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ON BINOCULAR VISION AND THE STEREOSCOPE:

A Lecture

DELIVERED AT THE LONDON INSTITUTION, MARCH 19, 1862.

BY

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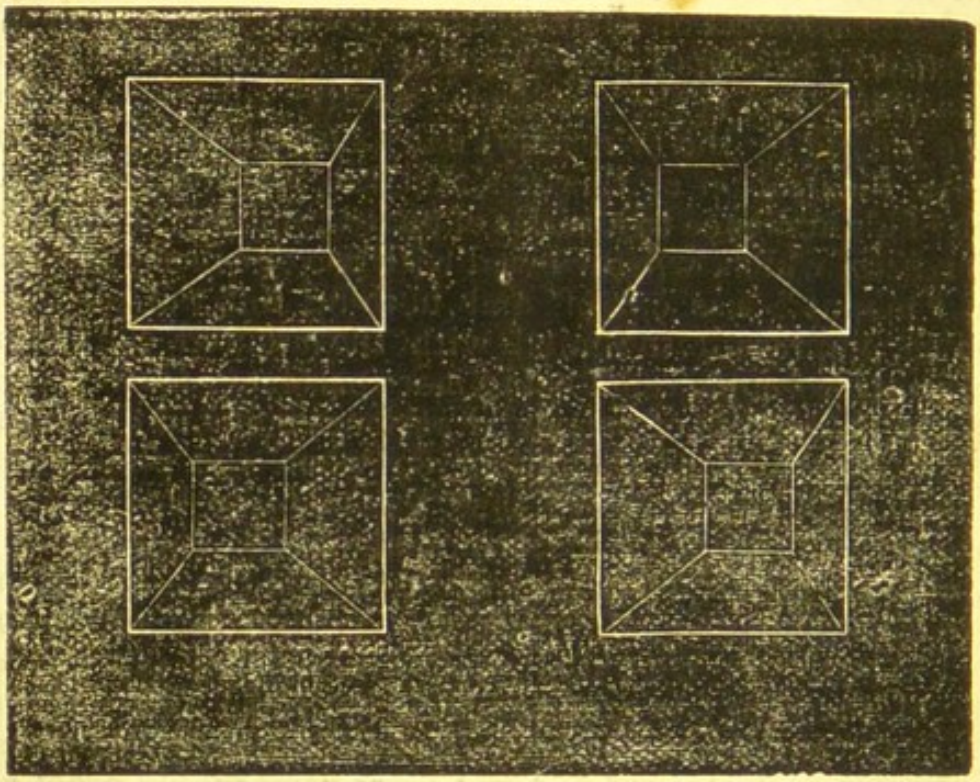
ON BINOCULAR VISION AND THE STEREOSCOPE.

THE first portion of this lecture was devoted to an exposition of the principles of binocular vision, which may be briefly summed up as follows :—

1. Objects are seen through *a single eye* with their proper outlines, colours, and lights and shades, but we have no *certain* appreciation of the *relative distances* of their different parts; and our notion of the *projection* or *solidity* of any object of three dimensions viewed through a single eye is the result of a mental interpretation of its aspect, as judged by the (virtually) flat picture formed of it on the retina.—In illustration of this position the lecturer directed the attention of his audience to a series of photographs of various works of art in *relievo*, which, when viewed with one eye in such a manner that the "mount" was cut off and nothing but the photograph was visible, impressed the mind with the assured conviction of solidity, no stereoscopic relief being more perfect. He also pointed out that the characters of particular surfaces come out much more strongly in this manner than they do when the photograph is viewed with both eyes jointly: thus the metallic lustre of a pair of bronze gates was made most unmistakeably apparent in one picture, and the glister of a pool of water on the sandy shore in another. Every single photograph, the lecturer remarked, should be looked at with one eye only, because it is essentially the representation of the object or scene as seen with one eye. When we use both eyes we are forced to recognise the flatness of the picture, and the illusion is destroyed.—A yet more remarkable proof of the want of power of the single eye to appreciate the true nature of solid forms was shown by the lecturer. The interior of a paper mask, painted like the exterior, was placed in such a manner as to be viewed with one eye only, the light being so thrown into it as to avoid shadow; and every one who thus looked at it was impressed with the belief that he saw the projecting exterior of the mask—this "conversion of relief" being the result of an erroneous *mental* interpretation of the (virtually) flat picture really seen.

2. The certainty of the appreciation which we form of the solidity of any near object of three dimensions, when we look at it with *both* eyes conjointly, essentially depends upon our receiving from it *two dissimilar images* with the two eyes respectively, and upon our *mental combination* of those images. This is proved by experiments precisely the converse of the preceding; for, if we

draw two outline perspectives of any geometrical solid as it presents itself to each eye respectively, and then place these two dissimilar pictures in an instrument which shall throw their images upon the corresponding points of the two retinæ, so far is the dissimilarity of these pictures from being a source of confusion or embarrassment, that it forces on our minds the resultant perception of solidity which we do not derive from either outline separately. Thus, in the subjoined figure, the visual combination of the upper pair of perspectives gives the notion of a projecting truncated pyramid, with the small square in the centre of the larger one; whilst the combination of the same two perspectives reversed in position gives the perception of a hollow or receding pyramid. To the instrument by which this combination may be



most conveniently made, the name "Stereoscope" (seeing solid) was given by its inventor, Mr. Wheatstone. Two forms of this instrument are in general use:—the reflecting stereoscope of Mr. Wheatstone, and the lenticular stereoscope of Sir David Brewster. As the respective claims of these two eminent men of science in regard to this invention have lately been again brought under discussion, the lecturer thought it right to place before his audience the real facts of the case. [The notes and some parts of the text of what follows were omitted in the delivery of the lecture from want of time.]

