Verheijen & Oosting, 1964; Whiteside et al, 1965).] Early research has established the fact that large eye movements and, therefore, large shifts of the retinal image of the autokinetic target, are not a necessary concomitant of autokinesis (Charpentier, 1886; Bourdon, 1902; Marx, 1913; Ziehen, 1927; Guilford & Dallenbach, 1928). Since this early work, the interest of eye-movement theorists has centered upon the small involuntary motions of the eye during accurate fixation of the autokinetic target.

Skolnick (1940) suggested that in autokinesis the small movements of the retinal image of the target are summated in some fashion to produce a sensation of continuous motion. At first glance, it might seem that such a mechanism, operating upon a random pattern of retinal image shifts, would produce little, if any, apparent motion. Nachmias (1959), however, investigating the two-dimensional motion of the fixating eye, demonstrated that the slow drifts of the eye occur predominantly within a small range of directions, different for different Ss, and that saccades occur predominantly within the opposite small range of directions. Thus, the drifts of the retinal image of the target, for instance, might be summated to produce a sensation of continuous motion.

Matin & MacKinnon (1964) suggested that movement detectors, such as those found in the striate cortex of the cat, might be present in the human visual system and be responsible for the generation of the autokinetic illusion. It can be seen that if such detectors were to have maximal

sensitivities for restricted ranges of image velocities and directions of movement on the retina, repetitive stimulation by a drift-saccade (slow-fast) sequence of small image shifts could produce a sensation of continuous motion.

Brosgole's work follows from the experiment of Matin & MacKinnon (1964) which tested the involvement of eye movements in autokinesis by stabilizing the retinal image of the autokinetic target against horizontal eye movements. They found that horizontal autokinesis was markedly reduced by this procedure and concluded that such a result is consistent with an eye-movement interpretation of autokinesis. Brosgole concludes that a target stabilized on the retina in the vertical dimension as well as the horizontal dimension, e.g., an afterimage, will not, according to an eye-movement interpretation of autokinesis, be seen to move at all, unless the eye "pursues" or "tracks" the afterimage; a condition known to cause apparent motion of the afterimage. Thus, if autokinesis is experienced with an afterimage, one could, perhaps with reservations,² reject a retinal shift theory of autokinesis. Let us consider the experimental test which Brosgole in fact performed.

To inhibit pursuit of the afterimage, Brosgole had his Ss center the afterimage on a small fixation light. The Ss viewed the two stimuli for 5 sec and reported the direction and extent of the motion of the afterimage. Brosgole reports that in 190 of 200 trials with eight Ss, the afterimage appeared to drift through space with the fixation target located at its center. Since the afterimage appeared to move, Brosgole rejects a retinal shift interpretation of autokinesis. This conclusion might be appropriate to the viewing of the afterimage alone, but the experiment performed involved a fixation point. The argument presented in this paper is that the use of a fixation point invalidates Brosgole's experiment as a critical test of a retinal shift interpretation of autokinesis.

From the retinal shift point of view, the presence of a fixation light means that the conditions for the generation of autokinesis of the fixation light were present, e.g., shifts of the retinal image of the fixation light were occurring.³ A retinal shift interpretation would, then, predict that the fixation light in Brosgole's experiment would exhibit autokinesis: Brosgole's results confirm this prediction. Concerning the behavior of the afterimage in this situation, a retinal shift interpretation might be considered to make no prediction at all. Strictly speaking, a retinal shift interpretation is confined to the discussion of whether a single stimulus will

generate autokinesis, or "self-movement." In terms of the present discussion, the theory predicts that the fixation light will exhibit autokinesis and the afterimage will not. Whether the afterimage may appear to move for reasons related to the presence of a fixation light⁴ is outside the domain of prediction of the retinal shift theory of autokinesis since it is not intended to be a general theory of visual movement perception.

To summarize: Brosgole correctly inferred that a retinal shift interpretation of autokinesis predicts that an afterimage would not exhibit autokinesis. Further, Brosgole notes that the afterimage may appear to move for other reasons related to the "pursuit" movements of the eye; that is, the simple observation of the apparent movement of an afterimage does not mean that it is moving autokinetically. In the same fashion, it is possible to argue that when a fixation light is added to the viewing situation, the afterimage does not move autokinetically but for reasons related to the presence of the fixation light, which *does* move autokinetically. On this basis we do not accept Brosgole's claim to have refuted a retinal shift interpretation of autokinesis.

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NOTES

1. DRET Technical Note No. 732.
2. One might wish to argue that autokinesis of an afterimage demonstrates only that factors other than retinal shifts may be involved in autokinesis.
3. Brosgole suggests that, "A change in eye position would result in a displacement of the fixation point relative to the after-image. The absence of such relative displacement indicated that the eyes were not moving [Brosgole, 1968, p. 234]." This suggestion must be rejected in view of the abundant literature describing the small, involuntary movements of the eye during accurate fixation. Brosgole's finding that the relative motion between a fixation light and an afterimage

may not be perceived during autokinesis of both stimuli confirms the findings of Carr (1910), Piggins (1965), and Whiteside et al (1965), all of whom additionally note that the relative motion may, indeed, be observed during autokinesis.

