CRITICAL INQUI

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NEW MEMBRANE IN THE EY

DISCOVERED BY

MR. GEORGE HUNSLEY FIEL

AND DESCRIBED BY HIM IN A LECTUR

DELIVERED AT OXFORD,

BEFORE THE LATE MEETING OF THE BRITISH ASSO

FOR THE

ADVANCEMENT OF SCIENCE.

BY

WILLIAM GORDON, F.

MEMBER OF THE ROYAL COLLEGE OF SURGEONS, EI

&c. &c.

In scientiâ excellere pulchrum ducimus, errare autem, ne
decipi, malum et turpe.—Cicero.

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WILLIAM GORDON, F.L.S.

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J. PURDON, PRINTER, MARKET-PLACE, HULL.

DEDICATION.

TO

THOMAS RAIKES, ESQ.

WELTON.

My dear Sir,

There is no one to whom I can dedicate the following pages with greater pleasure than to yourself. In my success you have taken the most kindly interest; and in the prosecution of those subjects of science which have engaged my attention, you have ever generously afforded me the most ample facilities.

I remain,

My dear Sir,

Your very sincere and much obliged Friend,

WILLIAM GORDON.

Welton, near Hull, Yorkshire,
Oct. 20th, 1832.

PREFACE.

The following statement will afford an explanation of my entering into a review of Mr. Fielding's opinions. In 1828, Mr. Fielding read at a Meeting of the Hull Literary and Philosophical Society, a Paper on Vision, in which he annonnced the discovery of a new Membrane in the Eye, and propounded a new theory of Vision. Not being able to attend the Meeting, I published a Letter in one of the Hull Newspapers, stating my belief that Mr. Fielding had no claim to the merit of a discovery. In 1829, Mr. Fielding again read his Paper before the same Society. On this latter occasion, being present, I endeavoured to prove that Mr. Fielding had found out no new Optical Membrane, and that his theory of Vision was incorrect. In June last, Mr. Fielding delivered the Lecture above-mentioned before the "British Association for the Advancement of Science." In consequence of this, I considered that I ought, in justice to myself, not to allow it to remain unnoticed.

It will be proper to mention, that in my dissections and experiments, I have chiefly employed the eyes of oxen, sheep, and cats.

A

CRITICAL INQUIRY,

&c.

In order fully to comprehend the situation and uses of the Membrana Versicolor, it will be necessary for me to give a short description of the anatomy and functions of the different parts of which the eye is composed. The eye consists of a ball or globe, and is lodged in a bony cavity, termed the orbit. It has implanted into it six muscles, which are destined to retain it in its situation, and to give it motion. The ball of the eye is very nearly of a spherical form ;—it is composed of several coats or membranes, and of three transparent substances, called humours. The principal membranes of the eye are the Tunica Sclerotica, the Cornea, the Tunica Choroides, the Tunica Jacobi, the Retina, and the Iris. Besides these, there are some others, of which, however, it is not necessary for me to take any particular notice. The humours of the eye are the Aqueous Humour, the Crystalline

Lens, and the Vitreous Humour. The Tunica Sclerotica is the outermost membrane of the eye. It is perfectly opake, and possesses great density and toughness. Its outer surface is convex, its inner surface is concave, and in apposition with, and connected to, the Tunica Choroides. In its anterior part it presents a circular aperture about six lines in diameter. This aperture is filled up by the Cornea, which is a clear translucid membrane, formed of six or seven concentric lamellæ, firmly united together by a fine cellular tissue. The Cornea constitutes the first optical surface at which the rays of light passing to the Retina, undergo refraction. At the junction of the Sclerotica and Cornea, is a ring of light-gray matter, about a line and a half in breadth. This ring is termed the Ligamentum Ciliare, and from the late researches of Dr. Knox, it appears to be particularly concerned in the adaptation of the eye to distinct vision at different distances. Lining the whole of the inner, or central surface, of the Tunica Sclerotica, and united to it by vessels, nerves, and cellular substance, is the Tunica Choroides. This coat is extremely vascular, and can be divided into two layers. The first, or outer one, is composed of veins, which are termed Vasa Vorticosa. The second, or inner layer, is covered by the first.—

It is arterial, and termed Tunica Ruyschiana.— Its inner surface has a villous or fleecy appearance, and has been denominated Tapetum.[a] In carnivorous animals which prey by night, and in ruminating animals, that portion of the Tapetum which occupies the temporal side of the bottom of the eye, is of a yellow-green and sapphire-blue colour.* This brilliant part is called the *lucid* Tapetum, to distinguish it from the rest of the inner surface of the Tunica Choroides, which has been called dull Tapetum,† or simply Tapetum. For the sake of perspicuity, I shall call the lucid Tapetum the *portio lucida.* The Tapetum, in the eyes of many of the lower animals, may be taken off from the whole or greater part of the Tunica Ruyschiana like a layer of membrane, and by the French anatomists it seems to be considered as such.‡ Lying in the *central* or *inner* surface of the Tapetum, and in close contact with the *peripheral* or *outer* surface of the Tunica Jacobi, is a layer of a peculiar dark-coloured viscid material, called the Pigmentum Nigrum. This pigment

* Vid. Blumenbach's Comparat. Anatomy. † Ibid.

‡ Vid. Bell's Anatomy.