Thus, then, in the invention of the Stereoscope, three separate stages may be distinguished; and I am anxious to fix your attention upon these, since your right estimation of the respective merits of the two principal claimants will depend upon your precise perception of what each has contributed to the general result:—

1st. The *recognition of the fact* that the images of any near object of three dimensions seen by the right and left eyes respectively are *sensibly different*, in virtue of the dissimilarity of the two retinal perspectives.

2nd. The *conception of the idea* that the dissimilarity of the retinal pictures of such an object, so far from being a cause of embarrassment, is actually the most certain source of our appreciation of its solidity or projection.

3rd. The *experimental verification* of that idea, by an instrumental contrivance for throwing on the two retinæ the two dissimilar perspectives of the solid, and causing them visually to coalesce, so as to impress the mind with the image of a single object in vivid relief.

Now it may be freely admitted that in the *first* of these positions there is no essential novelty. Every person of common observation is aware that the visual image of any near object of three dimensions sensibly varies with the position of his eye, so that by moving his head a few inches he obtains a view of it different from that which he had before; and hence every one who had either *thought* of the matter, or had made the simple *experiment* of looking at a projecting solid first with one eye then with the other, may have so far anticipated the invention of the stereoscope as to have recognised the dissimilarity of the two images so received. That recognition, however, seems for the most part to have had reference to the fact that more of *the right side* of a projecting object could be seen with the *right* eye, and more of the *left* side with the *left* eye. Thus I have been informed by portrait painters that they were quite aware of their being able to see further *round* the face with *both* eyes than they could with either *one;* and it was pointed out by Harris, nearly a century ago, that—"by the parallax, on account of the distance betwixt our eyes, we can distinguish, besides the front part, the two sides of a near object not thicker than the said distance, and this gives a visible *relievo* to such objects, which helps greatly to raise or detach them from the plane in which they lie: *thus the nose on the face is more remarkably raised by our seeing both sides of it at once.*"

Now this is the very nearest approach to the *second* principle that has been yet found in any of the older writers on vision; and to what does it actually amount? Really to nothing more than an imperfect recognition of the *first.* For you will observe that Harris makes no mention of the necessary dissimilarity of the retinal pictures of *every* near object of three dimensions, but merely states that by means of the parallax of the two eyes—that is, by the difference of their points of view—we are enabled by their conjoint use to see both sides of any object *not thicker than their distance;* and to objects of such thickness or breadth he expressly limits his statement.

Of the second idea, which constitutes the essential principle of the

stereoscope, I unhesitatingly affirm that no real trace has yet been detected in the works of any writer on Optics or on Vision anterior to 1832. To Sir D. Brewster it was most assuredly quite unknown; as is evident, not only from the absence of the slightest hint of it in that part of his *Natural Magic* (1833) in which he treats of the curious phenomena I have described to you under the name of "conversions of relief," and in the section of his *Optics* (1831) in which he treats of binocular vision,* but also from the very high appreciation he at first expressed (as I shall presently show you) both of the novelty and ingenuity of Mr. Wheatstone's invention; and this not only on its first promulgation, but after having had ample time to look into the history of the subject. Of this second principle the earliest public enunciation is contained in the 3rd edition of Mr. Herbert Mayo's *Outlines of Human Physiology*, published in 1833. That author, who was at the time a colleague of Mr. Wheatstone, as a professor at King's College, in a short notice of Mr. W.'s experimental researches on binocular vision, describes the following (p. 288) as one of their most remarkable results:—"A solid object being so placed as to be regarded by both eyes, projects a different perspective figure on each retina: now if these two perspectives be actually copied on paper, and presented one to each eye, so as to fall on corresponding parts, the original solid figure will be apparently reproduced in such a manner that no effort of the imagination can make it appear as a representation on a plane surface."

In this extract we have the clearest evidence not only of the *distinct conception* of the essential principle of the stereoscope, but also of the *experimental verification* of it; and it has been admitted by Sir D. Brewster himself,† as proving that "Mr. Wheatstone was acquainted with the principle of the stereoscope in 1833," though it makes no mention of any instrumental method of combining the pictures. Mr. Wheatstone, however, has furnished the unimpeachable testimony of the late Mr. Murray‡ to the fact of his having completed his invention, both of the "reflecting" and of the "prismatic refracting" stereoscope in the year 1832. And I have my-

* "Although an image of every visible object is formed on the retina of each eye, yet when the two eyes are capable of directing their axes to any given object, it always appears single. There is no doubt that, in one sense, we really see two objects, but these objects appear as one, in consequence of *the one occupying exactly the same place as the other.*" (*Op. Cit.*, p. 300). Sir D. Brewster could scarcely have written these last words if he had even thought of the *dissimilarity* of the two retinal pictures; far less if he had arrived at the faintest conception that in this dissimilarity lies the source of the binocular perception of solidity.

† See his letter in *The Times*, dated Oct. 22, 1856.

