THE ROMANCE OF VISION

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Sight, in a general sense, may be taken to mean sensitivity to light, while in a more restricted but more proper sense, it means the conscious appreciation of a sensation obtained through the eyes. Sight is therefore the response to light. In our school days we were thought that light was a form of energy and that there was an unbridgeable difference between energy and matter; we now know that the two are really different manifestations of the same thing; both are composed of electrons and protons, the different proportions of each, their affinities and their relative movement, determining the nature of the substance, whether it be light, sound or a piece of stone. We know that light has mass, volume and weight.

In the vegetable kingdom, no true vision is present, but various forms of light sensitivity are encountered. The response is usually in the form of movement towards or away from the source of light. We all remember how the sun-flower turns towards the sun, following it across the horizon, and bending woefully on its stem during the hours of darkness. Heliotropism is the simplest form of light sensitivity among living objects and is the result of chemical reactions in the cells of plants produced by light.

The simplest form of animal life, the amoeba, reacts to light by going towards or away from it; the kind of movement is constant for any given species. Up to this stage of development in life, the response to light is of the whole body; no discrimination as to the nature or direction of light is possible. For these it is necessary to have specialised organs of sight. Thus the earthworm has a number of light-sensitive cells scattered over its body. When it is wholly underground no light is perceived, but when partially above ground, only part of its light-sensitive cells are stimulated and this will give it an indication as to where the light is coming from, and possibly also to its intensity. Similarly some marine animals have patches of light-sensitive cells spread out on the flat, and they can thus perceive light, its direction and if a definite shadow falls across their surface, also the shape of an object. Furthermore, by the successive stimulation of neighbouring cells these animals may become aware of the movements of objects.

Such types of animals so far described, can have no clear image of the world outside, as they lack a focussing mechanism; for this, a lens (or a lens system) is necessary in higher animals endowed with a specific organ of sight, and in these we notice it for the first time. An eye consists essentially of a condensing mechanism, an aperture and a sensitive layer or retina. The lens or system of lenses should possess a mechanism by which rays from different distances could be focussed on the sensitive layer. Different animals have different ways of focussing rays. In some, the lens can be moved backwards and forwards in much the same way as is done in a photographic camera. Moving the lens forwards would increase, while moving it backwards would decrease its refracting power. In higher animals and in man, change in refractivity is brought about by changes in the shape of the lens, which remains in the same position. Changes of shape are possible because the lens is enclosed in an elastic capsule, and because of the presence of the ciliary muscle. This process of changing focus is called accommodation, and in virtue of it, objects at different distances from the eye can produce a clear image on the retina. In man, with the advance of years, the lens becomes less plastic, so that it does not readily change its shape by the action of the ciliary muscle; as a result there is increased difficulty of focussing near objects without the aid of an additional lens. This condition is called presbyopia, and it should be emphasized that it is not a disease, but a manifestation of ageing.

The 'aperture' of the eye is represented by the iris, a coloured diaphragm controlling the amount of light entering the eye and contributing to the sharpness of images. The pupil is round in man, but may be of other shape in animals; we are all aware of the slit-like pupil of the cat. In some animals devoid of a lens, a slit-like pupil permits of the 'focussing' of rays on the retina from different distances; it does this by allowing only a small pencil of rays to get through, and these need not be refracted to get to the retina; in other words the clearness of an image is at the expense of its luminous intensity. The colour of each iris varies from one individual to another and often from one eye to the other; the various patterns are chiefly due to the different distribution of pigment. It is well known that all white babies are born with blue irides, due to lack of pigment; this colour is due to the passage of light through the stroma of the iris. Many a young mother will show disappointment at the changing of the colour of the eyes of her offspring from a beautiful shade of blue, to one of the shades of brown.

The sensitive layer in the living camera is the retina and it is composed of specialised cells which are variously affected by light. The receptive cells are of two kinds, the rods and the cones. The former are the more sensitive to light and to movement, while the latter are responsible for clear vision and for the perception of colour. Some animals have only one type of cell, others have both, but in different proportions. Nocturnal animals require greater awareness of the slightest amount of light, and their retina tends to have exclusively or preponderantly rods. On the other hand, diurnal animals need greater acuity of vision for feeding, hunting or defence purposes and they also require colour perception. Thus, examination of an animal's retina will tell us much of its habits. Man has compromised in this respect. His retina has both rods and cones, the former greatly outnumbering the latter. The cones enable him to perceive colour and to notice the minute details of things, but for their proper functioning a minimum amount of light is necessary. This explains why at dusk we cannot read or tell the colour of an object. By means of the rods, which are more numerous in the periphery of the retina, we can go about in comparative darkness, and we can also become aware of objects at the periphery of our field of vision, and so receive the stimulus to look directly at such of them as interest us. The macula of the retina is composed almost exclusively of cones and this explains why objects are seen best when we look at them; it also explains why on a starlit night a faint star disappears when we look at it, only to re-appear when we look to its side. In this case, the star emits enough light to stimulate our rods but not our cones.