(a) Vid. Bell's Anat.; Quain's Anat.; Blumenbach's Comp. Anat.—— Mr. Fielding observes, that he has some difficulty in knowing what is meant by Tapetum. It is *not* synonymous with Pigmentum.

is likewise found on the *peripheral* or *outer* surface of the Tunica Choroides, and indeed it appears to be diffused throughout the entire substance of this membrane. The Pigmentum Nigrum is capable of resisting the influence of the air, of heat, and of various chemical agents. According to MONDINI, its constituents are mucus, and oxide of iron; but according to Dr. YOUNG they are mucus, and a carbonaceous matter. The Pigmentum Nigrnm is to defend the eye against strong light, and to absorb the superfluous rays which might otherwise be reflected, and thus occasion indistinctness or inaccuracy of vision. Hence in the inhabitants of the Polar regions it is of a lighter colour than in those living near the Equator. It is dark in most animals which look upwards, as man, and monkeys; and also in birds which are exposed a great deal to the sun's rays. In albinoes the eye is nearly or entirely destitute of the Choroid Pigment. Hence in these cases it is oppressed by the strong light of day, but at night it is able to perceive objects with tolerable distinctness. We also find, that in the animals of the Polar regions, the Pigmentum Nigrum acquires a dark hue during the summer months, but in winter again becomes lighter. In the eyes of the Cuttle Fish, and in those of almost all insects, the Pigmentum Nigrum, or choroid tunick, is situated between the Retina and the Vitreous Humour. Where the Tunica Choroides becomes attached to the Ligamentum Ciliare, it is drawn into a number of folds which encircle the margin of the Crystalline Lens, and constitute what is called the Corona Ciliaris. On removing the Tunica Choroides, the membrane which next appears is the Tunica Jacobi. It is spread over the outer, or medullary layer of the Retina, and is united to it by extremely minute vessels. It is transparent and very delicate. On the central, or inner aspect of the Tunica Jacobi, and expanded over the Tunica Hyoloidea, is the Retina. It is composed of two laminæ, the outer one of which is formed of medullary matter, and is connected with the Optic Nerve. The inner layer is vascular and has been denominated the Tunica Vasculosa Retinæ. The Retina consists of a number of extremely delicate fibrils of nervous matter, presenting a reticulated arrangement. It is of a gray colour, and in the living subject is nearly or perfectly transparent. The Retina is the immediate seat of Vision, or the structure on which the impressions of sight are received. It is most sensitive at its centre, but the part which joins the Optic Nerve, is insensible to the action of light. The Vitreous Humour is situated at the posterior part, and occupies about threefourths of the interior of the eye-ball. It is of a spherical form, highly transparent, and consists of an albuminous fluid, which is lodged in a fine membrane termed the Hyaloid. Embedded in a depression on the anterior part of the Vitreous Humour, and placed perpendicularly behind the Pupil, is the Crystalline Lens, which is a small translucent body of a lenticular form, enclosed in a transparent capsule. The space between the anterior surface of the Crystalline Lens, and the posterior surface of the Cornea, is occupied by the Aqueous Humour, which is a thin pellucid fluid, consisting principally of water, and contained within a delicate membrane that partly secretes it. The cavity in which the Aqueous Humour is contained is divided into two copartments or chambers by means of the Iris, which is a flat circle distinctly seen through the transparent Cornea. It exhibits great variety of colour, and in its centre there is a small opening called the Pupil, through which the rays of light pass to the interior of the eye. Such is a brief outline of the descriptive anatomy of the eye. It is an organ consisting of an assemblage of lenses, which converge the rays of light, that radiate from every point of external objects, and cause them to fall in foci on the surface of the Retina. By this means, there is depicted on this delicate nervous structure, an exact but inverted image of the object presented to the eye, and it is this image or representation, and this alone, which the Retina perceives or feels. The impression thus made on the Retina is communicated to the Optic Nerve, by means of which it is conveyed to the Brain, where it produces the perception of Vision. From the description which I have given of the relative situation of the different parts of the eye, it will be perceived that a layer of pigment lies between the Tunica Choroides, and the Tunica Jacobi, being in close contact with the *central** surface of the former, and with the *peripheral*† surface of the latter. Mr. George Fielding, however, is of opinion that the above description, which agrees with that given by the most celebrated anatomists, is *not correct*, and avers that a layer of *membrane*, and *not* a layer of *pigment*, is situated *immediately behind*, and in apposition with the Tunica Jacobi. This membranous stratum, Mr. G. Fielding says, he has been the first to discover, and he has given to it the name of Membrana Versicolor. He describes it as being attached to the Tunica Ruyschiana, or inner surface of the Choroides, and as forming the bright and beautiful colours observed in

* Inner. † Outer.

the concave aspect of the eye of the ox, sheep, &c. Its colours cannot be washed out, neither can they be communicated to the Retina, nor to paper which is applied to it. Its surface is bright and polished; it is separable into several layers; it possesses elasticity; it is vascular; and supposed to be furnished with nerves. Its use is twofold: it prevents the Tunica Jacobi from being stained with the Pigmentum Nigrum; and it receives and reflects back upon the Retina the image of the objects to which the eyes are directed. Such is the description given of the Membrana Versicolor. I must confess, however, that after the most careful investigation, I have never yet been able to find it; and I feel fully persuaded, that *no such* membrane as the one which Mr. G. Fielding fancies he has discovered, exists either in the eye of the ox, or in that of any other known animal. The conclusion at which I have arrived is the result of numerous dissections, and I think no one will dissent from it, who diligently examines the structure of the Tunica Choroides; a minute description of which I shall now endeavour to give.

The Tunica Choroides, as I have before observed, is composed of two layers, the internal of which can again be separated into two others.