‡ The following letter from the late Mr. Murray (of the well-known firm of Murray and Heath) who was formerly assistant to Mr. Newman, the celebrated philosophical instrument maker, of Regent Street, was published by Mr. Wheatstone in *The Times*, in a letter dated October 29, 1856:—"From an examination of the accounts furnished to you by Mr. Newman, of Regent Street, during the time I was in his establishment, and which were prepared by myself, I am enabled to assign the date of my first knowledge of your stereoscopes, both with reflecting mirrors and refracting prisms, to the latter part of 1832."

self seen a letter from Mr. Martin, the son of the painter of *Belshazzar's Feast*, in which he recalls to Mr. Wheatstone's recollection the fact of his having made drawings for his stereoscopes, when the instrument was first exhibited by Mr. Wheatstone in the private circle of his friends; and in which he states that from particular circumstances he is able to fix the date of this occurrence in the winter of 1832. Sir D. Brewster, who has admitted it to be obvious that Mr. Wheatstone did combine the pictures before 1833, and has further expressed his readiness to "place implicit confidence in Mr. Wheatstone's statement that he did it by means of the reflecting instrument," can hardly repudiate Mr. Wheatstone's assertion, backed by such independent testimony, as to the *completeness of the invention* of the "refracting" as well as of the "reflecting" stereoscope as far back as the year 1832; notwithstanding that it was not until 1838 that Mr. Wheatstone communicated to the Royal Society his first series of *Contributions to the Physiology of Vision*, in which the reflecting stereoscope was fully described and its principle investigated. That he should not have earlier found time to record his researches in the form he deemed best for their publication is not surprising, when we bear in mind that during this interval he was engaged not only in a great variety of the most important scientific inquiries, but in the prosecution of those labours which resulted in the Electric Telegraph. And it is also to be borne in mind that the photographic art was not at that time capable of furnishing for the stereoscope those marvellous pictures which now constitute its principal source of interest: so that, for several years after the invention of that instrument, its use was limited to mere outline diagrams of geometrical solids, and to such perspective representations of real or imaginary scenes as the comparatively imperfect labours of the draughtsman could furnish.

It will scarcely be credited by those who are only acquainted with Sir D. Brewster's later writings on this subject, that no one was more ready in the first instance to recognise the merits of Mr. Wheatstone's invention than Sir D. Brewster himself; for the stereoscope having been brought by Mr. Wheatstone before the physical section of the British Association, at its meeting in 1838, we find in the *Athenæum* of Sept. 8th the following statement of what passed on that occasion:—"Sir D. Brewster was afraid that the members could scarcely judge from the very brief and modest account given of this principle, and the instrument devised for illustrating it, by Professor Wheatstone, of its extreme beauty and generality. He considered it one of the most valuable optical papers which had ever been presented to the section." If any confirmation of his *then* opinion be needed, it is furnished by Sir John Herschel, who followed up Sir D. Brewster's commendation by characterising Mr. Wheatstone's discovery as "one of the most

curious and beautiful for its simplicity in the entire range of experimental optics." The interest which was taken by Sir D. Brewster in the new line of inquiry thus opened up is evidenced by the memoirs on the subject which he successively communicated to the Royal Society of Edinburgh in 1843 and subsequent years. In these he discussed the theory of binocular vision, on the basis of his own previous doctrines, endeavouring to show that the phenomena of the stereoscope are to be explained by the *optical* rather than by the *mental* relations of the images; and he also pointed out various additional means of producing stereoscopic effects; but he did not *then*, even whilst controverting Mr. Wheatstone's theoretical conclusions, say a single word in disparagement of his claim, either to the discovery of the essential principle of the stereoscope, or to the invention of the instrument itself. In fact, it would be difficult to give stronger testimony in Mr. Wheatstone's favour than the following, spontaneously offered by Sir D. Brewster in his memoir of 1843:—"In prosecuting this subject, my attention has been particularly fixed upon the interesting paper of my distinguished friend Professor Wheatstone, 'On some remarkable and hitherto unobserved Phenomena of Binocular Vision.' *It is impossible to overestimate the importance of this paper, or to admire too highly the value and beauty of the leading discovery which it describes—namely, the perception of an object of three dimensions by the union of the two dissimilar pictures formed on the retinæ.*"

Among the various means devised by Sir David Brewster for the combination of the two perspective projections, one was selected by him as alike simple and easy in its construction, effective and convenient in its application—namely, the substitution for the mirrors of the reflecting stereoscope* of the two halves of a double convex lens, separated and turned back to back, so as to form two lenticular prisms: these form on the two eyes magnified images of the two pictures placed respectively before each, and, at the same time, bring these images into visual coalescence. An instrument constructed upon this plan for Sir D. Brewster, by the late Mr. Andrew Ross, was exhibited at the meeting of the British Association in 1849; but it did not attract at first much attention on the part either of scientific men or of manufacturing opticians, and Sir D. Brewster had to seek in Paris for an appreciation of his lenti-

* A refracting stereoscope with prisms had been constructed, as we have seen, by Mr. Wheatstone in 1832; and, according to Sir D. Brewster's own canon that "priority of publication is not priority of invention," Mr. Wheatstone is entitled to the full merit of having devised that arrangement, although he did not make it public until 1852. And I am assured by Mr. Malone, who executed the photographs sold by Mr. Newman for the reflecting stereoscope as far back as the year 1846, that there existed at that time in Mr. Newman's shop a refracting stereoscope of Mr. Wheatstone's construction, with a pair of lenses placed above it to magnify the pictures. Into the question whether or not Sir D. Brewster had or had not become acquainted with this instrument, I do not think it desirable to enter; since it mainly turns upon the nature of the private communications which passed between these two gentlemen, whilst still in friendly relation with each other.

