Isotopically labeled compounds are expensive and often difficult to synthesize; more important, in the aforementioned work, radio-labeled products could not be identified as part of the analysis, that is to say, the determined product might be the original pesticide or a product thereof, or both. Such identifications have been made by us, using electron-affinity gas chromatography to study the fate of seven chlorinated insecticides and a degradation product of heptachlor in aqueous suspensions containing mosquito larvae (*5*), and in the larvae.

One milliliter of acetone containing an appropriate quantity of insecticide was stirred into 225 ml of distilled water in each of a number of wide-mouth half-liter jars. Twenty-five fourth-instar larvae (*Anopheles quadrimaculatus* Say) in 25 ml of water were added to each open jar, and mortality was noted after 20 hours at 26.5°C. From 12 to 18.5 g of water volatilized during the test. Both the suspension and separated larvae (50 larvae were rinsed with hexane and homogenized for analysis) were extracted with hexane and analyzed by electron-affinity gas chromatography (*6*). The fact that added insecticides could be recovered practically quantitatively from suspensions and larvae at the outset demonstrated the reliability of the procedure; no metabolites or other products were found in freshly made suspensions. Identification of products was based on retention times (Table 1).

Metabolic conversion of aldrin to dieldrin, DDT to DDE (*7*), and heptachlor to its epoxide by larvae of *A. quadrimaculatus* was determined quantitatively. These metabolites must have been formed by the larvae because (i) the metabolites were not present initially, (ii) they could not be found in appreciable quantities in the aqueous medium, and (iii) 50 percent or more of the insecticide in the larvae was present as the metabolite. In contrast with this result, formation of nontoxic 1-hydroxychlordene from heptachlor appeared to be exogenous to the organism, since appreciable amounts of it formed in the absence of larvae.

More than half of the DDT in aqueous suspensions (0.001 to 0.100 ppm) at 25°C was lost in 1 day by codistillation with water (*1, 2*). The low recovery of DDT was therefore expected; but the incomplete recovery of the other insecticides suggests that they too may codistil. This premise is supported by the finding that the concentration of lindane necessary to kill 50 percent of the larvae was greater in open jars (0.032 ppm) than in closed jars (0.012 ppm) which precluded codistillation.

If we assume that the low recovery of insecticide (Table 1) is due to codistillation, our data are consistent with the concept that the less polar compounds codistil with water more readily than polar compounds. Thus aldrin and heptachlor, which are less polar than their corresponding epoxides, codistilled to a greater degree (82 to 94 percent) than their epoxides (27 to 56 percent); the most polar compound, 1-hydroxychlordene, codistilled very little (3 percent).

About three times more dieldrin than aldrin and from three to five times more heptachlor epoxide than heptachlor were found in larvae exposed for 20 hours to approximately equivalent initial concentrations of insecticide (metabolites expressed as original insecticide). However, the conclusion that aldrin and heptachlor have a lesser affinity for the larvae than their epoxides must be considered tentative because certain variables are not controlled in the bioassay. For example, the lower uptake by larvae of aldrin and heptachlor, when compared with their epoxides, may be due in part to the exposure of the larvae over the test period to a lower concentration of aldrin and heptachlor, the lower concentration resulting from the greater loss of these insecticides (probably by codistillation) than of their epoxides.

Our findings illustrate the potential of electron-affinity gas chromatography in determining the fate of chlorinated hydrocarbons at very low concentrations in aqueous suspensions and in minute organisms. Codistillation with water may be an important route for the loss of aldrin, dieldrin, heptachlor, heptachlor epoxide, γ-chlordane, and lindane, and codistillation should be considered in investigations dealing with these insecticides as water contaminants.

