

# INTRAOCULAR PRESSURE OF NORMAL AND GLAUCOMATOUS EYES AS AFFECTED BY ACCESSORY LIGHT STIMULI\*

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The influence of accessory stimuli upon the visual functions has now been safely established. On the basis of the data available it can be assumed that accessory stimuli also affect such an objectively recordable function of the eye as the intraocular pressure.

The present investigation is concerned with the effect of a special accessory light stimulus in the form of illumination of the second eye from a white or colored light source.

## I. EXPERIMENTS WITH WHITE LIGHT

### METHODS

The patient, reclining on his back, was allowed to adapt himself for 10 minutes to the illumination of the room in which the experiment was to be made. Then, the intraocular pressure of his right eye was measured with a Schiøtz tonometer after it had been anesthetized with a 1-percent dicaine solution.

The light was then switched off, and the patient was left in an absolutely dark room for one hour. After this, one eye of the patient was covered with a black eye shield, and the other eye was illuminated for 30 minutes by means of a special device arranged in the following manner. A cone-shaped tube 40 cm. in length, was suspended over the left eye of the patient. The tube contained at its base a 75-watt frosted bulb. The brightness of the lightest spot of the bulb was equal to about 16 foot-candles. The left eye of the observer had to be fixed on this spot. The illuminating cone had several lateral apertures which reduced the possible effect of temperature.

During the time that the left eye was exposed to the light stimulus, the patient's right eye was repeatedly subjected to tension measurements at approximately 5-minute intervals. The tension of this eye was also measured some 15 to 20 minutes after the elimination of the accessory stimulus; that is, under the initial illumination conditions of the laboratory room.

The experiments were carried out on 35 subjects, 14 of whom had normal eyes, and 21, glaucomatous eyes. The investigative procedure just described was applied to both normal and glaucomatous subjects. The glaucoma subjects were divided into two groups. One group comprised cases of clearly pronounced glaucoma. In the second group were patients displaying prodromal glaucoma, as well as the "normal" eyes of glaucomatous patients.

### RESULTS

The results obtained demonstrated that, under the influence of unilateral illumination of one eye, the intraocular pressure of the other eye was reduced. Our experiments likewise showed that the variation in the tension of glaucomatous eyes exposed to light or to dark follows the same general course as that revealed by our experiments on normal eyes.

In glaucomatous eyes, however, the reduction in the intraocular pressure is more sharply pronounced, as a rule. A certain smoothness of the curve, typical of a normal eye, vanishes, giving place to a curve which is not infrequently distinguished by its broken shape.

Typical curves illustrating the drop of intraocular pressure resulting from illumination of the second eye both in normal and glaucomatous observers, are plotted in Figure 1, A and B.

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The pupillary reflex does not seem to have any appreciable bearing upon the variation in the intraocular pressure, when the sec-

second eye. Thus, by exposing one eye to a light intensity of 3.3 or 0.28 foot-candles, we obtained, in an average of 26 tests, a maximum drop of tension in the second eye of 2.7, 5, and 9 mm. Hg, respectively. The tests also showed that an increase in the brightness of the light stimulus is accompanied by an increase in the rate of reduction of intraocular pressure in the second eye.

DISCUSSION

The mechanism underlying the influence of dark or light upon intraocular pressure still remains obscure. But the material available does not seem to corroborate the purely mechanical interpretation given this phenomena by certain authors, who ascribe the main role in the changes of tension to the pupil reaction (Grönholm, Seidel).