Now, if you take the Tunica Choroides from the eye of an ox, and tear off its outer or venous layer, the inner layer will appear, if held to the light, diaphanous, and of a bluish green colour. This inner layer can be subdivided into two other distinct layers: the outer one of these, which is in fact the Tunica Ruyschiana, is composed of arteries running longitudinally; the inner one forms the Tapetum, which secretes the colouring matter of the eye, and has a layer of this substance spread over its *central* surface. The Tunica Choroides is, therefore, at the most, only composed of *three* layers, besides the Pigmentum Nigrum; the venous layer, the arterial layer, and the Tapetum. But if the Membrana Versicolor exist, the Choroides would be formed of *four or more* layers, exclusive of the colouring matter; and not only this, but *one or more* of these layers would be found to lie on the central or inner surface of the Pigmentum Nigrum, and in contact with the Tunica Jacobi; which, however, is not the case, as the following simple experiment will clearly prove. If a piece of white paper be applied to the central surface of the Tunica Choroides of the eye of an ox, or a pig, or indeed of any other animal, it will be stained with the Pigmentum Nigrum—a circumstance which could *not* take place if there were *any membrane* attached to the Choroides, inclosing the Pigmentum Nigrum, and destined for the use which has been assigned to it, viz. that of preventing the Tunica Jacobi from being stained with the choroid pigment. That the Pigmentum Nigrum is contiguous to the Tunica Jacobi is also proved by the fact, that this material often comes away attached to the *peripheral* surface of the Tunica Jacobi, whilst we are raising this delicate membrane along with the Retina, from the *central* surface of the Tunica Choroides; besides the Pigmentum Nigrum can easily be removed in flakes from the *central* surface of the Choroides, and collected upon paper or glass, and submitted to examination. In addition to these circumstances, we have the testimony of all the best anatomists to prove, that a stratum of pigment is interposed between the Tunica Choroides and the Tunica Jacobi.

If we wish to show, that the stratum of matter which is affixed to the *central* surface of the Tunica Choroides, and contiguous to the *peripheral* surface of the Tunica Jacobi, is true pigment, let us attend to the results obtained by exposing this matter to the action of the mineral acids diluted with water, and to ammonia.—Bichat discovered that the pigment of the eye suffers, when submitted to the influence of some of the most active chemical agents, no change whatever. Take, therefore, from the eye of an ox the Tunica Choroides, which, as I remarked before, has a bright spot at its centre, called the lucid tapetum, or portio lucida,* and plunge it into water: after macerating it for a few hours, you will be able to separate from its inner surface a thin film, or layer. That portion of the film which is spread over the more central part of the bright spot just mentioned, is of a dullish white colour; that which covers the margin of this spot is brown; and that which covers the other parts of the *central* surface of the Tunica Choroides, is black. If, now, the Tunica Choroides, from which this film has been detached, be thrown into nitric acid diluted with water, the variegated colours of the bright spot above referred to will instantly vanish, and the part which they occupied will become nearly black. But if the film itself be put into the same mixture, or even into the strongest undiluted nitric acid, it will remain perfectly unchanged in appearance. Again, let the Choroides, from which the colours have been discharged by the nitric acid, be immersed in aqua ammoniæ, the part

* Vid. page 3.

where the colours previously existed will immediately become white: if the film, however, be removed from the nitric acid, and placed in aqua ammoniæ, the black and brown, as well as the white portions of it, will continue entirely unchangeable. From these experiments, I conclude that the attenuated stratum of matter lying between the Choroides and the Tunica Jacobi is pigment; for since it is proved that the choroid pigment suffers no change from the action of the most powerful chemical agents, and since these agents have no effect upon the substance *behind*, and in *contact with* the Tunica Jacobi, it is clear that this substance is *pigment*, and *not* membrane, as Mr. G. Fielding supposes.—Where, then, is Mr. Fielding's newly-discovered membrane? Certainly not, where he tells us it is, "immediately *behind* and in *contact* with the *Tunica Jacobi.*" In fact, I fear that in whatever part of the eye we look for it our search will be unsuccessful; for even if we agree with Mr. Fielding, and admit that the "part immediately behind and in *contact* with the Tunica Jacobi is *not pigment* but *membrane*," we shall still be able to show not only that the Membrana Versicolor cannot possibly exist, but also, that Mr. Fielding either very much misunderstands the anatomical structure of the

Tunica Choroides, or has, for the sake of answering a particular purpose, intentionally given an incorrect description of it.

When the *central* surface of the Tunica Choroides of an ox is washed by means of a little water and a camel's hair pencil, the colours of the portio lucida appear more brilliant, and the rest of the Tapetum is found to exhibit a bluish tinge. If now we carefully divide the Tunica Choroides into layers in the situation of the portio lucida,* (and it is divisible into three, and three only,) we shall find that the innermost layer, or Tapetum, at this part, is of a yellowish white colour: the second layer, or Tunica Ruyschiana, is green; and the outermost or venous layer is blue. The portio lucida, therefore, owes its colours, in some degree, to *all* the *three* layers of the Choroides, but *principally* to the Tunica Ruyschiana, and the Tapetum. But Mr. G. FIELDING affirms that the colour of the portio lucida is attributable to the Membrana Versicolor. The Membrana Versicolor then, and the Tunica Ruyschiana, would seem to be identical, and yet it is evident that they are *not so*, because Mr. G. FIELDING states that he can detach the Membrana Versicolor from the Tunica Ruy-

* Vid. page 3.

schiana, and can likewise divide the former into three layers. Now, it is acknowledged by all anatomists, that the Tunica Choroides consists of at least *two* layers, and if the Membrana Versicolor consist of *three*, it is plain, according to Mr. G. Fielding's notion, that there should be *five* distinct strata of membrane inclosed between the Tunica Sclerotica and the Tunica Jacobi.—This, however, it is well known, is altogether at variance with fact! Even in fishes, the Tunica Choroides can be divided only into four layers at most—the Proper Choroid, the Membrana Vasculosa, the Tunica Ruyschiana, and the Tapetum. According to Mr. F.'s description, the Membrana Versicolor and the Tunica Ruyschiana are joined together, and a layer of pigment is interposed between them.* Therefore, since the Membrana Versicolor consists of *three* layers, we ought, after taking these off, to exhibit a stratum of choroid paint, and then to show, that beneath this stratum there are the Tunica Ruyschiana, the venous layer of the choroides, and a *second* stratum of pigment. But what dissector, I would ask, after having removed three layers from the *central*† surface of the

* Vid. Mr. F.'s Lect. p. 13 and 14.—(Obs. 5thly and 6thly.)