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6. Using a Jarrell-Ash model 700 instrument equipped with a 1 m by 0.6 cm outside diameter stainless steel column packed with 5 percent wt/wt purified silicone grease (*8*) on 80-100 mesh acid-washed Chromosorb W. Operating parameters were: injection port 200°C, column 180°C, detector 200°C, voltage 22, range 10^{-9} amp, nitrogen flow rate 200 ml/min (exit). Mention of an instrument does not necessarily imply its endorsement by the U.S. Department of Agriculture.
7. DDT: 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)-ethane; DDE: 1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethylene.
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Averaged Brain Activity Following Saccadic Eye Movement

Abstract. *Since a change of stimulus is required to effect a visual response, and since saccadic eye movements change the locus of the retinal image, the hypothesis was developed that there should be a brain response following saccadic eye movement. The hypothesis was tested experimentally by averaging the activities following successive saccadic eye movements. A response was found whose characteristics were dependent on illuminance of the stimulus.*

A change in stimulation is generally recognized as necessary to elicit a response in the visual system. This can be shown by electrical recording; electroretinograms and other forms of evoked visual responses are elicited only by flashes, flickering, or other changes in stimulation. The importance of a change in stimulation is also demonstrated by experiments with stabilized images (*1*). With this procedure, the stimulus viewed by an observer moves exactly in step with movements of the eye so that the retinal image does not move on the retina, and the retinal stimulus is continuously presented to the same set of receptors. Stabilized images gradually fade. Since the change of stimulation ordinarily produced by fine eye movements is no

longer present the eye "adapts" to a constant stimulus, and response activity decreases.

A positive interpretation of these findings for normal vision is that the change of stimulation resulting from eye movement is responsible for maintaining vision. Saccadic movements which shift the position of the image rapidly across the retina are especially likely to play a significant role (*2*).

The hypothesis considered here is that a volley of activity might be expected to follow each saccade. Electrical potentials following successive saccades were averaged by using the saccades as triggers for a response averaging system. The mere existence of an electrical response related with saccades would not constitute adequate support for the hypothesis since the saccades might be accompanied by some non-visual activity. Therefore, the illuminance of a fixation target was varied systematically to determine whether the responses obtained were under stimulus control.

We used a method which combines two well-known techniques: (i) recording the fine eye movements by means of light reflected from a mirror mounted on a close-fitting contact lens; and (ii) recording evoked brain responses by taking a number of responses which are marked by a stimulus event and averaging their waveforms.

The photoelectric method of recording fine eye movements has been used by Riggs *et al.* (*3*); its value in the present context is that it yields electric signals proportional to the eye movements. Pulses signifying the occurrence of saccades were obtained by means of electric analog circuits. These pulses served to trigger a CAT computer (*4*) which averaged the brain responses. Saccades were detected in the following manner.

The electric eye movement signal was first differentiated electronically. Since the saccades are rich in high-frequency components, they appear in the differentiated signal as sharp spikes and are much larger than the background variation produced by the slower movements. Saccades in one direction produced negative spikes; those in the other direction, positive spikes. All spikes were made positive by passing the differentiated signals through an absolute value circuit. A spike exceeding the value of an adjustable threshold produced a trigger signal which activated the computer which then accepted the next 500 msec of brain activity