4. A simple interpretation is that the afterimage is not moving autokinetically; that is, it is not "self-moving," but is participating in the perceived motion of the fixation light. Since the fixation light will be perceived as moving and little or no relative motion will be perceived between the fixation light and the afterimage, it is not unreasonable to suppose that the resulting perception will be joint motion of the two stimuli (Carr, 1910; Gregory, 1963).

localize a small visual stimulus in space (Sandström, 1950; Mandel, 1963). In addition, such a visual target has been shown to appear to move based upon its continuous displacement relative to the egocentric system (Brosgole, 1967, 1968b; Brosgole & Cristal, 1967a; Brosgole, Cristal, & Carpenter, 1968a, b; Brosgole & Hansen, in press; Click, Wapner, & Werner, 1965; Jordan, 1967). Other studies have related autokinesis to an apparent spatial location change, although not specifying the body as the primary system of reference (Cormack, 1963; DeSisto & McLaughlin, 1968). From this discussion it should become apparent that the presence of an isolated visual stimulus is not needed for the autokinetic process to be initiated. This fact has been disclosed by Jordan (1967) who briefly presented Ss with a target and then occluded it for a specified period of time. Upon its reappearance, it seemed to be displaced as much as a stimulus viewed continuously, and thereby having drifted autokinetically. This study constitutes a powerful refutation of any eye-movement interpretation which relies upon the factor of retinal displacement. In addition, ongoing research in our laboratory has led to the development of conditions under which two stimuli can be seen to drift autokinetically in opposite directions. This, too, argues against a retinal interpretation of autokinesis. In spite of all of the above, our position is very close to the ocular explanation offered by Gregory (1963).

Duncker (1929) found that various parts of the body may participate in the induced motion of a visual stimulus. We have observed this type of effect with a host of body parts, including the eye. This is to say, as S fixates an apparently moving target, he gains the impression of actively pursuing it. The same applies to the autokinetic experience.

When S is seated in total darkness and told to keep his eyes fixed in a direction perpendicular to the nasion, the eyes typically drop more and more over time. However, S reports no felt change in eye position. When S is required to fixate a visual stimulus instead of some imaginary point in space, he feels that the target is rising with his eyes in active pursuit—even though both are perfectly stationary. Whereas Gregory would attribute autokinesis to a misinterpretation of the afferent signals from the musculature of the eye, we go one step further in an attempt to explain both in terms of egocentric displacement. In other words, both target and eye, in this instance, were felt to move because of a shift in location relative to the apparent eye-level position. In this vein, our view may be construed as an eye-movement explanation, even though we do not intend it as such. In

Reply to Pearce

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It is difficult to respond to Pearce's article, for he commences with disagreement and then proceeds to the point of substantive agreement in his summarizing statement. Accordingly, the purpose of this paper will be first to quickly dispense with the objections raised, and then to formulate a theoretical position very briefly and simply so that it can be understood readily.

Pearce cited a body of literature (in the footnote section, as well as in the main text) which allegedly established a causal relationship between eye movements and autokinesis. In each instance, both factors were induced either through caloric irrigation of the ear, passing current from one mastoid to the other, or rotating the body (Sholnick, 1940; Whiteside, Graybiel, & Niven, 1965). Although nystagmus and autokinesis frequently occurred together, this was not always the case. Therefore, their apparent relationship probably was due to some mutual correspondence to a third variable, namely, the condition of the bodily stimulation utilized to initiate the phenomena.¹

In addition, it must be noted that retinal displacement may constitute a necessary condition for the perception of autokinesis, insofar as it is needed for the maintenance of figural integrity. However, this is not to imply a causal relationship between the two. To draw an analogy, the heart may be said to be necessary in order to see apparent motion, because it is needed to preserve normal life functions. Yet, it would not be logical to conclude that the perception of movement is generated by cardiac displacement. Thus, Pearce's contention that I have failed to understand and integrate previous work in this area must be rejected. The

failure to cite certain pieces of literature in the afterimage report (Brosgole, 1968a) was based upon a precise experimental evaluation of findings and a careful analysis of their theoretical import. As a result, some of my own work on eye movements (Brosgole, Cristal, & Carpenter, 1968a, b) was not referenced.

Pearce's main objection was to the presence of a fixation target, around which S superimposed a negative afterimage. He contended that the fixation point underwent autokinesis and that the afterimage merely participated in its apparent motion.² Accordingly, he concluded that the little red stimulus invalidated the entire study. On the other hand, Pearce admitted that a fixation target was needed to inhibit pursuit movements, since they could be used to explain the autokinesis of a visually isolated afterimage. Thus, it seems that Pearce is proposing that the autokinesis of an afterimage is not subject to scientific scrutiny. This point must also be dismissed. Since there should be some constructive element to every article submitted for publication, let us go on to describe a theoretical approach to the understanding of the perception of motion.

Witkin (1946) showed that in the absence of visual stimulation, there is a loss in egocentric orientation. His Ss reported self-movement when placed in a sitting position. The sense of bodily movement included rotation, side-to-side and fore-and-aft tilt, as well as ascent and descent. Witkin described the phenomenon as the "postural autokinetic effect." It seems reasonable to assume (based upon the work of Oppenheimer, 1934) that when a target is then presented to such an observer, the sense of motion would be attributed or allocated to the smaller of the two bodies. Thus, it has been found to be difficult to manually