† Inner.

Tunica Choroides, can find *two* layers of pigment and *two* of membrane still remaining.

I have elsewhere stated, that the Tapetum, because it can be torn off in a layer from the Tunica Ruyschiana, has been denominated a membrane. Does Mr. Fielding then attempt to identify the Membrana Versicolor with the Tapetum? If he does, he is as much in error in this as in the former case; for it is plain that either there is *no* identity between the Membrana Versicolor and the Tapetum, or that Mr. F. has given an incorrect description of the *former;* because, in the first place, the Tapetum only consists of *one* layer, while the Membrana Versicolor is stated to be composed of "*numerous layers.*" The Membrana Versicolor, too, is said to constitute the *whole* of the portio lucida,* but the Tapetum forms only *part* of it; and lastly, the Membrana Versicolor has a layer of pigmentum nigrum spread over its *peripheral or outer* surface, but the tapetum has not. Although Mr. Hunter formerly, and Cloquet more recently, have described the choroid pigment as a substance having the appearance of membrane; and although Sir Charles Bell has stated, that

* Vid. page 3.

being sometimes so firm it might be taken for a membrane, yet to suppose that Mr. FIELDING can mean by the Membrana Versicolor the layer of pigment lying on the central surface of the Choroides is impossible, for the characters of the *two* present the greatest dissimilarity.— The Membrana Versicolor, for instance, in the eye of the ox, is, Mr. FIELDING tells us, of of a greenish-blue colour ; it is said to be organized, and it undergoes *considerable changes* from the action of acids and ammonia ; but the choroid pigment in the eye of the same animal is partly of a white, and partly of a brown and black colour ; it is an inorganic substance, and both acids and alkalies appear to be incapable of producing in it *any* alteration. From all that has been advanced then, it is manifest that the *Membrana Versicolor* cannot be identified with any of the layers of the Tunica Choroides, neither can any structure at all resembling it be found contiguous or adherent to these layers ; nor is the *Membrana Versicolor*, nor any other membrane, interposed between the Pigmentum Nigrum and the Tunica Jacobi. In short, it is obvious that the *Membrana Versicolor* is *not* to be found in any part of the eye whatever. There can be no doubt that Mr. FIELDING intends it to be understood that the *Membrana Versicolor* constitutes the lucid tapetum, or *portio lucida;* but it is easily ascertained that this bright spot is, as I have observed above, formed by the layers of the *Tunica Choroides;* for if you remove the one, you remove the other. It is evident that Mr. FIELDING has taken the Tunica Choroides itself, dissected or pretended to dissect it, practised experiments upon it, misrepresented its characters and relative position, and then called it a *new* membrane. He never has, he never can detach a membrane consisting of "*numerous layers*" from the *central* surface of the Tunica Choroides, and after all leave the substance of the Tunica Choroides entire. Indeed, if what Mr. FIELDING has advanced were true, we ought to find between the Tunica Sclerotica and the Tunica Jacobi *five* or *six* layers of membrane, the innermost of which should be *contiguous* to the Tunica Jacobi, and between the *third* and *fourth* there should be a stratum of pigment, whereas we find in this situation only *two* or *three* layers at most, the internal one of which is *not* in contact with the Tunica Jacobi, but separated from it by the Pigmentum Nigrum.

I repeat, therefore, that Mr. FIELDING has entirely failed in demonstrating the existence of his new optical membrane, for we have proved that *no* membrane such as he describes is attached to the Tunica Choroides; and both by experiment and dissection we have shewn, that there is *no* membrane of *any kind whatever* spread over the Pigmentum Nigrum, inclosing this substance, and separating it from the Tunica Jacobi. And even if Mr. FIELDING contends for the merit of having called a part of the eye a membrane, which before was not called such, in this case too, I say, he must resign his claim, for the ***Pigmentum Nigrum*** has been called and compared to a membrane by CLOQUET,* HUNTER, and BELL, and the *tapetum* has been termed such by the French Academicians.

In concluding this part of the subject, I may remark, that I should be disposed to doubt the existence of the Membrana Versicolor, had I no other reason for doing so than Mr. FIELDING'S vague and contradictory description of its situation and character. From its name, and from what is said of it at p. 2—13 and 20 of his Lecture, we might infer that the *Membrana Versicolor* means *only* the bright spot† observed at the bottom of the eye of the ox, &c.; but at p. 13, it is

* Vid. Cloquet Traitè d'Anatomie Descriptive.

† Portio lucida.

described as being "spread over the *whole* internal surface of the Ruyschiana." At p. 3, it is said to be in *contact* with the Tunica Jacobi; but at p. 20 and 28, to be in "*connexion* with" (*i. e.* joined to) "the Retina;" and at p. 26, in "*contact* with the Retina." At p. 13, Mr. FIELDING speaks as considering himself successful in being able to divide the *Membrana Versicolor* into "three laminæ;" but at p. 18, he talks of its "numerous layers."

From its function, and from what is mentioned respecting it at p. 13 (5thly), p. 14 (6thly), p. 16 (9thly), and at p. 24, we should conclude that it is *opake;* but from what is stated at p. 16 (7thly and 8thly), we should suppose that it possesses a degree of transparency, and in a note at p. 10 it is actually termed *semi-opaque;* and that found in the eye of man is stated to be (p. 19) *semi-transparent.** Are *semi-opaque* and *semi-transparent* synonymous?

Having now finished my observations respecting the Membrana Versicolor, I shall make a few remarks on Mr. FIELDING's new theory, or rather theories, of Vision, for he seems to advocate two.