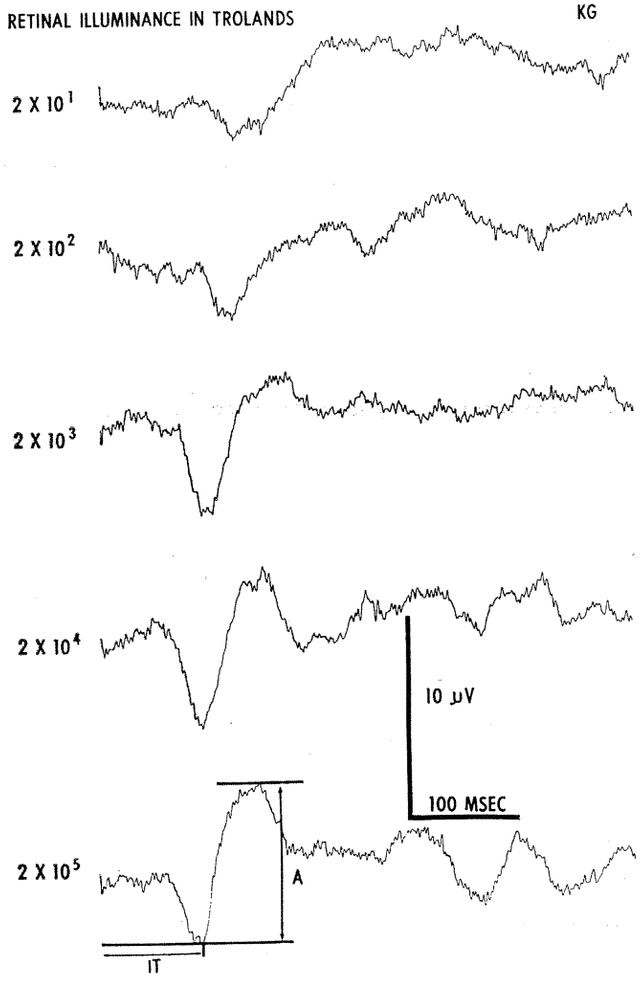

Fig. 1. Typical averaged potentials recorded from the scalp following 50 saccades. Saccades coincident with the beginning of each trace. Increasing positivity of the anterior electrode is indicated by an upward movement of the traces. *IT* indicates implicit time measurement; *A* indicates amplitude measurement.

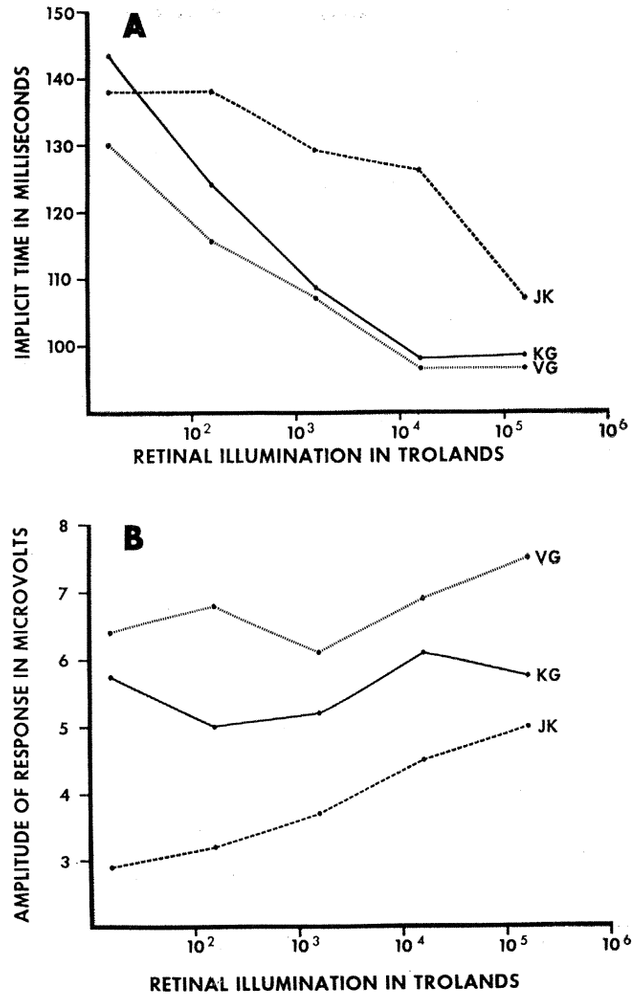

Fig. 2. Average implicit time and voltage amplitude as a function of retinal illuminance. *A*, Implicit times in milliseconds; *B*, amplitudes in microvolts. Each point represents the mean for ten ascending and ten descending trials.

as its input. The input fed to the computer was picked up from a bipolar pair of electrodes on the scalp, one mounted over the inion and the other about 5 cm anterior. The output of the computer, after it averaged the activity which followed 50 saccadic movements, was fed to an *X-Y* plotter. The ongoing brain activity, the raw eye-movement record, and the computer trigger signal were constantly monitored on an ink writer.