cular stereoscope which it failed to obtain in this country. He was fortunate enough to convince the eminent optician, M. Duboscq, of the practical value of his modification; and the instruments displayed by that maker in the International Exhibition of 1851, together with the beautiful photographic pictures which were shown by its means, excited an interest on the part of the public, which soon, as has been truly said, "warmed into a passion which has scarcely since cooled down." No one can be more ready than I am myself to recognise the obligation of the public to Sir D. Brewster for the vast amount of instruction and enjoyment which it has derived from those varied applications of his lenticular stereocope, which the simultaneous development of the photographic art has made so familiar. But, in estimating the amount of that obligation, we must not lose sight of what is primarily due to Mr. Wheatstone; and it is with great regret that I have now to call your attention to the singular change which took place in Sir D. Brewster's appreciation of Mr. Wheatstone's merits and claims, at the time when his own came into competition with them. The first announcement of this change was made in the *North British Review* for May, 1852, in an article of which the ostensible purpose was to exalt its author,* Sir D. Brewster, at the expense of Mr. Wheatstone; the assertion being then for the first time put forward that the essential principle of the stereoscope had been enunciated whole centuries previously by several writers on optics; so that (it was asserted) Mr. Wheatstone could claim no more than the merit of contriving a clumsy method of carrying that principle into operation, which had been completely superseded by the reviewer's own more simple, more convenient, and more effective instrument. The following is the opening paragraph of this article:—

"The history of science presents us with numerous cases where an important idea or an ingenious invention have long failed to attract the attention they have merited, and where the development of the one, and the improvement of the other, were requisite to bring them into public notice or practical use. An original idea may derive all its importance from the discovery of its useful application, and a rude instrument may be forgotten by all but its author, till a more fortunate inventor reproduces it under a new form, and with more valuable and extensive properties."

The reviewer then alludes to the history of the microscope and the telescope, and thus continues:—

"Like these valuable inventions, the stereoscope has had its infancy and its manhood. *At first a simple experiment exhibited with a rude and imperfect apparatus, it was soon forgotten;* and it was not till the discovery of its true theory and its valuable applications, and till the invention of new combinations

* Although this article was anonymous, the subsequent incorporation of a large part of it into Sir D. Brewster's *Treatise on the Stereoscope* not only removes any doubt as to its authorship, which might have been suggested by its tone of self-laudation to those who are unacquainted with Sir D. Brewster's style, but fully justifies me in publicly attributing its authorship to him.

by which these applications were to be effected, that it was brought into public notice, and made one of the most popular and interesting instruments which science has presented to the arts."

Now, so far was the original reflecting stereoscope of Mr. Wheatstone from being "a rude and imperfect apparatus," that, for the purposes of scientific investigation, as well as for the production of the finest stereoscopic effects, it remains unrivalled by the lenticular; and nothing but its want of portability and the comparative costliness of the large photographic pictures it is fitted to exhibit, prevent its superiority from being generally recognised. So far, again, was Mr. Wheatstone's invention from being "soon forgotten," that it has been specially noticed, and its importance fully appreciated, in every standard treatise on physiology I am acquainted with—English, French, or German,—and in nearly every work of authority upon physical optics, from 1840 to the present time, besides being exhibited and commented on to their classes by the best-informed teachers both of physiology and of physical science in every country. Further, Mr. Wheatstone himself was continuing his researches in the same direction; and in 1852 he communicated to the Royal Society a second series of researches on binocular vision, which, for their scientific merit, and for their important bearing on the most interesting questions of the psychology as well as the physiology of the visual sense (questions too recondite to be generally intelligible), leave Sir D. Brewster and his purely optical investigations far behind.* And I can assert, from my own knowledge, that the production of those stereoscopic photographs which have given quite a new value to the instrument had been accomplished, not only privately by Mr. Fox Talbot, on Mr. Wheatstone's suggestion, but by those who practised photography as a matter of business, some time before there is any evidence that Sir D. Brewster turned his attention to the matter. So much, then, for the extraordinary assertion that but for Sir D. Brewster the stereoscope would have been "soon forgotten."

I shall not detain you with examining at any length the assertions of Sir D. Brewster in regard to the approximations to the essential principle of the stereoscope which he affirms to be discernible in the works of previous writers. You may judge of the honesty of his representations by these two facts:—that he makes out from the words of Harris (which I just now read to you) that he had come to perceive as a general fact that "the *relievo* is produced by the combination of the two dissimilar pictures given

* Sir D. Brewster speaks of the Pseudoscope of Mr. Wheatstone as "a most capricious and unsatisfactory instrument, which often fails to show what it ought to show." So far is it from deserving this contemptuous description, that, as I have shown in the *Edinburgh Review* for October, 1858, it is an instrument of the most singular value, as furnishing the means of testing the degree of tenacity with which our *minds* hold to their habitual appreciation of the forms of the several objects around us, notwithstanding the reversal of their retinal images, which, on the purely optical doctrines of Sir D. Brewster, ought in every instance to produce a "conversion of relief."

