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Sir David Brewster K.H. LL.D. F.R.S. V.P.R.S. Ed.

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XIX. *On the Effect of Compression and Dilatation upon the Retina.* By SIR DAVID BREWSTER, K.H. LL.D. F.R.S. V.P.R.S. Ed.*

THE production of light by a gentle pressure upon the eyeball, or by a sudden stroke upon the eye, is a fact which has been long known, but which, so far as I know, has never been carefully examined. In the sixteenth Query, at the end of his Optics, Sir Isaac Newton describes the fact, and reasons upon it in the following manner:

“When a man in the dark presses either corner of his eye with his finger, and turns his eye away from his finger, he will see a circle of colours like those in the feather of a peacock’s tail. If the eye and the finger remain quiet these colours vanish in a second, but if the finger be moved with a quavering motion they appear again. Do not these colours arise from such motions excited in the bottom of the eye by the pressure and motion of the finger, as at other times are excited there by light for causing vision? And do not the motions once excited continue about a second of time before they cease? And when a man by a stroke upon his eye sees a flash of light, are not the like motions excited in the retina by the stroke? And when a coal of fire moved nimbly in the circumference of a circle makes the whole circumference appear like a circle of fire, is it not because the motions excited in the bottom of the eye by the rays of light are of a lasting nature, and continue till the coal of fire in going round returns to its former place? And, considering the lastingness of

* Read before the British Association at Oxford, June 22, 1832.

the motions excited in the bottom of the eye by light, are they not of a vibrating nature?"

The circle of light referred to in this passage always appears opposite to the point of pressure, and its centre has the same visible direction as that of a ray of light incident on the centre of the compressed portion of the retina. The reason why the phænomenon is best seen by turning the eye away from the finger is, that the retina is thus brought under the point of pressure; for if the eye remains at rest, or is turned towards the finger, the luminous circle is either imperfectly seen or disappears altogether, because the finger then presses, either wholly or partly, upon a part of the eyeball beneath which the retina does not extend. Sir Isaac Newton is mistaken in saying, "that the colours vanish in a second when the eye and the finger remain quiet." They undoubtedly continue as long as the pressure is kept up; and in proof of this I may mention a case which I had occasion particularly to study, in which the patient constantly saw the luminous circle, in consequence of an excrescence on the inside of the eyelid, which produced a continued pressure on the eyeball.

Sir Isaac Newton has not named the colours which he saw in the luminous circle, any further than by saying that they are like those in the feather of a peacock's tail. Although I have made the experiment a thousand times, under all varieties of circumstances, I have never been able to observe any other circles but *black* and *white* ones, with the exception of a general *red* tinge which is seen when the eyelids are closed, and which is produced by the light which passes through them.

When a gentle pressure is first applied so as to compress slightly the fine pulpy substance of the retina, a circular spot of colourless light is produced, though the eye is in total darkness, and has not been exposed to light for many hours. If light is now admitted to the eye, the compressed part of the retina is more sensible to the light than any other part, and consequently appears more luminous. Hence it follows, *that a slight compression of the retina increases its sensibility to the light which falls upon it, and creates a sensation of light when the eye is in absolute darkness.*

If we now increase the pressure, the circular spot of light gradually becomes darker, and at last black, and is surrounded with a bright luminous ring of light. By augmenting the pressure still more, a luminous spot appears in the middle of the central dark one, and another luminous spot diametrically opposite, and beneath the point of pressure. Considering the eye as an elastic sphere filled with incompressible fluids, it is obvious that a ring of fluid will rise round the point depressed

by the finger, and that its pressure from within outwards will *dilate* the part of the retina under the finger which was formerly compressed, and will compress all that part of the retina in contact with the elevated ring. An increase of pressure will be resisted by the opposite part of the retina, and will thus produce a compression at both extremities of the axis of pressure, occasioning the diametrically opposite spot of light, and also the luminous spot in the middle of the circular black space. Hence we conclude, *that when the retina is dilated under exposure to light it becomes absolutely blind, or insensible to all luminous impressions.*