Continuously illuminated fixation targets were the only stimuli presented to the three observers; maximum retinal illuminance of the targets was 2×10^5 trolands. The illuminance could be varied in steps of 1.0 log unit over a range of 4.0 log units with neutral filters. The dimmest stimulus used was estimated by psychophysical means to be between 1.0 and 2.0 log units above absolute threshold. For one observer (J.K.) a single circular fixation spot 20 minutes in diameter produced reliable responses. The electroencephalogram records of the other two observers (K.G. and V.G.) had considerable "alpha" activity which made it difficult to evaluate the responses in the averaged records with this target. With the last two subjects a larger, more complicated target elicited useful records. This target had an overall diameter of 5 degrees and an internal grid structure consisting of 53 circular spots 20 minutes in diameter.

The experimental procedure was as follows. After alignment of the optical systems, the observer fixated the target at its lowest illuminance. The computer was activated, and the average of 50 samples of electrical brain signals was written on the plotter. The stimulus was then set at the next higher illuminance level and the process was repeated. An experimental session consisted of one ascending and one descending series of illuminances covering the whole 4.0 log unit range available. Each observer served in ten sessions.

A typical set of averaged records is given in Fig. 1. Each record showed a response consisting of a negative wave with an implicit time (or peak latency) of the order of 100 msec, followed by a positive wave which reached its peak by 250 msec. The waveform was sharply defined at the higher illuminances and more rounded and slower at the lower illuminances.

Averaged potentials recorded from the scalp exhibit complex and ephemeral waveforms (*5*). Since the purpose of our study was to determine whether any stimulus-determined response followed saccades, quantitative analysis was limited to the prominent negative-positive complex found in all records. Two measures were taken: (i) the implicit time or peak latency to the lowest negative point, and (ii) the amplitude from the lowest negative point to the highest positive point within the first 250 msec following the saccade. These measures are presented in Fig. 2. The implicit time of all observers was a monotonic decreasing function of fixation-target illuminance. In the case of J.K., the amplitude was a monotonic increasing function of illuminance. The amplitude curves for the other two observers were not simple functions of illuminance.

Because the observer is unaware of saccadic eye movements or of changes in the stimulus occurring during fixation, it is hard to attribute the responses to startle or variation in attention. The results indicate that a true evoked response is produced by the retinal image displacement accompanying saccadic eye movement, lending support to the idea that saccadic eye movements help to maintain vision. The results suggest that the nervous-system discharge accompanying vision may not be solely continuous, but instead may be characterized by more or less discontinuous bursts related in time to saccades. This contrasts with the observer's reports that the fixation target appeared steady, a result which may have implications for theories of perception.

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Culturally Transmitted Patterns of Vocal Behavior in Sparrows

Abstract. *Male white-crowned sparrows have song "dialects," acquired in about the first 100 days of life by learning from older males. In the laboratory an alien white-crowned sparrow dialect can be taught. Once the song is established further acoustical experience does not change the pattern. White-crowned sparrows do not copy recorded songs of other sparrow species presented under similar conditions.*

The white-crowned sparrow, *Zonotrichia leucophrys*, is a small song bird with an extensive breeding distribution in all but the southern and eastern parts of North America (*1*). Ornithologists have long remarked upon the geographical variability of its song. Physical analysis of field recordings of the several vocalizations of the Pacific Coast subspecies *Z. l. nuttalli* reveals that while most of the seven or so sounds which make up the adult repertoire vary little from one population to another, the song patterns of the male show striking variation (see *2*).

Each adult male has a single basic song pattern which, with minor variations of omission or repetition, is repeated throughout the season. Within a population small differences separate the songs of individual males but they all share certain salient characteristics of the song. In each discrete population there is one predominant pattern which differs in certain consistent re-