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XXV. *Observations on the supposed Achromatism of the Eye.* By Sir DAVID BREWSTER, F.R.S., &c.

IN a paper "*On the Achromatism of the Eye*," by the Rev. Baden Powell, just published by the Ashmolean Society of Oxford, he has endeavoured to refute the opinions and statements of different authors who have maintained that the eye is not an achromatic instrument. As Mr. Powell has referred to opinions and experiments of mine upon this subject, I feel myself called upon either to renounce them, if they are wrong, or to endeavour to explain and support them if they are correct.

The experiment on the marginal dispersion of my own eye, quoted by Mr. Powell, is admitted by him to be so far decisive of the question as to prove "*that the principle of its achromatism* (if it exist) *must be such as is not effective in oblique excentrical pencils*," p. 11; but he is of opinion, that notwithstanding this, the eye may be *in general* achromatic for *direct* rays.

In order to establish this opinion, Mr. Powell discusses some very decisive experiments of Fraunhofer, which I published in the *Edinb. Phil. Journal*, No. xix. p. 35. The objections which he makes to these experiments do not, in my opinion, invalidate the results which their illustrious author deduced from them; and I have every confidence in the conclusion at which he arrives, that, in his eye, *blue* rays must *diverge* from a point 21·1* inches distant, in order to have

* This is the mean of *four* experiments.

the same focus as *parallel red* rays. In support of this opinion I may adduce the experimental testimony of Dr. Wollaston and Dr. Young. In order to prove "the dispersive power of the eye," Dr. Wollaston "looks through a prism at a small lucid point, which of course becomes a linear spectrum. But the eye cannot so adapt itself as to make the whole spectrum appear a line; for if the focus be adapted to collect the *red* rays to a point, the *blue* will be too much refracted, and expand into a surface; and the reverse will happen if the eye be adapted to the *blue* rays; so that in either case the line will be seen as a triangular space." To this interesting observation Dr. Young adds the following experiments. "The observation is confirmed by placing a small concave speculum in different parts of a prismatic spectrum, and ascertaining the utmost distances at which the eye can collect the rays of different colours to a focus. By these means I find *that the red rays, from a point at* 12 *inches' distance, are as much refracted as white or yellow light at* 11. The difference is equal to the refraction of a lens 132 inches in focus*."

In a subsequent paper, "*On some cases of the Production of Colour*," (Lectures, vol. ii. p. 638,) Dr. Young informs us that he has confirmed his previous observations on the dispersive powers of the eye: "I find," says he, "that at the respective distances of 10 and 15 inches the extreme *red* and the extreme *violet* rays are similarly refracted, the difference being expressed by a focal length of 30 inches. Now the interval between *red* and *yellow* is about one fourth of the whole spectrum; consequently, a focal length of 120 inches expresses a power equivalent to the dispersion of the *red* and *yellow*, and this differs but little from 132, which was the result of the observation already described. I do not know that these experiments are more accurate than the former one; but I have repeated them several times under different circumstances, and I have no doubt that the dispersion of coloured light in the human eye is nearly such as I have stated it. It may also be ascertained very accurately, by looking through an aperture, of known dimensions, at the image of a point dilated by a prism into a spectrum, and measuring the angle formed by its sides on account of the difference of refrangibility of the rays; and this method seems to indicate *a greater dispersive power* than the former."

When Dr. Wells, as quoted by Mr. Powell, states "that the eye has no principle of achromatic compensation in its lens, since the refractions are all performed one way," he would be

* On the Mechanism of the Eye: Lectures, vol. ii. pp. 584, 585.

right in his argument, if his facts were correct. The refractions are *not all performed one* way. The vitreous humour acts as a concave lens, and the rays are refracted *from* the axis in passing from the capsule of the crystalline into the vitreous humour, and, as Mr. Powell justly observes, this case is precisely the same *in principle* as the construction for achromatic microscopes which I have given in p. 408 of my *Treatise on New Philosophical Instruments.* But in practice it is very different. The refractive and dispersive powers of the crystalline and vitreous humours are such *that an achromatic compensation is impossible.*

But there is another point of view in which I would beg to submit this subject to Mr. Powell's consideration. I have elsewhere stated, (and Mr. Powell has quoted the passage without pursuing the idea which it contains,) "that no provision is made in the human eye for the correction of colour, *because the deviation of the differently coloured rays is too small to produce indistinctness of vision.*" If the last of these two propositions be true, the first will be instantly admitted; for it is inconceivable that the all-wise Author of nature, who never works in vain, should have made the eye achromatic when it was not required for the purposes of vision.

The idea that the eye would answer the purposes of vision more perfectly if it were achromatic, seems to be founded on a hasty analogy. Because an achromatic telescope, or microscope, or lens, is preferable to the same instruments when they are not freed from colour, it is conceived that an achromatic eye should have the same superiority: the two cases, however, are considerably different. In using the telescope, &c., the eye views in succession every part of the image which they form, in every part of the object within the field of view; but there is no eye behind the retina to view in the same manner the image which is formed upon that membrane. In point of fact, *the eye is incapable of seeing any object distinctly* unless *it is situated in or near its axis*, and hence it is of no importance whatever to render the image distinct at a distance from the axis. Whenever the eye wishes to examine an object, or a part of an object, minutely, it instantly directs to it the axis of its vision, and from the rapidity of its movements, and the duration of the impressions of light, it thus obtains the most perfect view of a given object, and can scrutinize in succession its minutest parts.

Now in order to obtain distinct, and a *sensibly colourless* vision, near the axis of the eye, achromatic compensation is not necessary. In order to prove this, look through a convex lens, about an inch in focal length, at any sharp and well-

defined dark object on a luminous ground, and the most perfect and colourless vision of this object will be obtained in and near the common axis of the eye and the lens. Now in this case we have *sensibly colourless* vision, although the lens is not achromatic, and although its chromatic aberration is increased by whatever colour there may be in the eye itself. How much more, then, should vision be *sensibly colourless near the axis of vision*, and with the eye alone, when we consider that it is composed of substances which have a much lower dispersive power than glass!

Mr. Powell has quoted the admirable paper of Dr. Maskelyne, in which, without referring to the physiological fact on which I have proceeded, he regards the eye as a lens, and calculates the amount of indistinctness in the image which it forms. He has shown that the calculated dispersion, which we believe to be even less than he makes it, is not incompatible with distinct vision, and he has pointed out causes which tend to diminish the injurious effects of this dispersion. But though Mr. Powell quotes these results, he does not attempt to call them in question, or to disprove them by other calculations founded on more recent measures of dispersive power; and until this is done, great weight must be attached to the reasoning of Dr. Maskelyne.

After a careful perusal of Mr. Powell's Memoir, I have no hesitation in stating that I continue to maintain the opinions which, along with others, I have published on this subject; and that I consider the *non-achromatism of the eye* as a fact as well established as any other fact in natural philosophy.

Belleville, January 15th, 1835.

XXVI. *On the General Existence of a newly observed and peculiar Property in Plants, and on its Analogy to the Irritability of Animals.* By Henry Johnson, *M.D.**

I DO not know that it has ever been remarked, that, on dividing the stem of almost any herbaceous plant, a singular separation of the divided segments uniformly occurs, and that this separation continues until the stem withers and dies from the loss of its moisture.

It was in the autumn of 1827 that I first observed this fact; and from an opinion which at once occurred to me that it was connected with the motive powers of the plant, I have been induced, since that period, to pay much attention to the

* Communicated by the Author. This paper is an abstract of a Memoir read before the Ashmolean Society of Oxford.