THE PHOTOGRAPHICAL ASPECTS OF ROD VISION

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The incoming spring season brought a couple of amateur photographers together who were soon discussing some problems on night photography. The conversation naturally turned to the question of taking pictures of moonlit scenery, or of the moon above an illuminated town. The concensus of opinion regarding the photography of a moonlit landscape, *i. e.* the transmittal of negatives into positives was that these never really reflect the sensation experienced in that peculiar dim light, which is so characteristic of moonlight. Positive photograps of this kind are generally harsh and white, and fail to give the sensation so familiar to all of us. Soon we were discussing the question of how to reproduce the "moonlight-sensation" by photography, a phenomenon seen visually, but actually due to psychological reasons.

A satisfactory solution of this technical problem can only be found by taking into account both the physical and psychological factors. Under conditions of poor illumination we perceive objects by "rod vision", *i. e.* it is the rods of the nerve endings which produce the image. The sensation so created is called "stäbchenweiss" in German (rod white), a term alluding to the role of the rods in vision. Since the spectral composition of moonlight is almost similar to that of the overcast sky at day, it would be wrong to call moonlight yellowish. Actually, moonlight has a greenish tint, a fact which is once more rooted in psychological facts, and is accounted for by the Purkinje effect. As the illumination intensity of moonlight is only 0.25 lux, and the cones which are highly colour-responsive cease to function in such light, we are almost colour blind. In this light we can only just read the headlines of a newspaper.

All the visual faculties, including orientation, distance estimation and stereoscopic vision are noticeably reduced in moonlight. The lack of colour perception, the acute contrasts between the deep black shadows and the surfaces which are so bright as to represent high-lights, — coupled with a number of other unaccustomed phenomena, bring about uncertainty, a lack of orientation and, in some cases, a certain amount of anxiety. For these reasons people will call moonlight mysterious.

The peculiar features of moonlight have induced poets of all times to

sing its praises, and painters to depict it in countless variations, mostly with a prevailing melancholy. How is it, that while paintings often create quite natural impressions, photography fails to produce an even approximately true reproduction of moonlight? It is not intended here to extensively treat the anatomical, optical and above all the psychological properties of the human eye, since these latter vary with the individual, and psychological researchers have still a number of problems to answer. The object of this paper is to improve the photographical rendering of the sensations and sights experienced in moonlight.

The rod vision, as observed in moonlight, can at any time be created by producing a retinal image of the human eye. The test to be described below is due to Helmholtz, and was first made in the 19th century. Though very interesting, it is relatively unknown. The image achieved by the test is neither a real optical image, nor a virtual one. Actually, it represents the shadows cast by the venous system, standing out in relief from the retina, *i.e.* it amounts to the subjective perception of shadows. Therefore these images cannot be photographed, all one can do is to reproduce by drawing the sensations, gained by repeating such tests over and over again.

In accordance with the Helmholtz test, a burning candle is placed laterally from the direction of viewing, and is displaced in front of the eye horizontally and vertically. Soon one perceives a dull, silvery-white area against a dark background, with the veinous system network visible in a darker tone. A lateral displacement of the candle makes visible the vertical veins, and vice versa. The displacement of the entire veinous system upon shifting the light source is not uniform. Some viewers have observed, in the middle of the light spot, a circular, elliptical or sometimes semi-lunar bright area which may be the image of the fovea.

Another, still simpler test merely consists of shifting a dark screen, which is provided with a fine bore, in front of the eye fixed on a uniformly illuminated surface, for example the sky.

The beams emitted by a light source A placed laterally from the eye reach the eyeball through the pupil. The crystalline lens forms an image of the flame at spot A' of the retina. Taking this latter spot as a source of light the pencils which arise therefrom illuminate the retina across the vitreous body, and the vein particle indicated by a black point in the drawing casts a shadow on A''. This we seem to see in the direction A'' to A'''. Beside the veinous system slightly protruding from the retina, one can perceive the effect of the cast shadows formed in the rear layers of the retina.

In the first test, the light enters the eye from an unusual angle, hence, it is directly remarked, as an unaccustomed phenomenon. In the second test, however, the light beam emerging from the customary direction enters the eyeball through the pupil, so that the rays emerge from all points of the