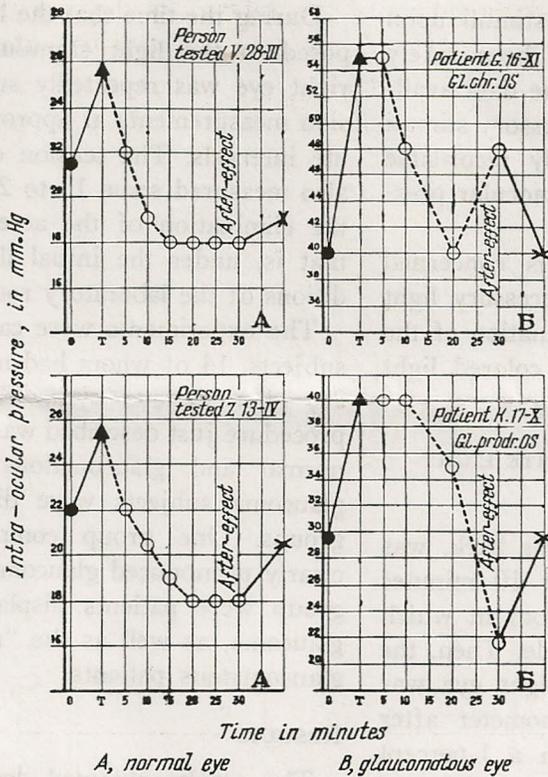


Fig. 1 (Zaretskaya). Intraocular pressure of one eye as affected by illumination of the other eye. Along the ordinate are plotted the values of the intraocular pressure in mm. Hg; along the abscissa, time in minutes. Black circles denote the initial tension found under general illumination of the experiment room; black triangles stand for points corresponding to the level of tension measured after dark adaptation of the eye for one hour; open circles and broken line denote data obtained by illuminating the second eye for 30 minutes; a solid line with crosses shows values obtained under initial light conditions, 15 to 20 minutes after exposure has been stopped.

ond eye is exposed to light. From 16 experiments carried out upon 12 patients whose pupillary reflexes were eliminated by means of homatropinization, it may be seen that under these conditions the tension of the tested eye is likewise reduced by illuminating the second eye (fig. 2).

The reduction of tension is dependent on the brightness of light acting upon the

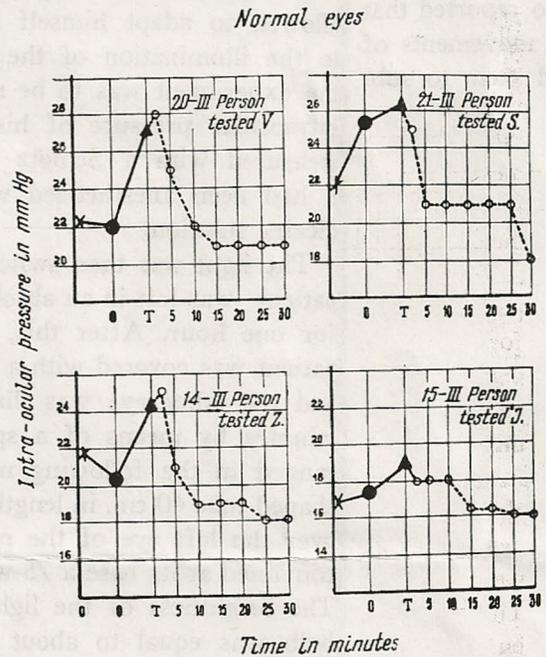


Fig. 2 (Zaretskaya). Intraocular pressure of the right eye as affected by illumination of the left eye. (Homatropine test.) Along the abscissa is plotted time in minutes; along the ordinate, intraocular pressure in mm. Hg. A cross denotes intraocular pressure at the start of measurement; a black circle, tension measured upon instillation of homatropine; a triangle, data obtained after one hour of dark adaptation; open circles and broken line, tension in the illuminated eye.

Feigenbaum's interpretation; namely, that the vascular system of the eye is affected by light through the vasomotors appears more plausible. The action of light may in this case be effectuated through the pituitary body and the vegetative centers whose excitation results in vasomotor reactions involving the optic apparatus, as well.

What are then the decisive conditions responsible in a glaucomatous eye for an increase in its tension, when kept in the dark,

posite way to such vegetative drugs as adrenalin and pilocarpine. It seemed, therefore, consistent to anticipate that the vegetative reactions of the organism will also be different in the case of the eye exposed to red or green stimulants.

METHOD

The procedure adopted was similar to that employed in our experiments with white light herein described.