On the retina, images should be able to follow in quick succession, and the chemical reaction in the retinal cells induced by light should be of a reversible character. In the rods visual purple is found, which is bleached by light and which is regenerated in the dark. Although no pigment has as yet been found in the cones, it is likely that some form of it is also present and that a chemical reaction so far unknown takes place in them by the action of light.

The perception of colours is a very interesting but elusive phenomenon. Colours themselves are not the property of this or that object, but are a personal appreciation of the individual or animal. It is well known that white light can be split into its seven constituent colours, but the number of hues present in the spectrum is in the region of 164. It is more than likely that some animals, notably birds perceive a far greater number of colours than we humans do, and to them the world would be luxuriously bright and colourful! We have all met colour-blind people who cannot perceive certain bands of the spectrum. The condition is usually congenital and there is no cure for it. Such people see things of a different hue than we do, but often pass unnoticed because they learn to call different shades of the same colour by the names traditionally attached to a particular colour. We all know that the famous English chemist Dalton was colour-blind and that to him strawberries were a close match to the leaves of a tree. Animals which have no cones are naturally colour-blind, but from this it does not follow that all those with cones perceive the same colours as we do. In fact, among mammals there is evidence of colour perception only for apes, monkeys and men. The great number of theories for colour vision testify to our ignorance in the matter. The most recent and the most plausible one has been put forward by Granit, who has found that different fibrils of the optic nerve react to different colours.

We have all noticed that on looking at any given object, we see all its details but at the same time we are also aware of many other things around the fixed object. That portion of space which one can see at any given moment constitutes one's field of vision. In man and in animals with forward-directed eyes, the field of vision of one eye overlaps that of the opposite side in the centre. This is of importance in the proper appreciation of solidity and of the relative position of objects, which is called stereoscopic vision. Because of the distance between the two eyes, each eye looks at an object from a slightly different angle; the two impressions thus obtained give one the basis on which to build a composite but single mental impression of the two. The high development of the human macula and the great degree of accuracy of detail seen by it, may lead some to belittle the value of the peripheral field. Nothing could be more erroneous. A person with perfect central vision but with restricted peripheral vision, as in a case of advanced Retinitis Pigmentosa, is worse off than one with depressed central and good peripheral vision. Humans and animals with forwardly-directed eyes, gain in stereoscopic vision what they lose in the extent of the field. The presence of a blind area behind in such animals is readily admitted. We cannot tell what is happening behind our backs both in the figurative and the literal sense! Birds and animals with laterally-directed eyes have little or no stereoscopic vision, but they have a large field of vision. Most of them have no blind area at all and they can see all round them at any given time — panoramic vision. This explains why it is so difficult to surprise such animals or to catch them unawares.

We have only considered so far the type of vision possible with a given eye or a given organ of sight. No sight, however, is possible without an adequate brain. One should not imagine that the human eye is the most perfect specimen of its kind. The bird for one, has a much better eye, with better acuity and a larger field; we have only to recollect how birds can see very small worms from great heights. Besides, the human eye has a fair amount of chromatic, spherical and other aberrations and a philosopher once exclaimed that he would have disdained to accept an offer of such an imperfect optical instrument! What then makes the human eye such a wonderful instrument of sight? It is the brain which gives man his pre-eminence in the world and which makes human treasure of the signals which the eye sends. Without the brain we would see without knowing that we are seeing, which is absurd.

The phenomenon of vision is chiefly a mental one, but requires the service of an adequate organ of sight. The two images focussed on the retina, reach the brain via the optic pathways; here they are received, fused, and elaborated into a new mental impression. By means of the numerous association fibres an object seen evokes many associations, and by reference to previous experience it obtains its meaning. It is this fact which explains why the same object will mean differently to different persons. A portrait by Raffaelc, will evoke in the mind of the art lover the purest form of pleasure, while the same picture to an art dealer will only mean so much money! The emergent sensation which an object produces depends on previous experience and training and is a feature of one's personality. Again a very good brain will put up with more defects of vision than a one which is less good. On this fact depend the many claims of correction of poor vision without glasses; patients are trained to understand the meaning of a blurred image and to integrate mentally defective portions of an image.

It is very fascinating to speculate as to how light affects the retinal elements and as to how the impulses thus started are carried to the brain and there interpreted. The process is still shrouded in much mystery, but a modern development of science may help us to understand how such a process could happen. The discovery of the photo-electric cell has made television possible. This cell has the property of transmitting current through it in proportion to the amount of light which falls on it. By increasing the number of photo-electric cells in the transmitting and receiving apparata, it has been possible to increase the clearness and definition of images sent. In animals, the retinal elements would act as the receiving photo-electric cells, while the optic pathways would carry the impulses thus set up to the brain where the messages are again unravelled and presented to consciousness. The psychical component of vision is not yet fully understood and offers good scope to the intelligent research worker.

To conclude, the story of vision is one of grades, starting at the lowest level with phototropism as exhibited in plants, passing through the appreciation of light, the appreciation of the direction of light, the appreciation of movement, of form, of colour and of perspective, to end at the highest level of human vision, in which objects seen have a meaning and have the power to evoke ideas and to stimulate action.