by each [either] eye," whereas Harris says no such thing, but something essentially different; and that he asserts that Aguilonius was acquainted with the dependence of the appearance of solidity upon the dissimilarity of the pictures of the objects, when the fact is that the solids (τα στερεα) of which Aguilonius speaks are not actual solid objects, but the imaginary solids formed by lines drawn between the angles of the objects (which may be plane surfaces) and the eye. Aguilonius was puzzled by the dissimilarity of these στερεα when the object is placed nearer to one eye than to the other; and attributes the union of the two dissimilar pictures to a "common sense," without the slightest hint of the notion that in this union lies the essential cause of our perception of solidity.* It is not a little singular, moreover, that Aguilonius, like Euclid, Galen, Baptista Porta, Leonardi da Vinci, and other writers who discussed the subject of binocular vision, drew their illustrations from objects with *rounded* surfaces, such as spheres or cylindrical columns. These, it is obvious, are the *very last* objects they would have chosen if they had wished to draw attention to the dissimilarity of the perspective projections; since the retinal picture of any such object placed equally in front of both eyes will be *identical*, except as regards any shadows its surface may present.

Let me cite, with reference to these and other asserted anticipations of Mr. Wheatstone's discovery of the essential principle of stereoscopic vision, the following very true remark, long since made by a distinguished scientific man with regard to a beautiful invention of his own, of the merit of which he complained that others were attempting to deprive him:—"It has always been the fate of new inventions to have their origin referred to some remote period; and those who labour to enlarge the boundaries of science, or to multiply the means of improvement, are destined to learn, at a very early period of their career, that the desire of doing justice to the living is a much less powerful principle than that of being generous to the dead." You would scarcely anticipate from what has gone before that the invention to which these remarks apply was the Kaleidoscope, and that the inventor was Sir D. Brewster! Surely a scientific man who had himself suffered from the depreciation of which he thus complains, should be the last to practise it towards a brother philosopher whose discoveries he had at first so warmly appreciated.

Before quitting the subject of these asserted anticipations, I must draw your attention to certain statements recently put forth by Sir D. Brewster in regard to two drawings by an Italian artist of the sixteenth century named Chimenti, which are preserved in the Museum at Lille, and which were reported to Sir D.

* In fact, he expressly states that when the object is placed directly in front of the eyes, the στερεα or optical pyramids are similar.

Brewster as being apparently right and left-hand pictures suitable for the stereoscope, and as producing an effect of relief when superposed by the convergence of the optic axes. On the strength of this report he publicly committed himself to the assertion that these pictures must have been drawn for the purpose, and that their existence distinctly proves the principle of the stereoscope to have been known to Chimenti; and, notwithstanding the published expression of a decided opinion on the part of the Photographic Society of France* that photographic copies of these drawings placed in the stereoscope do not present any true stereoscopic relief, Sir D. Brewster has reiterated that statement in the most positive manner a few weeks since, without having himself seen either the originals or photographic copies of them.† Since that time he has obtained such copies; and he now repeats as positive facts—first, that the pictures are truly stereoscopic; and, second, that they were drawn on stereoscopic principles; which I shall presently show you to be two very different propositions, having no necessary connexion.

You will yourselves have the opportunity of judging whether these pictures do or do not give a true effect of relief; for, by the kindness of Mr. Wheatstone, who has long had photographic copies of them in his possession, I am enabled to exhibit them in the stereoscope before you. In looking at them you will doubtless observe that *certain parts* do present the appearance of projection, and this is unquestionably owing to a dissimilarity of the two pictures. There is, in fact, no more delicate test of the dissimilarity of any two pictures than their stereoscopic comparison, which will show a difference of level in the conjoint image wherever there is the smallest departure from identity. Thus, as Prof. Dove, of Berlin, has pointed out, a difference may be detected between a genuine and a forged bank note, which the most careful ordinary comparison would not serve to distinguish; and it has been found to be difficult for a compositor to set up with the same type two lines consisting of the same words, with such exactness as not to show an inequality of level in the conjoint image when viewed stereoscopically. Now, I am authorised to state it as the opinion of several eminent artists, that one of the drawings in question is the work of the master and the other an inferior copy by a pupil; and I am assured by some of the most eminent por-

* See THE BRITISH JOURNAL OF PHOTOGRAPHY for Aug. 1 and Aug. 15, 1860.

† In commenting upon this statement of Sir D. Brewster, I was unfortunately misled by a letter from Prof. Kuhlmann, of Lille, to Mr. Wheatstone, into charging Sir D. Brewster with dishonesty in asserting what he must know to be untrue from an inspection of photographic copies of these pictures, which I believed to be in his possession. "This," says Sir D. Brewster, in his usual style of invective, "is a falsehood *invented* by Dr. Carpenter." Having given adequate authority for my statement that the photographs had been forwarded to Sir D. Brewster, but having been assured by him that he had not received them, I frankly retract the charge of dishonesty, and express my regret at having been led to make it; but I do not plead guilty to having *invented* the falsehood.

trait photographers of this metropolis that they are quite satisfied that these pictures were *not* drawn with any idea of giving stereoscopic relief. That these gentlemen do not wish their names to be drawn into the discussion, you will readily understand from a sample I shall presently give you of Sir D. Brewster's mode of dealing with antagonists who venture to dispute his *dicta*.*

But even if it were true, as Sir D. Brewster and the Photographic Society of Scotland assert, that these pictures when combined in the stereoscope give a true effect of relief, the assumption *that they were drawn to be so combined*, and that Chimenti was the "inventor of the ocular stereoscope," is altogether gratuitous. It seems to be altogether forgotten that, when the pupils of an Academy are set to draw from the living model or from a statue, any two of their drawings, done to the same scale, and from points of view ten or twelve degrees distant, will necessarily *pair* in the stereoscope, and will produce the effect of relief; and that multitudes of such drawings have been executed from the earliest period of art-study to the present time, without the smallest conception that such a use could be made of them. If a master and a pupil were making two such drawings from the same model, it would not be at all out of accordance with the practice of artists for the master to put his name to the drawing of the pupil, touched up (if necessary) by himself.

