ADAPTATION OF THE VISUAL APPARATUS TO NATURAL ILLUMINATION

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The lability of the visual analyzer [1-6] has been studied in terms of changes in the areas of light and color sensitivity, the number of microscotomata, the size of the blind spot, the threshold size of the area stimulated, and dark adaptation curves taken at different times of day. By this means it has been found how the retina becomes reorganized to adapt itself to the illumination by altering the mobilization of the photoreceptors.

The aim of the present study has been to examine the adjustment of the visual apparatus, and its reorganization during the changes of illumination occurring at sunset.

METHOD

Light thresholds were measured binocularly by means of an A-M adaptometer. No preliminary adaptation was given, in order that the measurements should reflect the correspondence between the organization of the eye and the current illumination. We made 40 observations on five subjects. In each experiment, the light sensitivity was measured every 3-4 minutes for 1 hour before sunset, and for 15-20 minutes after. The measurements were repeated several times during the day. Measurements of the light intensity were made by the luxmeter. The work was carried out in November and in February, when sunset occurred between 4.06 and 6.02 p.m.

RESULTS

A rapid increase in light sensitivity began 5-8 minutes before the sun had completely set. The maximum increase was at the actual time of sunset, though it might occur 3-5 minutes afterwards, or 3 minutes before; the peak increase in sensitivity therefore did not always coincide with the moment of sunset. When the sun had completely set, color sensitivity remained at a higher level.

We will give as an example the results obtained on subject A (Fig. 1).

Measurements of light sensitivity were made at intervals during the day, and at 40 minutes before sunset, which occurred at 4.06 p. m.

The mean values of the light sensitivity for the corresponding arbitrary time intervals were taken at 11 a.m., 12 noon and 3 p.m. The values from 3.30 p.m. to 4.30 p.m. showed the changes in light sensitivity which occurred during the experiment before and after sunset.

Fig. 1 shows that the relatively stable light sensitivity level underwent a sudden sharp increase, which in this case occurred 7 minutes before sunset, and which attained a maximum value at the time of sunset itself.

After the sun had set, the sensitivity was several tens of times higher than before.

In the subject Ch light sensitivity measurements were started 63 minutes before sunset (5.43 p.m.) and were continued for 17 minutes after. Fig. 2 shows that the relatively stable level of light sensitivity before sunset was followed by a marked increase, which occurred 8 minutes before sunset. The maximum increase in the light sensitivity was attained at the moment of sunset itself, and was maintained subsequently.

Therefore, before sunset the retina undergoes a gradual reorganization to twilight vision, and after the whole of the sun's disk has sunk below the horizon, a sudden increase in sensitivity is added on to the effect of the continuous adaptive process. The increase in light sensitivity during the decrease in illumination from the sun during sunset

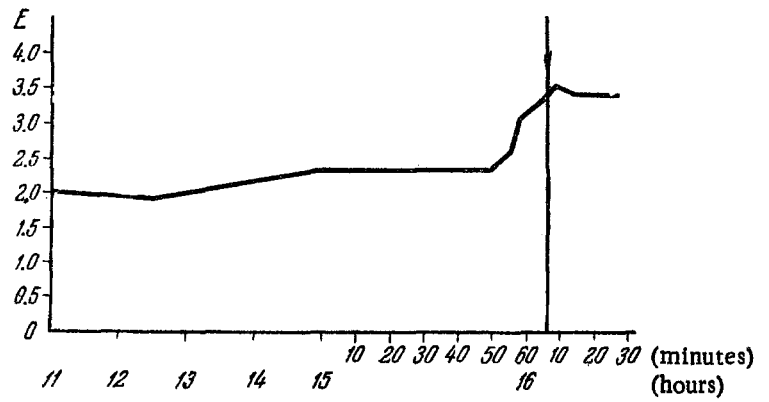

Fig. 1. Changes in light sensitivity at sunset in subject A. Abscissa-time of observation (from 11 a.m. to 3 p.m., and from 3 p.m. to 4.30 p.m.); ordinate - light sensitivity in logarithmic units (E). The arrow indicates the time of sunset (4.06 p.m.).

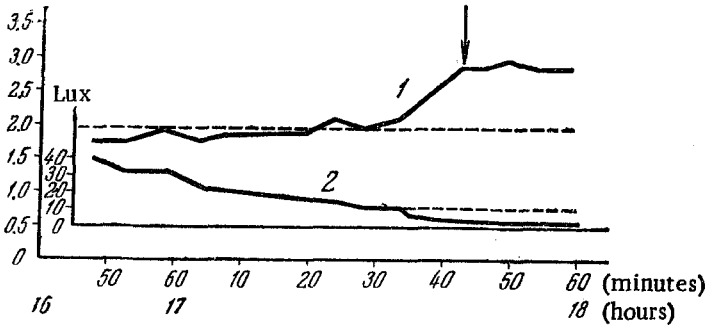

Fig. 2. Changes in the light sensitivity (1) in logarithmic units (E) and figures for intensity of illumination (2) in lux during the period in which light sensitivity changes occur. The arrow indicates the time of sunset (5.43 p. m.)

causes an increased activity of the retinal rods, and during the evening they become mobilized maximally. These observations also show that increase in retinal sensitivity can occur without previous dark adaptation, and therefore that under normal conditions of illumination the retinal receptors are in a condition in which they are ready to be mobilized.

Therefore, at sunset, the retinal rods become mobilized and their sensitivity increases rapidly to a maximum value before sunset. The peak light sensitivity occurs either at the moment of sunset, or 3-5 minutes previously, and remains at this level subsequently. This visual adaptive reaction has been brought about during the course of evolution and has been reinforced during the lifetime of the individual, and represents the biological means whereby the receptors become adjusted to external illumination. This index may be used as a clinical functional test for a broader study of the condition of the visual system.

SUMMARY

It was shown that natural illumination determines retinal adaptation. The moment of special interest occurred at the change from daylight to twilight vision while the person under observation was in natural conditions. Measurement of the retinal light sensitivity showed that the change from daylight to twilight vision was brought about by an increased sensitivity and activity of the rods which occurred after sunset.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