These properties of the retina often exhibit themselves involuntarily when the body is in a state of perfect health. When we move the eyeball by the action of its own muscles, the retina is affected beneath the place where the muscles pull the eyeball; and there may be seen opposite each eye and towards the nose two semicircles or crescents of light; and other two extremely faint towards the temples. At particular times when the retina is more sensible than at others, these crescents become complete circles or rings of light. From the same cause, in the act of sneezing, gleams of light are emitted from each eye, during both the inhalation of the air and its subsequent expulsion; and in blowing air violently through the nostrils two patches of light appear above the axis of the eye, and in front of it; while other two luminous spots unite into one, and appear about the point of the nose, when the eyes are turned in that direction.

The phænomena which have been described are those produced by the parts of the retina which are most affected by any given pressure; but it is obvious that this pressure is propagated over the whole retina;—and it is a curious fact, that though this pressure is too weak to produce a luminous impression, it has yet power to modify other impressions previously made upon the membrane. If, from looking at the sun, the eye sees a *pinkish-brown* spectrum, a pressure upon another part of the retina will change it to a *green* spectrum; and when the pressure is removed it will again become *brown*. If the pressure is such as to diminish the sensibility of the retina, it will either diminish or entirely remove a weak spectral impression.

When the eye is pressed in front by putting the finger on the eyelid above the cornea, no luminous spectrum is seen; and I have not ventured to make the pressure sufficiently strong to make an impression on the back of the eye. I know a case, however, in which this effect was produced accidentally. A person, in a state of intense grief, had been sitting for some time with his hand pressed against his eye;—the moment the

hand was removed and the eye opened, a black spot, the size of a sixpence, was seen in the axis of vision.

It is from pressures on the retina that those floating masses of light are produced, which appear in particular states of indisposition. In affections of the stomach the pressure of the blood-vessels upon the retina is shown in the dark by a faint blue light, floating before the eye and passing off at one side. As the pressure increases, the blue light becomes *green*, then *yellow*, and sometimes even *red*, all these colours being occasionally seen at the edge of the luminous mass.

The preceding observations on the influence of dilatation in making the retina insensible to light, render it extremely probable that the disease in that membrane, called *Amaurosis*, may sometimes arise from a general distention of the eyeball, arising from a superabundance of the fluids which it incloses. If this be the case, the removal of the pressure might be effected by puncturing the eyeball (where it can be done with safety), and letting out a portion of the aqueous humour. How far such an operation would be effectual when the disease has been of long standing can be determined only by experiment.

XX. *A Sketch of the Geology of Six Miles of the South-east Line of the Coast of Newcastle in Australia;—with a Notice of three Burning Cliffs on that Coast. By the Rev. CHARLES PLEYDELL NEALL WILTON, M.A. of St. John's College Cambridge, Fellow of the Cambridge Philosophical Society, and Chaplain of Newcastle*.*

THE whole line of the cliffs from the point (*a*) to (*b*) in the accompanying figure, affords a fine field for the operations of the geologist; and though in some parts the abruptness of the rocks, which project at their base into the sea, and in others the stupendous masses, which have from time to time (by the violent winds of the south-east gales, which prevail on this coast), been detached from the overhanging precipices, and been hurled to the bottom, impede the naturalist in his progress,—yet is his toil amply rewarded by the interesting results of his several investigations.

The height of the cliffs in general varies from about 100 to 300 feet, and their surface towards the sea presents in some places *three* and in others *two* parallel horizontal beds of coal, of the independent formation (with sometimes an occasional dip), having alternating layers of shale, *breccia*, more or less compact chert, sandstone, millstone-grit, clay-stone, slaty clay, clay-ironstone, and thin laminæ of ironstone divided into

* Communicated by the Author.