PHILOSOPHICAL

TRANSACTIONS.

I. *The Croonian Lecture. On the Power of the Eye to adjust itself to different Distances, when deprived of the Crystalline Lens.* *By* Everard Home, *Esq. F. R. S.*

Read November 5, 1801.

It is intended, on the present occasion, to state some facts and observations, in support of an opinion advanced in a former lecture, that the adjustment of the eye to see objects at different distances, does not depend upon any internal changes in the crystalline lens.

The first of the experiments which will be stated, was made with the assistance of the late Mr. Ramsden; and, had not the death of that valuable member of this Society deprived me of his further aid, the following observations would undoubtedly have been more deserving the attention of my learned audience.

It is impossible for me to mention Mr. Ramsden, from whom I have received so much assistance in every pursuit connected with optics and mathematics, in which I have been engaged,

without availing myself of this opportunity of paying that tribute of gratitude to his memory, which feelings of delicacy prevented me from offering to him while alive. It is unnecessary here to mention his genius, his merits, or his exertions for the promotion of science; these are equally well known to every member present, as to myself. It is only my individual obligations, in the prosecution of inquiries connected with the objects of this learned Society, that are meant to be taken notice of.

To his friendly and zealous assistance I am indebted for the information which was necessary to enable me to prosecute investigations upon the subject of vision; and, without such assistance, I should have shrunk from the inquiry. It is also to his early friendship, and his readiness to communicate to me his knowledge, that I look back, as among the sources of my early exertions, and love of philosophical pursuits.

In the year 1794, I laid before this learned Society some experiments, suggested and made by Mr. RAMSDEN, upon the comparative powers of adjustment of the eye, when in a perfect state, and when deprived of the crystalline lens. From the result of these experiments it appeared, that the removal of the lens did not deprive the eye of the power of seeing distinctly at different distances. As the person upon whom the experiments were tried did not see very distinctly, without a substitute for the lens, in making them, a double convex glass, of $2\frac{1}{4}$ inches focus, was placed before his eye; and, to render the image distinct, by correcting the spherical aberrations, the aperture was diminished to $\frac{3}{20}$ths of an inch; a less degree of diminution not answering that purpose.

The subject of these experiments was BENJAMIN CLERK, twenty-one years of age; one of his eyes was in a very perfect

state, and the other without defect, except what arose from the removal of the lens: and the results appeared to be satisfactory in deciding, that the eye, when deprived of the crystalline lens, retains a power of adjustment.

Opportunities of instituting experiments of this kind very rarely occur; the patients who have had their lenses extracted, either not seeing sufficiently well, or being too much advanced in life to be fit subjects for that purpose; but, in the year 1798, the following case came under my care, which enabled me to make some further observations, in confirmation of the former experiments.

HENRY MILES, a carpenter, at Westborough Green in Sussex, fifty years of age, applied, in the month of August, 1798, at St. George's Hospital, to be admitted as a patient, on account of blindness, from having a cataract in each eye; and was received under my care. Both the cataracts were extracted; and the eyes recovered from the effects of the operation, without suffering from inflammation. The right eye had the power of seeing objects with unusual distinctness; but the left was less perfect, the iris having been slightly torn, by the lens being too big to pass through the aperture, without injuring the membrane.

As soon as this man's eyes had recovered, I requested Mr. RAMSDEN to repeat some of the former experiments, on his right eye; which he readily agreed to do. Before the experiments were made, upon trying what was his power of vision with the naked eye, we were agreeably surprised to find that he saw so distinctly, as to admit of our ascertaining, without the aid of glasses, what were the ranges of his eye's adjustment.

A piece of pasteboard, with a letter of a moderate size, as an object upon it, was put into his hands; as he could not read, the

page of a book might have confused him: he was directed to vary the distance of the pasteboard from his eye, till he had ascertained the nearest and most distant situations, in which the object appeared distinct; these distances, by measurement, were 7 inches, and 18 inches. In repeating this experiment several different times, he brought the object very correctly to the same situations.

This result convinced Mr. RAMSDEN, that the eye possessed the power of varying its adjustment; and he did not think any more complex experiments would be nearly so satisfactory; consequently, no others were made, and the man was allowed to go into the country.

It was intended to make him a present of a pair of spectacles, allowing him to choose those best adapted to his eye; but his sight was so very good, that we entirely forgot it, till some time after he was gone.

These experiments confirmed the former ones so very strongly, and from their simplicity were so much less liable to error, that Mr. RAMSDEN and myself considered the object of our inquiry completely attained; the reason for not, at the time, laying them before this learned Society was, that they established no new fact, and the former ones did not appear to require their support.