* Vid. Mr. F.'s Lect. p. 19.

Vision, as I have before observed, is *generally* supposed to be produced by the pencils of light, which enter the eye, being made, by means of the lenses of this organ, to converge in foci at the surface of the Retina, so as to form upon this delicate tissue of nerves an exact image of the object whence the light proceeds. The sensation which the presence of this image imparts to the Retina is transmitted to the Optick Nerve, through the medium of which it is *somehow or other* conveyed to the Brain, where it occasions the perception of sight.

With this view of the subject, Mr. FIELDING "differs most decidedly," because, says he, as the Retina is transparent, it cannot "receive and retain an image" sufficiently distinct for the purposes of vision. For the production of sight Mr. FIELDING conceives it to be essential that the image of the object presented to the eye should be depicted on some *opake* surface,* so as to be rendered distinct. Such a surface, Mr. FIELDING says, is afforded by the Membrana Versicolor.

Vision, therefore, according to *one* of Mr. FIELDING's theories, is produced by the image

* Vid. Mr. F.'s Lect. p. 24.

of the object to which the eye is directed being received* upon the Membrana Versicolor, and thence reflected back upon the Retina,† where it produces an appropriate impression which is transmitted to the Brain. According to his *other* theory, "the image of the object is projected upon the *Membrana Versicolor*. Upon this sensible surface the stimulus of the rays produces certain *undulations* in the part where the image is depicted; these undulations are communicated to the *adjacent* Retina, in which similar undulations are excited which are propagated in a series of vibrations along the Optick Nerve to the sensorium."‡ The former of these theories I shall call the theory of *reflection*—the other, the theory of *undulation*.

We shall first consider the theory of *reflection*. This theory, as I have stated above, supposes that the impressions made upon the Retina are produced by rays of light *reflected* from the Membrana Versicolor, and *not* by rays proceeding to the eye *directly* from the object. I think, however, we shall find that the very reverse of this obtains, and that the theory of reflexion

* Vid. Mr. F.'s Lect. p. 24.

† Ibid. p. 22 (2nd Note); also p. 26 and seq.

‡ Ibid. p. 26.

accords neither with the structure of the eye nor the principles of optics. Mr. FIELDING has remarked, that "neither heat nor light produces any sensible effect until they are obstructed in their course, and consequently *none* can be produced by their passing through a transparent medium. Therefore, if the Retina be transparent, no image can be imprinted on it, because the rays of light must pass through it."*

The opinion expressed in the above extract is not *entirely* correct. It is well known that the most transparent substances with which we are acquainted, such as air, water, and glass, are capable of retaining a large proportion of the light which passes into them; and therefore the Retina, notwithstanding its transparency, must have the power of obstructing and absorbing a considerable quantity of the luminous rays which enter it. It is a law in opticks, that the effect of a uniform dense diaphanous medium is to diminish the intensity of light in a geometrical progression. This law of the density of light gave origin to the instrument termed the *Lucigrade*, which consists of a number of plates of glass whose surfaces are placed in contact. By adding plate

* Vid. Mr. F.'s Lect. p. 22.

after plate the light can no longer be distinguished. The same law is also one cause why objects appear so much less bright as they are more remote, because, a prodigious quantity of the rays emanating from them is dissipated by the atmosphere in their passage through it to the eye. It is also the reason why a less number of stars is visible to the naked eye in valleys than on the tops of mountains ;* and also why we see the sun less distinctly near the horizon than when at higher elevations, because the more horizontal the rays are the greater will be the distance of the atmosphere through which they have to pass, and the more, of course, will their progress be weakened.† It has been estimated that of the horizontal sun-beams passing through two hundred miles of air, only $\frac{1}{2000}$th part reaches us. Besides, we know that an image formed behind a lens may, in certain positions, be more distinctly seen in air, the transparency of which at least equals, if it does not surpass, that of the Retina, than when received upon white paper or ground glass.‡

From all these circumstances, it is evident that the Retina, like other transparent bodies,

* Vid. Brewster's Optics, p. 137. † Vid. Bouguer's Essay.
‡ Vid. Brewster's Optics, p. 47.

can obstruct some of the particles of light which pass into it, and can therefore receive and retain the image of an object.

Mr. Fielding next observes, that as it is impossible for us to see an image formed by a double convex lens, if it be projected upon fine transparent glass, or to heat water by means of a powerful lens *alone*, so it is impossible that the Retina, being transparent, can have the picture of an object imprinted on it, or at least *one sufficient* for the purposes of distinct vision.* By this, Mr. Fielding intends us to understand, that because light will pass through water without in any way acting upon it, that it will likewise permeate the Retina without making upon it any impression. The incorrectness of this deduction it is not difficult to point out. We allow that an image formed by a lens cannot, when received upon transparent glass, be distinctly seen ; and we also allow that water may be traversed by the solar rays powerfully concentrated without undergoing any change, but we must observe that the influence of light is not the same on all transparent substances. It does not, for instance, operate on water in the same

* Vid. Mr. F.'s Lect. p. 23.

manner that it does on nitric or prussic acid; and its effects on any of these liquids must necessarily be very different from its effects on the Retina, not only because the latter is a solid body, but because it is endowed with *vitality;* while water, nitric and prussic acids, are liquids, and destitute of the *vital* principle. But we will examine this subject more closely. If light of *any* degree of intensity be projected upon water, it will *not* heat it, nor produce in it any change; but if even a *weak* light be suffered to pass through prussic acid, it will hasten its decomposition, and if through nitric acid, it will deoxidize it.* The action of light, therefore, is different upon different substances of *equal* transparency. The same proportion of rays which, in their passage through water, will leave it unaffected, will produce in nitric and prussic acid the most important changes. From these circumstances, it will be perceived, that, by knowing the effects of light on *one* inorganic transparent substance, we cannot ascertain its effects upon *another* substance of the same kind. This being the case, how can we possibly calculate or determine the action of luminous rays upon the Retina,

* Vid. Murray's Chemistry, Artic. Light.

which is a solid organized structure, by their action upon water, which is a liquid body perfectly inorganic? From these considerations, and from the apparent functions of the Retina, we may safely infer, that the light which is propagated through this fine nervous web, is capable of impressing it in such a manner as to create in the brain the perception of sight.

