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Fluctuations of luminosity in visual fields

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The phenomena briefly described and commented on in the present communication are obviously of fundamental interest and offer a promising field for further investigation. It appears desirable to mention the actual circumstances in which they first came under the author's notice.

The early hours of the morning in a darkened bed-room afford a convenient opportunity of observing how our visual perceptions of the brightness and colour of various objects are influenced by the strength of their illumination ranging from complete darkness before dawn to ordinary daylight levels after sunrise. Comfortably esconced in bed, the author watched the appearance of a smoothly distempered wall about three meters away from his eyes under these conditions. The light reaching the wall was that from the southern sky falling on it through two ventilators high up near the ceiling of the room. The illumination was sensibly uniform over the area under observation. But not until some time after sunrise when all the objects in the room exhibited their normal outlines and colours, did the wall present the appearance of a uniformly illuminated surface. At all earlier stages, it exhibited a fantastic play of moving light and shade, difficult to describe but which showed a progressive alteration in its character as the strength of the illumination increased from the zero level upwards. At the lowest levels of illumination, dark patches of extensive size appear to move over the wall, becoming visible and then disappearing. At somewhat higher levels of illumination, the darker and brighter areas are distinctly smaller and shift about in a random fashion. At still higher levels, the wall appears to be covered by innumerable scintillations, continually varying in their positions and degrees of brightness. In the final stages, the areas of fluctuating brightness appear to be quite small and contiguous to each other.

As the eyes of the observer had been rested in the dark for many hours before the effects described were noticed, it is evident that the phenomena reported are entirely characteristic of our visual perceptions and are not in the nature of any after-effects of earlier exposures of the eye to light. One may also rule out the possibility of ascribing them to retinal "light" of purely subjective origin. This is clear from the manner in which the effects observed change with the strength of the illumination.

Essentially similar phenomena can be observed and studied under controlled conditions in a darkened room, using artificial sources of light of which the

intensity can be varied over the necessary large range. For example, we may use an ordinary tungsten-filament lamp with a frosted bulb as the source of light. Enclosing this in a box covered with apertures of various sizes through which the light can emerge, the intensity of the light received on an observing screen can be varied. A white reflecting screen or else a translucent plastic screen can be employed; in the latter case, the light emerging through the screen is viewed.

The explanation of the effects that naturally suggests is one which makes use of the fundamental notions of the quantum theory. Before light can be perceived by an observer, the energy of the radiation falling on the retinae of his eyes has to be absorbed and passed on through the visual receptors and the optic nerves to the brain. Such absorption necessarily takes place in complete quanta, and we may reasonably assume that the visual sensations we experience would be determined, firstly by the number of radiation-quanta falling on the retina in each small interval of time; secondly, by the proportion of that number that is actually absorbed and thereby becomes available for perception, and thirdly by the extent of the region of the retina in which the visual receptors are located which actually take up a quantum of energy. The smaller the area of this region on the retina, the more highly localised would be the region on the screen on which the resulting illumination would manifest itself. Each of these factors would influence the results, and taken altogether they would determine the observed effects. The appearance of fluctuations of luminosity in the visual field may thus be regarded as a direct consequence of the energy of light consisting of discrete quanta. The weaker the illumination, the more conspicuously would the resulting fluctuations be expected to manifest themselves. The changing character of the observed fluctuations at different levels of illumination would be explicable as the result of the visual receptors which actually take up the energy not being the same both at the lower and at higher levels of illuminations and also being connected with the cerebral centres in a different manner in the two cases.

It can also be suggested with some confidence that the phenomena now under consideration stand in intimate relationship with the subject of the acuity of vision and its variations, and especially with the well-known influence on visual acuity of the strength of illumination. Indeed, observational trials show that the fall in visual acuity with diminishing brightness of illumination appears in the same range of illumination as that in which the fluctuations in the luminosity of a uniformly lighted screen are distinctly observable. We are therefore entitled to infer that our eyes fail to perceive the details of the object viewed by them at low illuminations for the same reason that a uniformly lighted screen at such illuminations exhibits purely subjective variations of its observable luminosity.

Finally, we may remark that the effects with which we are concerned in the present communication are conspicuous at levels of illuminations much higher than those approaching the lower limit of visibility, where the notions of the quantum theory have been utilized to explain various facts of observation. It may also be remarked in this connection that the fluctuations of luminosity with which

we are concerned here may be observed when the light sources are covered by various colour filters and the corresponding colours can actually be recognized on the observing screen. As is to be expected, the fluctuations of luminosity are most conspicuous with filters of low visual luminosity transmitting blue light and least conspicuous with the yellow filters which have a higher luminosity.