This inquiry, always regarded as highly important by physiologists, has continued to engage their attention; and, in the BAKERIAN Lecture for last year, Dr. YOUNG has advanced some experiments to prove, that the adjustment of the eye to different distances, depends upon the crystalline lens: he considers the results of the experiments made by Mr. RAMSDEN, upon BENJAMIN CLERK'S eyes, as inconclusive; and the phenomena met

with, as arising from the smallness of the aperture, and not from any power of adjustment in the eye. Dr. YOUNG, therefore, with a view to obviate all possibility of deception in future, constructed an optometer, upon the principle of that of Dr. PORTERFIELD. In this instrument, when applied to presbyopic eyes, the eye, by looking along a line through a small convex lens, before which is placed a card with two narrow slits in it, near enough to each other to be within the limits of the pupil, will see the line as two lines, crossing each other at the point of perfect vision; and every eye that has the power of adjustment, will make the lines cross in different places, when adjusted to different distances.

With this instrument, Dr. YOUNG made experiments upon several eyes which had been deprived of the crystalline lens; and with all of them found, that the crossing of the lines was seen only at one point; he therefore concludes, that the power of adjustment was lost.

These experiments of Dr. YOUNG led me to reconsider the subject; and it was matter of regret that BENJAMIN CLERK was not in this country, as making a trial with the optometer on his eye, would have determined, in the most satisfactory manner, whether there had been a fallacy in the former experiments.

This not being in my power, I made inquiry after HENRY MILES, upon whom the second experiments were tried; and I had the pleasure to hear, that he was in good health, and that his eyes continued to have very distinct vision, so much so, that he never had occasion to make use of any glasses, from the time the operation had been performed.

With the view of making some experiments on this man's eyes, with Dr. YOUNG's optometer, I procured that instrument from

Mr. CARY, the optician, made exactly in the same manner as that which had been executed under Dr. YOUNG's direction. I first, however, tried the experiments upon my own eye; but had the mortification to find myself unable to make the lines cross in two different situations. This led me to try the eyes of several of my friends; who were equally unable to make the lines cross any where, except at one point. Young people, indeed all those under thirty years of age, were capable of varying the place of intersection; but none who were above forty, could produce any change in it.

As I could not doubt of my own eye having the power of varying its adjustment, I was led to believe that the instrument required some address in the management, which I had not acquired; and therefore despaired of making HENRY MILES sufficiently master of it, to do justice to my views.

To obviate these difficulties, I adapted the optometer, without the lens, to presbyopic eyes, by making a line 4 feet long, upon strong paper, divided into inches, and having the same slits to look through as in the other. This instrument, and Dr. YOUNG's, I put into the hands of my friend Sir HENRY ENGLEFIELD, with a request that he would examine them, and, when he had become perfectly master of them, and of the best mode of using them, that he would assist me in making experiments with them; for, as he was more in the habit of changing the focus of his eye, in using optical instruments, he would more readily detect the circumstance which prevented me from succeeding in the experiment.

After several trials with this optometer, and seeing its defects, Sir HENRY ENGLEFIELD improved it, by having the paper pasted upon a strong board, 4 feet long, which rendered the surface free from the slightest inequalities; and, instead of

a line marked with ink, a thread of black silk was stretched along the middle of the board. With this instrument, he found that his eye could make the lines cross at two different points, at several inches distance from each other. The readiest mode of making the experiment succeed, was first fixing his eye upon some near object, held above and a little on one side of the silk thread, and, when the focus of his eye was adapted to that distance, then to look at the thread; afterwards to look at some distant object, and, when that had become very distinct, again to look at the thread. Upon trying the instrument with my own eye, in this way, I found the crossing of the lines changed its situation, with every change of adjustment; and, after being accustomed to make this experiment, I was enabled to produce a similar change in the optometer with the lens, but by no means in so satisfactory a manner, nor did it last more than an instant; my eye probably not being so well fitted as many others, for experiments of this kind.

The optometer without the lens was hence admitted to be the most easily managed, by the eye of a person unaccustomed to such experiments, and therefore it was determined to make use of it in the trials upon HENRY MILES's eye; which we were enabled to do, as his vision was sufficiently distinct without the aid of glasses, and as, from never having used them, he saw much better with his naked eye.

The following experiments were made with the optometer without the lens, on the 27th of August, 1801.

The first trials were upon Sir HENRY ENGLEFIELD's eye; which, being most familiar with the use of the instrument, became a standard with which the others might be compared.