But Mr. FIELDING says, that *even* if the Retina were *semi-transparent*, it could *then* "but receive an exceedingly faint image, which would be totally unfit for distinct vision."* We will examine into the truth of this position.— At the focus of a double convex lens, the picture of an object is perfect, in whatever medium it may exist, or against whatever surface it may be impinged. Although it may not be so visible to us when it falls in contact with a transparent, as with an opake surface, yet it will contain as many rays in one situation as in another. The image, therefore, on the Retina, although it cannot be seen, is nevertheless complete in all its parts; and since we know that the Retina is sensible to the stimulus of light, we may infer that it experiences an appropriate and suffi-

* Vid. Mr. F.'s Lect. p. 24.

ciently powerful impulse from the image represented upon it. On what account, then, does Mr. Fielding suppose that this image is too faint for producing vision? Has he ascertained what is the precise nature of the effect that light has upon the Retina? Does he know whether it is a mechanical, a chemical, a magnetic, or an electrical effect? Has he, or has any physiologist, become so well acquainted with the structure and functions of nervous matter, as to inform us with accuracy what quantity of light is necessary to make an impression upon the Retina, or to tell us how vivid the image of an external object depicted upon this delicate nervous expansion should be, in order to create the perception of sight? I fear, that, on these abstruse points, Mr. Fielding has acquired no correct knowledge, nor, indeed, any knowledge at all. His doctrine, then, is left unsupported both by facts and arguments, and, on this account, no one can hesitate (in direct opposition to it) to conclude that the image upon the Retina, however faint and nebulous it may appear, is sufficiently vivid and energetic for all the purposes of vision.

As Mr. Fielding supposes that the Retina is incapable of retaining a distinct image, he conceives that the Membrana Versicolor, being *opake*, forms the part appropriated for its reception.* In other words, Mr. FIELDING infers that the image which is portrayed upon the Retina, by the luminous rays which flow *directly* into the eye, is too *faint* for distinct vision, whilst that which is *reflected* upon it by the Membrana Versicolor is sufficiently *vivid* for the purpose. How far this idea is correct will shortly be seen. The Membrana Versicolor is separated from the Retina by the Tunica Jacobi: the light, therefore, in passing to and from the Membrana Versicolor will pass *once* through the Retina, and *twice* through the Tunica Jacobi. Now, we have shewn that all transparent bodies absorb a part of the luminous moleculæ which enter them. The light, therefore, in passing through the Retina, will lose some of its rays; as it passes through the Tunica Jacobi, another portion of it will be stifled; on striking the Membrana Versicolor, a third, and (for reasons to be afterwards explained) a very considerable portion will be absorbed: what remains will be reflected. In its *second* passage through the Tunica Jacobi, more of its rays will be lost in the substance of this membrane; so that, of the light which first entered the eye, a very diminished proportion will ultimately reach the Retina.—It appears, therefore, that an image on the Retina,

* Vid. Mr. F.'s Lect. p. 24.

if formed according to the new theory—*i. e.*, by rays *reflected* from the Membrana Versicolor—will be much *less* vivid, than if produced by *direct* rays, consequently Mr. Fielding's theory is altogether untenable; because, if an image formed by *direct* rays be incapable, owing to its indistinctness, of creating vision, an image produced by reflected rays, which is still *more* indistinct, must of necessity fail to give rise to the perception of sight.

Hitherto, we have regarded the Membrana Versicolor as an *opake* substance. This, of course, is allowing to Mr. Fielding's views every possible advantage, for if we consider it as *semi-opake*, the objections which I have offered to the theory of reflection will apply with tenfold force, as will be seen by the following observations. In man, Mr. Fielding says, the Membrana Versicolor is *semi-transparent*,*[a] so that the picture which it reflects upon the Retina must be inconceivably faint. Mr. Fielding, however, informs us, that man, and other animals intended to see well in bright light, have a Membrana Versicolor of low reflecting power;† let this be granted: but can

* Vid. Mr. F.'s Lect. p. 19.

a Is there any difference between semi-opake and semi-transparent?

† Vid. Mr. F.'s Lect. p. 25.

Mr. Fielding explain if the Human Retina is unable to feel the faint image depicted on it by *direct* rays, (and he says it is unable,) how it can perceive an image still more faint, such as that must necessarily be, which is projected upon it from the Membrana Versicolor, the semi-transparent nature of which, in man, will render it capable of reflecting but little, if any, of the light which falls upon its surface. Moreover, how is it possible, if the Retina, in consequence of its semi-transparency, cannot receive an image fit for the exercise of vision, that the Membrana Versicolor, which is likewise semi-transparent, should be capable not only of receiving an image, but of projecting one upon the Retina sufficiently vivid for this purpose ?— These incongruities I leave to Mr. Fielding to reconcile.