*Normal eyes*

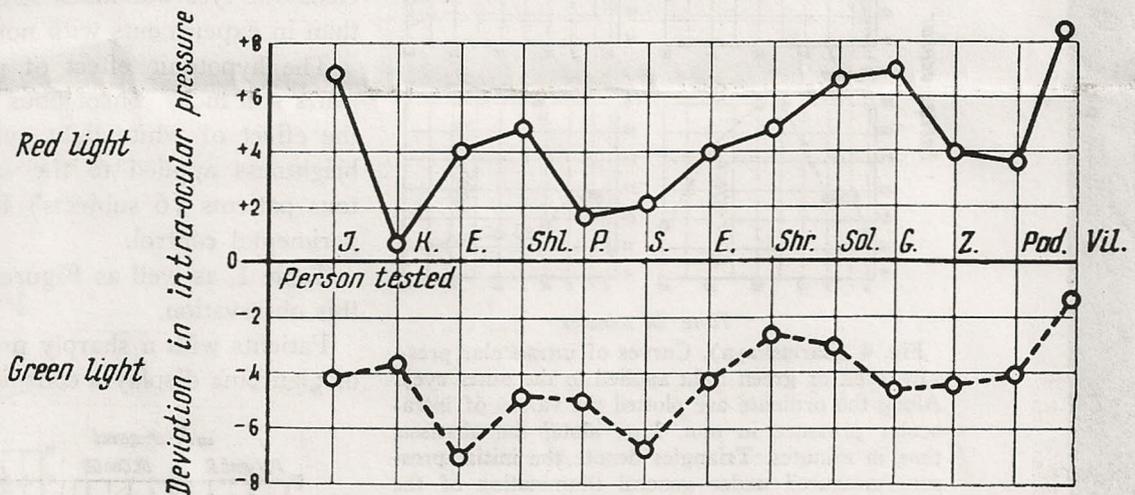


Fig. 3 (Zaretskaya). Effect of light stimulation of the one eye by colored light upon intraocular pressure of the other eye. Along the ordinate is plotted the maximum change in the intraocular pressure (in mm. Hg) from the level of dark adaptation. Along the abscissa are plotted the different persons tested. Circles and the solid line denote changes in intraocular pressure obtained by stimulating the other eye with red light; circles and the broken line, the results for the green light.

and for a reduced tension, when exposed to light?

Most of the authors look for an answer in a definite state of the neurovascular system of a glaucomatous eye; that is, in the so-called neurovascular reflex of Kalfa. This problem has not yet received any definite or satisfactory solution.

II. EXPERIMENTS WITH COLOR ILLUMINATION

Thanks to the experiments carried out by Prof. S. V. Kravkov, it has been established that the green- and red-sensitive apparatus of our vision responds in an op-

A 150-watt incandescent lamp served as a source of light stimuli. It was placed in a special pasteboard cone 40-cm. long, adjusted to the eye of the person tested, and supplied either with a green or a red gelatine filter. The green filter was transparent for rays approximately within the range of 433 to 586 mμ; the red filter for 578 to 720 mμ. Both the red and green light were equal in brightness.

The eye of each observer was exposed for 30 minutes, one day to red light, another day to green light. The experiments were carried out on 17 persons with normal eyes and on 25 glaucomatous patients.