Having thus disposed of these asserted anticipators of Mr. Wheatstone from among the dead, I now turn to the claimants set up by Sir D. Brewster from among the living. Mr. Wheatstone having found, on the publication of his second memoir in 1852, that his first (of 1838) was far from being generally known, caused it to be republished in the *Philosophical Magazine;* and it then, for the first time fell under the notice of Mr. Elliot, a teacher of mathematics in Edinburgh, who forthwith announced his own claim to priority in the idea that the union of the two dissimilar retinal pictures is the source of our appreciation of the *relative distances of different objects.* This idea, and the means of putting it to an experimental test, occurred to him, he states, in 1834; but he did not carry it out till 1839, and he then constructed, not a stereoscope, but merely a pair of pictures which he superposed by the convergence of the optic axes; and these pictures consisted, not of perspective projections of solid objects, but of landscape sketches with three distances, which distances, by this superposition, were rendered distinguishable.

* As Sir D. Brewster has assumed that Mr. Wheatstone and *his friends* (among whom he includes every person who coincides with him in this opinion) cannot see the stereoscopic effect of these pictures because they require transposition, I have separated and transposed them without in the least improving the effect; and the fact that the pictures are seen nearly as well in one way as in the other—some parts being seen in relief when they are placed L and R, and others when they are placed R and L—shows that the pictures are not truly stereoscopic. [See Appendix].

Thus, whilst Mr. Elliot may fairly claim to have made a very near approximation to the essential principle of the stereoscope, he did not apply it to the reproduction of solid forms, and did not devise any other method than *squinting* at the two pictures for bringing them into apparent superposition.

Another candidate for the same honour has more recently appeared in the person of Mr. George Maynard, formerly of Caius College, Cambridge, now of Toronto; who published in the *Toronto Times*, October 8, 1856, an article *On the Bathoscopical Effects of Binocular Vision and the Principles of the Stereoscope*, which he states to be a reproduction, with a little amplification, of an article he had published in 1836 on the same subject.

So far as can be judged of his first article from his second and amplified edition of it, I have not the slightest hesitation in affirming that Mr. Maynard advanced nothing that was new to any person acquainted with that doctrine of the appreciation of the relative distances of near objects by the sense of convergence of the optic axes, which has been long familiar to physiologists. Of his knowledge even of the dissimilarity of the two retinal pictures I can discover no distinct indication. That the union of these two dissimilar pictures has any connexion with our notion of solidity, there is not the faintest hint; and to the invention of any kind of stereoscope Mr. Maynard puts forward no claim whatever. Thus, therefore, he is really out of the field.

Let me now recall to your recollection the following dates, the accuracy of which is beyond all reasonable question:—

In 1832 Mr. Wheatstone *completed the construction* both of the *reflecting* and of the *prismatic refracting* stereoscopes.

In 1833 Mr. Wheatstone *published* in Mr. H. Mayo's Physiology *the essential principle* of the stereoscope.

In 1834 Mr. Elliot states that he *thought* of an approximation to the essential principle of the stereoscope, and of a means of experimentally testing it.

In 1836 Mr. Maynard published a paper which related simply to the estimation of distances by the conjoint use of two eyes.

In 1838 Mr. Wheatstone *published a full account* of his investigations on binocular vision, and of his invention of the *reflecting* stereoscope.

In 1839 Mr. Elliot experimentally tested, by the ocular superposition of two pictures, his imperfect notion of the principle of the stereoscope; but he did not invent a stereoscope of any kind.

In 1849 Sir D. Brewster *published* his invention of the *lenticular* stereoscope.

In 1852 Mr. Wheatstone *published* his invention (actually completed in 1832) of the *prismatic refracting* stereoscope.

In 1852 Mr. Elliot *published* an account of his experiment of 1839.

Thus it is obvious that *alike in the conception, the verification, and*

the publication of the essential principle of the stereoscope, Mr. Wheatstone's priority is indisputable; and you will scarcely be prepared to credit me when I state that within the last few weeks it has been asserted by Sir D. Brewster, with a full knowledge of those dates, that "Professor Elliot and perhaps Mr. Maynard *have as good a claim* as Mr. Wheatstone to the invention of the stereoscope." This extraordinary assertion affords a melancholy proof of the extent to which a perverse determination to see things in a wrong light can carry a man, whose scientific eminence and academical position give a weight to his assertions in public estimation which ought to make him doubly, triply careful of their correctness.

While Sir D. Brewster was thus doing all in his power to depreciate Mr. Wheatstone's scientific merits, and at the same time to exalt his own—so as to endeavour to make it appear that his own claims as the inventor of *the lenticular stereoscope* were at least on a level with those of the real discoverer of the essential principle of stereoscopic vision—he did not venture himself to put forward a claim to the invention of *the stereoscope.* This claim, however, was put forth in his behalf by the "London Stereoscopic Company," which was established not long after the Great Exhibition of 1851, and which advertised most extensively in the periodicals and serials of the time in terms like the following :—

"LONDON STEREOSCOPIC COMPANY.

"No Home without a Stereoscope.