I may mention another circumstance, to show that vision is not produced by reflection from the Membrana Versicolor. We know, that if a number of rays be collected to a focus by a double convex lens, and that focus be projected on the surface of a concave mirror, the collected rays, as soon as they have struck the mirror, will be reflected and dispersed ; and we have shown that luminous moleculæ will make an impression on *any* part of the Retina through which they may pass. As soon, therefore, as the image formed at the focus of the optical lenses impinges on the Membrana Versicolor, the rays will be sent back divergent, but they will *not* return in the *same* direction in which they approached the surface of this membrane. Consequently, a ray, when *direct*, will act on the Retina in *one* part of its substance, and, when *reflected*, it will act on it in *another* part. A direct ray, for instance, which passes through a point of the Retina a little above its centre, will, when reflected, pass through *one* below its centre. So that we shall have *two* parts of the Retina affected with rays emanating from the *same* point of the object which is contemplated; a circumstance which must give rise to imperfection of vision.

In proof of these remarks, it may be observed, that a lucid tapetum is *only* to be found in those animals which are destitute of great precision of sight. Physiologists have supposed that this bright spot, by reflecting a certain quantity of rays upon the Retina, strengthens the impression made by the *direct* rays; and this, perhaps, is a correct view of the subject. It is clear, however, from what has been already stated, that this internal reflection, although, it may enable the eye to see more distinctly in an obscure light, yet, in consequence of the reflected and direct rays affecting the Retina at *two* different points, it must necessarily give rise to inaccuracy of vision. Accordingly, we find that a lucid tapetum only exists in those animals whose nature and habits do not oblige them to examine minute objects with any degree of precision.—On the other hand, we observe that man, birds, insects, and all animals which require to contemplate small bodies with great nicety, possess a dark surface behind the Retina, whereby all internal reflections are obviated, and the accuracy of the image is *not* disturbed.

But, for the sake of argument, we will suppose that the Membrana Versicolor has the power of reflection,—that the rays of light are repelled from its concave surface in the *same* direction in which they approached it,—and that, therefore, *each* ray will pass *twice* through the *same* part of the Retina ; we will also suppose that the Retina is incapable of retaining or feeling any of the particles of the *direct* rays of light which enter its substance. If such be the case, then I would ask : by what means are we enabled to see ? or rather, how do we avoid being blind ? Because if *direct* rays of light pass through the Retina without being absorbed by it, or without affecting or acting upon it, would not *reflected* rays do the same? Certainly they would; consequently, if Mr. FIELDING's theory were true, we should have *no* sight at all; or do luminous rays become peculiarly modified by being reflected from the Membrana Versicolor, or is the posterior surface of the medullary layer of the Retina more sensitive than the anterior surface? Neither of these cases has been, or can be proved; and since we know that the eye is capable, when in a state of health, of producing distinct vision, the *theory of reflection* cannot be maintained.

We will, however, grant that the Retina is acted upon by reflected rays, and *not* by direct ones, and still it will be seen that Mr. FIELDING's views cannot be correct. At the focus of a lens the image of an object is perfect, because at this part the rays unite into a point. At a greater or less distance from this focus, the image is more or less imperfect, because the rays are more or less separate. Now, according to Mr. FIELDING's opinion, the focus of the refractive media of the eye is at the surface of the Membrana Versicolor; the image, therefore, can be distinct *only* at this point. On the Retina, which is *glabellad* or *anterior* to this point, the image must be confused and incomplete, because it is produced by rays which are *returning* from the focus on the Membrana Versicolor, and are, therefore, in a state of *divergence*. Is it not clear, then, that if even we admit more than we are justified in admitting, the theory of reflection is incompetent to explain the function of vision ?

I may now mention another circumstance that militates with great force against the theory of *reflection*. When we look at an object placed at a short distance before us, that part of it appears most distinct which sends its rays along the *axis* of the eye to the *centre* of the Retina, while the remainder of its length, which sends rays to the more *lateral* parts of the Retina, is less vivid.—This effect is produced by the eye concentrating, like all other optical instruments, those rays, which are nearest to its axis, more perfectly than those at a distance from this part. Now, the centre of the Retina is in a line with the axis of the eye, and is, therefore, the only point at which perfect vision can take place. When we wish, therefore, to contemplate an object, we direct the axes of our eyes towards it, so that a quantity of rays will pass along these axes. Now, if vision be produced by light *re-*

flected from the Membrana Versicolor upon the Retina, we should *not* receive more lively impressions of external objects at the *centre* of the Retina than at any *other part* of it, because it will be seen, that, according to a law in optics, there can be little, if any, reflection of light from the *central* point of the surface of the Membrana Versicolor. The reflection of a ray of light depends not only on the nature of the *reflecting* body, and the state and colour of its surface, but also upon the quantity of the angle of incidence. The metals are the best reflectors, particularly those which are white; and it is proved that reflection is inversely as the angle of incidence, supposing the angle to be formed by the ray, and the surface of the medium. Now, the angle, which the rays, that enter the eye, (when they proceed along the axis of the organ) form with the central point of the surface of the Membrana Versicolor, must be very elevated, and therefore but a very small proportion, if any, of these rays can be reflected upon the Retina. Quicksilver is one of the best reflectors, and if, out of 1000 parts of light which were made to strike the surface of this metal at an angle of $11^{\circ}30'$, only 250* were reflected, how small a proportion of the

* Vid. Bouguer's Essay.

same number of parts must be reflected from the surface of the Membrana Versicolor, impinging on it at an angle of 80°, or 90°? For the Membrana Versicolor at best possesses not only a surface, but a colour unfavourable to reflection, as it is generally of a green, brown, blue, or black hue, all of which are very indifferent reflecting colours.* It is clear, then, that if vision be caused by the reflection of light from the Membrana Versicolor, the rays proceeding in the axes of the eyes, because they are less reflected, will have less effect upon the Retina, than those, which are more distant from the axes, and are reflected in greater abundance; hence sight, instead of being *most distinct* at the centre of the Retina, will *not* be so: nay, it will really be *less distinct* at this than at any other part of the Retina. If, in opposition to Mr. FIELDING's theory of reflection, we regard vision as being produced by direct light, we shall perceive that the rays, which proceed along the axis of the eye, will make the most powerful impression on that part of the Retina, which corresponds to this axis; not only because they are concentrated to greater advantage, but also because the angle which they form with the surface of the Retina approaches to

* Vid. Bouguer's Essay.

the perpendicular, and the more perpendicularly the rays of light strike the surfaces of transparent bodies, the greater will be the quantity of luminous particles that will enter these bodies: while, on the contrary, the more perpendicularly the rays strike opaque bodies, the less will be reflected. From this view of the subject, we perceive that the theory, which considers vision to be caused by direct rays, requires that distinctness of vision shall exist *only* at the axis of the eye; it therefore must approximate much nearer to truth than the theory of reflection, which is so imaginary as actually to make sight less distinct at the centre of the Retina than at any other point of its surface.