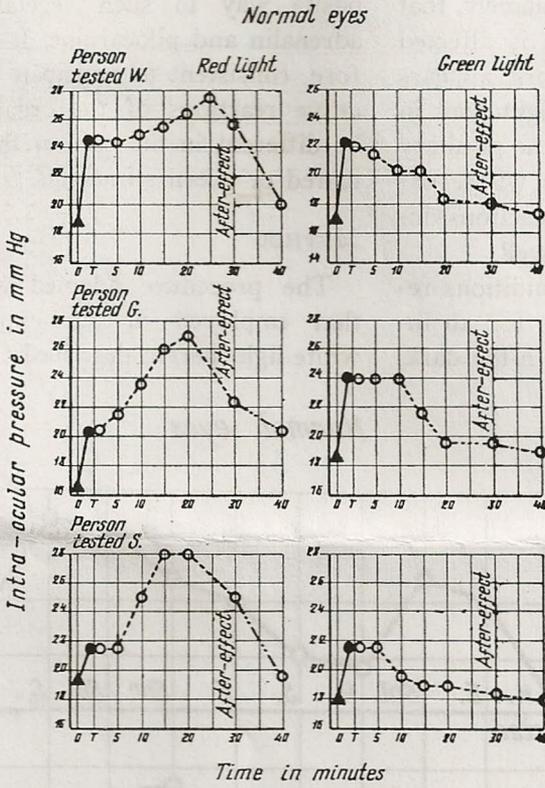


Fig. 4 (Zaretskaya). Curves of intraocular pressure (red or green light applied to the other eye). Along the ordinate are plotted the values of intraocular pressure in mm. Hg; along the abscissa, time in minutes. Triangles denote the initial pressure measured under general illumination of the room; black circles show the level of pressure with dark adaptation of the eye; open circles and broken line are readings obtained when the second eye was exposed either to red or green light; circles and dotted line show tension values found after stopping exposure of the second eye to the light stimulus (that is under the initial illumination conditions).

**RESULTS**

The experiments with normal subjects showed the reaction of the intraocular pressure to be a reverse one, according to whether red or green light was employed.

The exposure of the second eye to green light brought a reduction of the intraocular pressure of the investigated eye; with the red light, the effect was reversed (fig. 3).

A similar picture of a reverse reaction to the red or green light is offered by Figure 4, which shows individual curves plotted for several patients tested by us.

As borne out by Figure 4, the curves

obtained with red or green light show a different run.

**COMMENT**

Glaucomatous eyes display a well-pronounced specific reaction of their intraocular pressure for the same color stimuli. Thus, in all experiments carried on by us an appreciable reduction in tension was observed when the second eye of the subject under test was exposed to green light; the hypotonic effect in experiments with glaucomatous eyes was much stronger, however, than in experiments with normal eyes.

The hypotonic effect of green light appears still more conspicuous if compared to the effect of white light even of a higher brightness applied to the same glaucomatous patients (6 subjects) for sake of experimental control.

Table 1, as well as Figure 5, substantiate this observation.

Patients with a sharply pronounced form of glaucoma display a conspicuous deviation

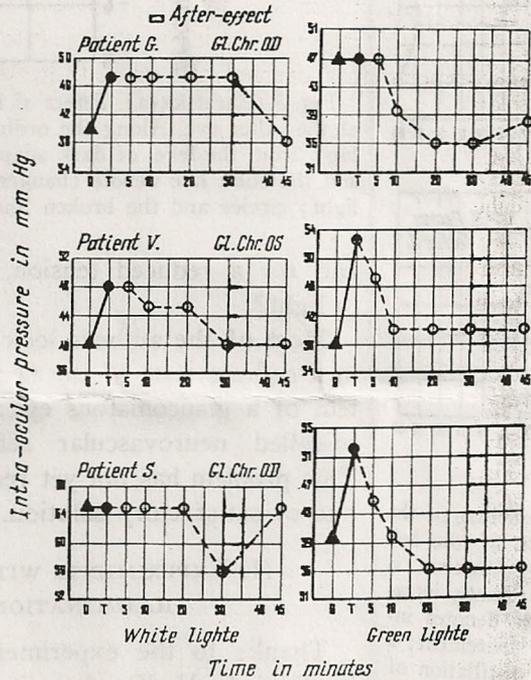


Fig. 5 (Zaretskaya). Intraocular pressure of one eye when the other eye is illuminated with green or white light. (For chart details, please see legend of Figure 4.)