"This delightful invention of Sir D. Brewster's is unapproached for the exquisite entertainment it affords in the social and domestic circle," &c., &c.

With variations according to season and circumstances, this advertisement was repeated, not merely for months but for years (I show you a copy of it in the *Athenæum* for December, 20th, 1856); and I ask any person who is competent to understand the meaning of language, whether it does not most explicitly claim for Sir D. Brewster the whole merit of the invention of *the stereoscope?* The advertisement has been recently justified by Sir D. Brewster* and by Mr. Nottage (the manager of the London Stereoscopic Company) on the ground that it was intended to apply solely to the particular instrument manufactured and sold by that company, and that, as they did not manufacture or sell Mr. Wheatstone's instrument, they were in no way called upon to include it in their advertisement. Such an excuse, as you must at once see, could only be admissible if the Stereoscopic Company had announced themselves as "established for the sale of Sir D. Brewster's Lenticular Stereoscope," and had expressly limited their claim in his behalf to the invention of *that* instrument. There was no reason why they should be required to manufacture and advertise Mr. Wheatstone's reflecting stereoscope,

* "The Company," says Sir D. Brewster, "manufactured and sold *my stereoscope*, and their advertisement *of it* was literally and perfectly correct."

if they did not find it to their commercial interest to do so; but there *was* a reason why they should not have announced Sir D. Brewster as the inventor of the stereoscope—namely, that truth and honesty forbad their doing so. If their advertisement was justifiable, then, if Mr. Wheatstone were to construct a new form of kaleidoscope, and a company were to be established for its manufacture and sale, he might be rightly advertised as the inventor of *the kaleidoscope;* so the inventor of the screw-propeller might claim to have introduced *steam navigation;* and every person who may devise a new telegraph instrument is to be regarded as the inventor of *the electric telegraph.*

What has been the effect of this reiteration on the popular mind, I have had abundant opportunities of judging.* That large portion of the public press which had no special information on the subject accepted the statement as an uncontroverted fact, and, of course, carried their readers along with them; while they furnished the advertisements of the "London Stereoscopic Company" with choruses of praise to Sir D. Brewster and the company, of which I give you the following sample :—

"The two become one, and produce effects unknown to art. No family or school should be without one. It is one of the wonders of our age."—*Britannia.*

"Sir David Brewster, for this charming discovery, deserves the thanks of the nation."—*Morning Chronicle.*

The collocation of these two sentences is not mine, but is that of the advertiser;† and I put it to you what other possible meaning their union can convey, than that Sir D. Brewster deserves the thanks of the nation for the charming discovery that the two become one, and produce effects unknown to art?

I fearlessly ask, then, if I have gone one whit beyond the facts of the case in asserting that Sir D. Brewster not only "permitted others to represent him as the inventor of the stereoscope,"‡ but that "he has allowed his own book to be made the medium of

* Thus, in the article "Stereoscope," in Knight's *English Cyclopædia*, we find all that Mr. Wheatstone has done dismissed in a few lines, with the statement, given on Sir D. Brewster's authority, that "writers in every age knew the two facts that the pictures on the retinæ of the two eyes are dissimilar, and that by the union of these two flat distinct pictures we obtain the vision of solids;" whilst nearly a column is devoted to the account of Sir D. Brewster's own contributions to the inquiry, which are treated as of much higher value.

† They are thus placed at the head of a *Catalogue of Binocular Pictures of the London Stereoscopic Company*, which is bound up with Sir D. Brewster's *Treatise on the Stereoscope* (published in 1856), and which is issued in every copy of that book sold across Mr. Murray's counter to the present time, as I have lately taken means to verify.

‡ This assertion I made explicitly more than three years ago in the pages of the *Edinburgh Review;* yet Sir D. Brewster took no notice of it whatever, until, in a lecture recently delivered at Bristol, I used a very strong term of reprobation in reference to the claims he has put forward, and allowed others to put forward in his behalf. The word "nefarious" was uttered without due premeditation; and I gladly avail myself of this opportunity of expressing my regret that it escaped me. I most certainly should *not* have used it, had I been aware of the disclaimer which Sir D. Brewster inserted in *The Times* of June last.

diffusing, year after year, an advertisement virtually attributing to himself the invention of the stereoscope, which he well knew to be untrue?"*

Of the effect of this continued misrepresentation upon the public mind, we have a signal exemplification in the fact that Mr. Thomas Jones Barker last year advertised a picture entitled *The Intellect and Valour of England*, in which English intellect was typified by Sir D. Brewster announcing to a group "his discovery of the stereoscope." Sir D. Brewster states that, immediately on seeing this advertisement in *The Times*, he wrote to Mr. Barker, informing him that he was "not the discoverer of the stereoscope, but only the inventor of the lenticular stereoscope now in universal use," and he forwarded a copy of this letter to *The Times*, in whose crowded columns its brevity might readily cause it to be overlooked by others, as it was by myself. Sir D. Brewster seems to think that this tardy disavowal should be sufficient to remove from the public mind that erroneous impression of his claim to the invention of "the stereoscope," which he affects to attribute to the fact of his being "the inventor of the lenticular stereoscope, and the first person that gave the true theory of the stereoscope" (as regards which last point he may not, being an interested party, be an impartial judge); and he not only altogether refuses to admit that the continued reiteration of the claim in his behalf, explicitly put forth and extensively diffused for *nearly ten years* by the London Stereoscopic Company, has had anything to do with it, but he so far justifies and sanctions that claim as to encourage its continuance!