Such, then, are the objections which can be advanced against the theory of *reflection*, and they will be equally applicable whether we adopt the Newtonian, or the undulatory theory of light. In his attempt to give us a more correct knowledge of the function of vision, Mr. FIELDING has entirely failed. We must, therefore, still hold the opinion, that the *anterior* surface of the Retina is the part, on which, the rays that enter the eye converge in their final focus;—that vision is effected by the action of *direct* rays of light upon the Retina, and not by *that* of rays *reflected* from the Membrana Versicolor, or from any other membrane ;—and lastly, that the Pigmentum Nigrum of the Choroides, by absorbing and stifling the light as soon as it has done its office of exciting the Retina, prevents internal reflection and confused vision.

I have now to consider the theory of *undulation*, which, we are informed, is borrowed from that of De la Hire. It supposes that "the image of the object is projected through the Transparent Retina upon the Reflecting Membrane which is placed behind and in *contact* with the Retina.— Upon this sensible surface the stimulus of the rays produces certain undulations which are communicated to the Retina, in which similar undulations are excited, which are propagated in a series of vibrations along the Optick Nerve to the Sensorium."* According to this theory, it appears that the light which enters the eye acts *only* on the Membrana Versicolor, and *not* at all on the *Retina ;* and that the latter derives all its sensations, from those undulatory movements of the Membrana Versicolor, which are produced in it by the stimulus of the luminous moleculæ, that fall upon its surface. This theory repre-

* Vid. Mr. F.'s Lect. p. 26.

sents vision as being altogether independent of any reflection of rays upon the Retina. It, therefore, contradicts the theory of reflection, and, of course, it gives to the Membrana Versicolor a *new* function, that of causing, by its own movements, corresponding movements in the Retina; at the same time, it takes away from it, its former, and what Mr. Fielding has all along been considering its most important function, viz. that of receiving the pictures of external objects, and projecting them upon the Retina. Perhaps Mr. Fielding means us to understand that the Membrana Versicolor exercises two functions—that of reflection and also that of undulation. But that this should be the case is impossible, for these functions must be performed either simultaneously or at different times.—Now, they cannot be performed simultaneously, because they are of such a nature, that each is perfectly incompatible with the other; for supposing, that internal reflections were necessary for the production of sight, they could not be efficiently made from a waving surface; and reflection and undulation being performed at different times, would give rise to two theories of vision: but we know there cannot be two theories of vision, and both of them correct. We have endeavoured to prove that the theory of reflection is false; but allowing it to be true, then the theory of undulation must be untrue; and if the latter be correct, it does away with the necessity of a polished reflecting membrane behind the Retina, such as Mr. FIELDING de-describes the Membrana Versicolor to be. It would rather require an opake structure, with a *dark unpolished* surface, which would not only admit into its surface the greatest possible quantity of light, but would also obviate those internal reflections, which would inevitably arise from a smooth bright membrane, and which would at all times give rise to confusion of sight, but especially so if produced from a surface in a state of undulation. The theory of undulation assumes that the Retina is sensible to mechanical stimuli, and likewise that it does not constitute the immediate seat of vision: the former of these positions is refuted by experiment;* and the other is rendered so improbable by all that is known of the uses of the nerves, that it cannot be acceded to. Instead of the Retina, the Membrana Versicolor is considered as the part on which visible impressions are received, and yet Mr. FIELDING has not discovered whence this membrane derives its nerves; indeed he hardly

* Vid. Majendie's Journ., tom. 5.

knows whether it be furnished with nerves at all. To imagine, that because it is membranous, it must be sensitive even without nerves, partakes too much of the Stahlian doctrine for the physiologists of the present day. With regard to the undulations of the Membrana Versicolor, I may remark, that Mr. FIELDING has no means of ascertaining whether such undulations ever take place; and as to his Hartleian* Hypothesis, that the undulations of the Retina are propagated in a series of vibrations along the Optick Nerve to the Sensorium, it is perfectly gratuitous; in short, the experiments of Dr. WILSON PHILIP have shown that the nerves, even when divided, can convey impressions to the Brain—a circumstance which entirely disproves that nervous action consists in any vibratory or oscillatory motion.† From facts, then, as well as from the most legitimate arguments, it appears, that the theory of *undulation* is founded on data and reasoning not more satisfactory than those, on which is based the theory of *reflection*. It is not easy to determine which of Mr. FIELDING's theories is the most charged with difficulties. If we adopt the theory of undulation, we must not only dispense with the new membrane (the Membrana Versicolor), or at least (supposing

* Vid. Hartley on Man.

† Vid. Philip's Experim. Inquiry.

it to exist) take away from it its power of reflection, but we must assent to many hypotheses which cannot be prcved ; and before the theory of reflection can be established as true, it will be necessary that all animals endowed with sight, should become nearly, if not entirely, deprived of that faculty.

I must now conclude, and, in doing so, I cannot avoid observing, that Mr. FIELDING'S Lecture has done any thing rather than tended to elucidate the intricate subject of Vision.

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