TABLE 1

INTRAOCULAR PRESSURE IN GLAUCOMATOUS EYES AS AFFECTED BY WHITE OR GREEN LIGHT STIMULI

No.	Patient	Diagnosis	Tension Deviation in mm. Hg. Under Exposure of the Other Eye to	
			White Light	Green Light
1	F	Glaucoma chron.	-5,0	-10,5
2	S	" "	-6.0	- 5.5
3	G	" "	0	-12,5
4	V	" "	-8.0	-13.0
5	R	Glaucoma absol.	0	- 8.5
6	Sa	" "	0	-17.0

from the normal in the reaction of their intraocular pressure to red light. In normal subjects, however, the stimulation of the one eye with red light almost always results in a rise of the intraocular pressure of the second eye; no increase of intraocular pressure has, as a rule, been observed in glaucomatous eyes.

The intraocular pressure of the glaucomatous eye either remains stable, or may even show a slight tendency to decrease (fig. 6).

A similar picture of different responses to the red and the green light may be seen also in Figures 7 and 8, representing individual curves bearing out the results of experiments carried out on definite days.

DISCUSSION

The reaction of intraocular pressure in

response to red light, which is missing in glaucomatous patients, points to a definite disturbance between their color-perceiving apparatus and their autonomous nervous system. The green-perceiving apparatus of these patients may possibly be more active than in normal subjects.

It is of interest to recall the remark made by Khodin as early as 1897 (*Journal for War Medicine*, 1897, in Russian), namely, that the increase in intraocular pressure is accompanied with a definite shift of color perception toward the green.

Wessely (1927) has described the presence of scotoma for the red as a symptom of glaucoma.

Some changes in color sensitivity have also been described in glaucomatous patients by Colomba (1932), who is likewise inclined to regard the analysis of color per-

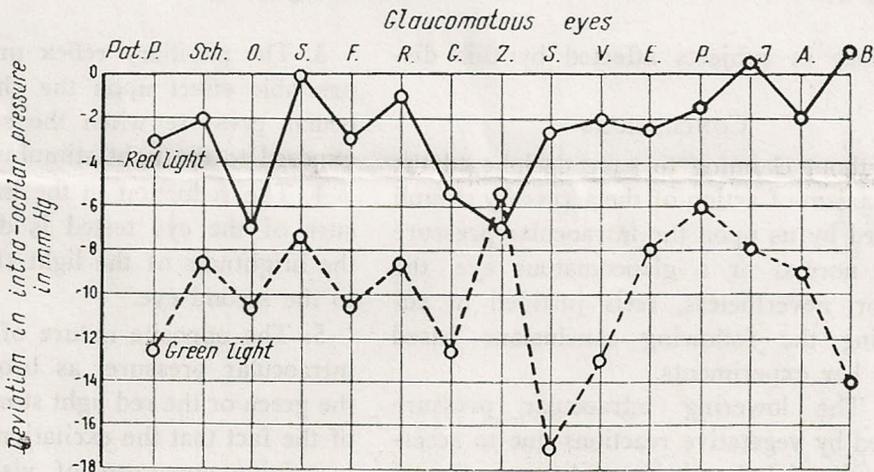


Fig. 6 (Zaretskaya). Intraocular pressure of one eye as effected when the second eye is exposed to colored light. (For chart details, please see legend of Figure 3.)

ception as one of the tests helpful in an early diagnosis of glaucoma.

Pointing out the importance of the investigation of color-vision disturbances for the diagnosis of glaucoma, Oloff (1932) remarks that they are of rather frequent oc-

smoother curve, than in eyes of glaucomatous patients.

2. Fluctuations in intraocular pressure caused by darkness and light are likewise much more sharply expressed in glaucomatous eyes than in normal ones.