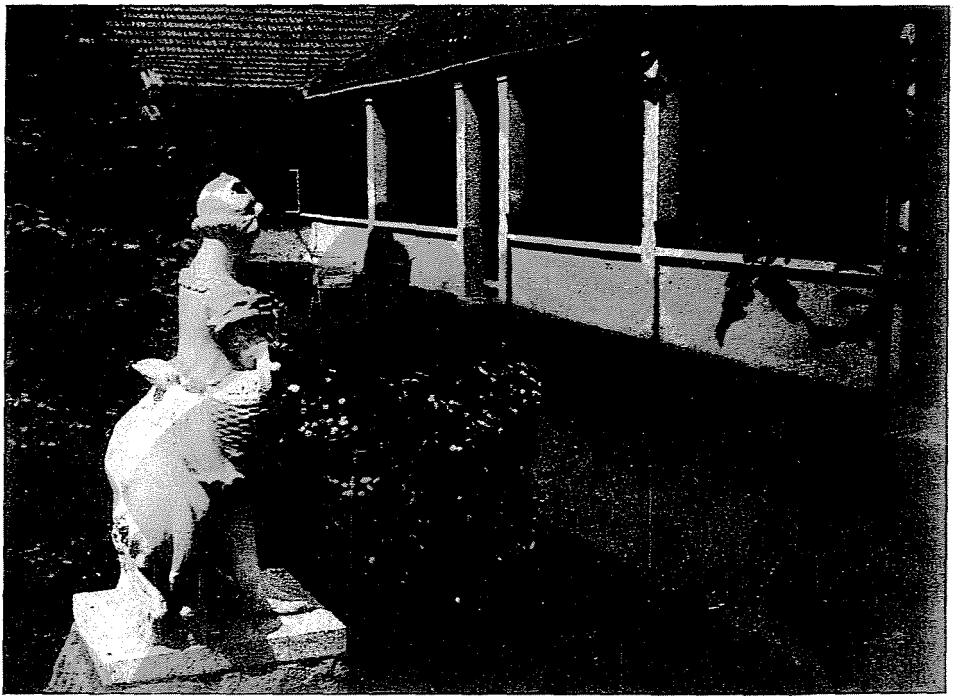
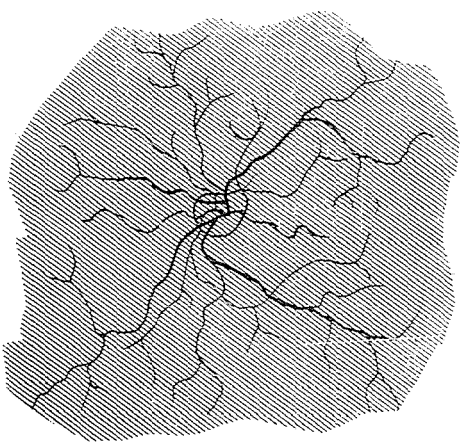


Fig. 3. A normal black-and-white photography of a moonlit scenery

Fig. 4. The same as in 3, with the picture printed on a coat of silver

pupil towards the retina, the area of the pupil representing a self-luminous surface. The sensitivity of the obscured portions of the retina is higher, and its spectral response is not so much exhausted as those of the adjacant parts. If, however, the position of the shadows is changed by moving the light source or the screen, the shadows due to the faint illumination are displaced to those retinal portions which are already exhausted, but less responsive to stimuli. At the same time, those retinal areas which were previously obscured, and are more responsive to stimuli, are fully illuminated, whereby perception is better.



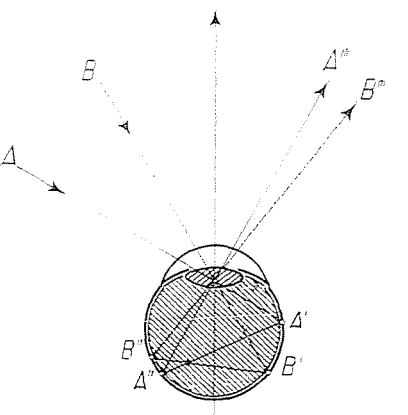


Fig. 1. A diagram of the human retina, made visible artifically, with the arteries in heavier and the veins in lighter lines

Fig. 2. The Helmholtz test for making the retina visible

The artificial rod-vision produced by means of the above described test is closely related to the sensations perceived in moonlight. Perhaps we should call the colour sensation of rod vision silvery bright instead of white, a term referring to the possibility of conveying the moonlight sensation by photography. It has been found that beside photography, this can also be realized in print.

Figure 3 shows a moonlit courtyard, using the conventional methods of printing.

In Figure 4, the actual picture was printed on a film of dull silver previously spread on an area corresponding in size to the picture. If well printed, the silver coating has an effect even on the deepest shadows.

Imitating the Purkinje effect, one can apply a very thin gold coating instead of silver, onto a smooth thin paper, free of texture. Owing to the selective absorption of the gold film, the picture shows a greenish hue if exposed to permeating light.

In order to create this effect, it is essential to use excellent printing methods. The positive copies are made on silver or gold coated paper. This type of paper is fairly scarce nowadays, but was widely used some time ago for producing decorative effects. It must be borne in mind that only real gold serves this purpose, on account of the selective absorption, while the synthetic gold dyes show no greenish hue.

It has been observed that high-contrast copies or magnified pictures give an effect similar to that of moonlight, when viewed in permeating light, a sensation not evoked by normal black-and-white copies.

Considering the rapid progress of photography, scientific and technical, as well as amateur, author feels it might be of interest to set forth some applications of certain earlier principles which could hardly find response at their time, and with which the new generation is quite unacquainted.

It is intended to treat in a latter paper the method of bringing about a highly decorative effect in photography by using a filter based on diffraction. While one hardly realizes the changes caused in a picture by light diffraction, this phenomenon may be well utilized in photography by those who are aware of the underlying physical theory.

Summary

The paper gives a brief survey of the effects to be observed in moonlight, and describes the methods for artificially producing rod vision. The results so arrived at are applied in the technique of photography and in printing. Mention is made of the manner in which optical phenomena can be utilized in photography, *i.e.* how sensations experienced *in natura* can be rendered.

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