Sir HENRY ENGLEFIELD's eye made the lines to intersect

each other at $12\frac{1}{4}$ inches, as the near distance; and at $28\frac{1}{2}$ inches, as the furthest distance. The experiment was repeated several different times, and the results were very nearly the same.

My own eye made the lines intersect at $12\frac{1}{2}$ inches, as the near distance; and at $29\frac{1}{2}$ inches, as the furthest distance.

A man servant of Sir HENRY ENGLEFIELD's, twenty-five years of age, made the lines intersect at 12 inches, and at $31\frac{1}{2}$ inches.

HENRY MILES, fifty years of age, whose eye had been deprived of the crystalline lens for three years, made the lines intersect at $8\frac{3}{10}$ inches, as the near distance; and at $13\frac{3}{10}$, as the furthest distance.

This experiment was repeated two different times in the forenoon, with the same result, and again in the afternoon, without there being any considerable variation; but, upon trying it again, after the eye had been fatigued, he was unable to make the lines cross nearer than $11\frac{2}{8}$ inches, although he could make them cross at $13\frac{3}{10}$ inches; so that adjusting the eye to a near distance, was more difficult after it had been much used, than before.

HENRY MILES was unable, in the optometer with the lens, to produce any change in the crossing of the lines, nor did he see them cross with sufficient distinctness to make us consider it a fair experiment.

The following experiment was made upon MILES's eye, at the suggestion of Sir HENRY ENGLEFIELD, with a view to ascertain in another though less decisive way, whether any change took place in it, when directed from a near object to a more distant one.

A piece of pasteboard, in which a black circle, about $\frac{1}{4}$ of an

inch in diameter, with a dot in the centre, had been described near to its edge, was placed perpendicularly to the horizon, at 5 inches distance from the eye; another piece of pasteboard, with a circle and dot in it, was placed at the distance of 18 inches; the farthest circle was made a little larger than the other, that it might appear equally distinct at the greater distance. When the eye was directed towards these two objects, they appeared upon the same level; and the circumference of the circles, had they been projected on the same perpendicular plane, would have been nearly in contact.

MILES was placed opposite these objects, with his head made steady, and prevented from moving: he was then told to look at one, till it became very distinct; and, when he had done so, this was removed, and he was directed to look at the other, which did not immediately appear to him with the same distinctness. This was equally the case, whether he looked from the near one to the distant one, or the reverse: the eye did not see the object to which it was so suddenly directed, with the same defined outline as that from which it had been withdrawn.

This man sees best in a strong light; and it was in that light all the experiments were made: he can see very well in any degree of daylight; but his eyes are much fatigued by candle-light. Upon examining the eye attentively, the pupil was rather larger than in perfect eyes; the iris was in a very perfect state; and the cicatrix of the wound, in the inferior part of the cornea, was scarcely visible.

The sight being so good, without the aid of glasses, is not common; and, had not the lenses been extracted in a public

hospital, before a number of spectators, some doubts might be entertained whether they had been removed.

From the experiments which have been stated, it appeared to Sir HENRY ENGLEFIELD, that MILES's eye was not deprived of its power of adjustment; and, by whatever circumstances my own judgment might be deceived, or rendered partial, there was nothing by which his could be biassed, as he could have no object in view, but the promotion of science. His knowledge of optics, and his habit of making experiments, are the best pledges of these having been as accurately performed as the nature of the subject admits of; for, certainly, the sources of fallacy, in optical experiments, are numerous. Those that have been related, to be made with perfect accuracy, should be tried upon the eye of a person skilled in optics, and accustomed to such experiments; and whose eye had been deprived of the crystalline lens, without having received the slightest degree of injury in any of its other parts.

The experiments were instituted in the Isle of Wight, which prevented me from requesting several of my friends to be present at them, whose knowledge of the subject would have made me desirous of their assistance.

HALLER mentions the case of a nobleman, from whose eye the crystalline lens had been extracted, who used glasses, and could see with them objects at different distances. As this was an observation made upon a particular friend of his own, and as he refers to PEMBERTON, who mentions a case of depressed crystalline lens, in which no such effect took place, it is natural to suppose, that he had given considerable attention to the subject; and that, although the experiments he instituted are

not mentioned, the opinion was not advanced, without what appeared to him sufficient authority.*

* Et lente ob cataractam extracta vel deposita, oculum tamen ad varias distantias videre, ut coram in nobili viro video, absque ullo experimento, quo eam facultatem recuperaverit. Et si enim tunc, ob diminutas vires, quæ radios uniunt, æger lente vitrea opus habet, eadem lens in omnia distantia sufficit.

HALLER. *Elementa Physiologiæ.* Tom. V. Lib. xvi. §. 25. p. 514.