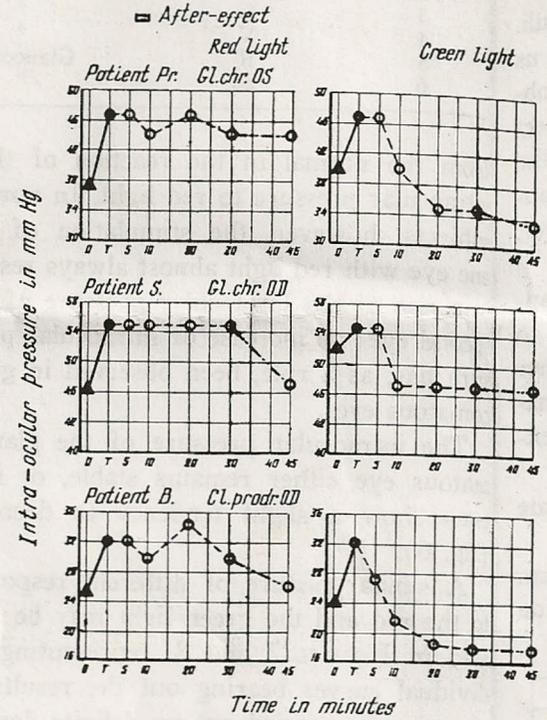
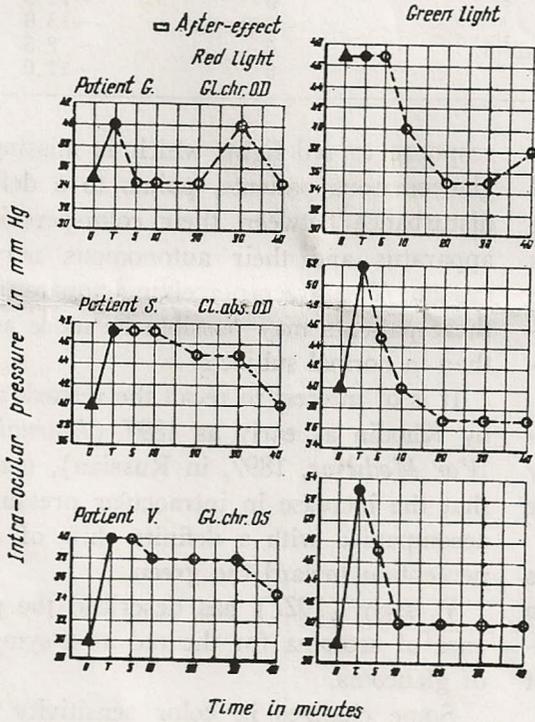


Fig. 7 (Zaretskaya). Change in intraocular pressure produced in one eye of glaucomatous patients by illuminating the other eye with red or green light. (For chart details, please see legend of Figure 4.)

Fig. 8 (Zaretskaya). Change in intraocular pressure produced in one eye of glaucomatous patients by illuminating the other eye with red or green light. (For chart details, please see legend of Figure 4.)

currence in subjects affected by this disease.

CONCLUSIONS

Without claiming to have deciphered the mechanism of action of the accessory stimuli applied by us upon the intraocular pressure in a normal or a glaucomatous eye, the author, nevertheless, feels justified in advancing the following conclusions based upon her experiments.

1. The lowering intraocular pressure caused by vegetative reactions due to accessory stimuli is less in normal eyes and proceeds in a more uniform way, along a

3. The pupillary reflex produced no appreciable effect upon the change in intraocular pressure when the second eye was exposed to the light stimulus.

4. The reduction in the intraocular pressure of the eye tested is dependent upon the brightness of the light stimulus applied to the second eye.

5. The opposite nature of the change in intraocular pressure, as brought about by the green or the red light stimuli, is evidence of the fact that the excitations of the green-perceiving apparatus of vision and of its red-perceiving apparatus produce two an-

agonistic reactions of the autonomous nervous system.

6. The fact that, in contrast to unaffected subjects, glaucomatous patients do not show the usual increase in intraocular pressure in response to red stimuli of the eye, gives us ground to believe that the determination of the response of the intraocular pressure to the red light may become a supplementary method for diagnosing glaucoma.

7. In so far as stimulation with green light is followed by a particularly marked drop in intraocular pressure in glaucomatous patients, there seems to be some hope that green light may be applied to such patients for therapeutic purposes in the form of green spectacles used for reducing their intraocular pressure.

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