I put it to you, therefore, whether it is not due to Mr. Wheatstone that those scientific men who have studied this question, and who have followed all the stages of it from its commencement, should freely express their convictions upon the subject, without being deterred by the unsparing vituperation which Sir D. Brewster considers to be the language befitting his scientific and academical position.

It is doubtless unpleasant to be styled (as I have lately been†) "malignant, vulgar, and coarse," and to be held up to public odium as the "malicious" utterer of the "grossest untruths," and as "breathing falsehoods at every opening of his mouth;" but I had much rather put up with this, than shrink from the advocacy of a cause which I am satisfied to be that of truth and justice. I have been asked why I have specially put myself forward in behalf of Mr. Wheatstone, instead of leaving him to fight his own battle? I reply, simply, that I have had so strong an interest in his researches on Binocular Vision, from the first announcement of their results nearly thirty years since, to the enunciation of those of still higher importance—

* Letter to the Bristol *Daily Post*, Feb. 12, 1862.

† See Sir D. Brewster's recent letters to the Bristol *Daily Post*.

psychologically as well as physiologically—contained in his second memoir, that I should be doing violence to my sense of right if I did not give him such support as my advocacy can afford. I have no personal quarrel with Sir D. Brewster,* and have no unworthy purpose to serve by disputing his assertions. He might well rest on his own well-earned fame, without refusing to others what *they* may justly claim. But whenever I see a man, however eminent in position or distinguished for attainments, using his *prestige* with the public either to grasp what is not his own or to detract from the merits of another, I feel strongly moved by the English love of fair play to strike a blow in defence of the assailed party—whoever he may be—and to aim it with more vigour in proportion to the measure of injustice attempted; and I consider it the more incumbent upon any scientific friend of Mr. Wheatstone to speak openly and fearlessly upon the points in dispute, because he is well known to have his own mind so constantly engrossed by researches of the greatest importance to public as well as private interests, as to have but little time or thought to spare for the defence of his purely scientific claims. The philosopher to whom (more than to any other living man) we owe the Electric Telegraph, is one whose righteous cause any one may be proud to advocate.

* Sir D. Brewster has endeavoured to make it appear that my charges against him in regard to the stereoscope have been put forward in retaliation for his criticism (in the *North British Review* for 1856) on my Manual, entitled *The Microscope and its Revelations*. In this imputation he seems to judge of *my* motives by *his own*—the fact being that I had felt called on to express myself pretty strongly upon the injustice of his claims in the fourth (1853) and fifth (1855) editions of my *Human Physiology*, long before the appearance of the critique in question. The remarks I there made were prompted (I well recollect) by the article to which I have referred in the *North British Review* for 1852, and by the reiteration of the advertisement of the London Stereoscopic Company, attributing to Sir D. Brewster the invention of the stereoscope.

APPENDIX.

THE following extracts conclusively show the opinions of competent and unprejudiced judges upon the subject of Chimenti's pictures :—

From the letter of the Paris Correspondent of *The British Journal of Photography*, August 1st, 1860.

"The letter in which Sir David Brewster spoke of the two drawings of Chimenti existing in the Lille Museum, and presenting, according to the illustrious *savant*, the stereoscopic relief, has been reprinted in the *Lumière* and other special journals. We were all asking each other if the invention which so greatly honours Wheatstone and Brewster really dated from the sixteenth century?

"Mr. Bingham, who has just returned from Lille, conceived the happy idea of reproducing the two designs in question to offer them to the Society. We all examined them with care, but no one detected in them the slightest difference. They appeared to all perfectly identical. In the stereoscope they are superposed, but without any effect of relief. For the present, then, we must be permitted to doubt that they were intended for the application Sir David attributes to them."

From the *Photographic News*, March 28, 1862.

"We have examined these pictures carefully with the aid of the stereoscope and without it, and we have examined them in their original position and transposed. The result of each method of examination is to lead us to the unhesitating conviction that, on the one hand, they were not drawn with any knowledge of stereoscopic principles, or any view to stereoscopic effect; or, on the other hand, they are a complete failure. In no case is anything like an approximation to perfect stereoscopic relief produced; but in every mode of combining the pictures certain parts possess some amount of relief, whilst other parts remain flat or are pseudoscopic, presenting a generally confused effect. The result is just what might be anticipated by placing side by side any picture and a carefully drawn duplicate; the slight differences which must inevitably occur would give rise to a similarly confused effect of relief and intaglio. The pictures are, in most respects, fac-similes, but a closer inspection at once leads us to the conviction that one is an artist's drawing, and the other a clever copy by a somewhat mechanical hand. In the drawing of the first there are freedom, ease, expression, and general character, which indicate the hand of the artist; whilst in the other there is faithful copying, but a loss of character and expression; the dimensions of the copy are, moreover, slightly greater every way than those of the original."

From a letter from GEORGE SHADBOLT, Esq., Editor of *The British Journal of Photography*, to Dr. CARPENTER.

"There is undoubtedly a certain appearance of relief in viewing the pictures *in either position* with regard to one another; that is to say, if placed L and R the left knee and hand appear to stand forward, but the head is then confused, and by a little adjustment of the instrument becomes pseudoscopic; whilst if the pictures be reversed, R and L, then the head can be made stereoscopic to a small extent, but the arm and knee are then very confused, and become slightly pseudoscopic by another adjustment. An adjustment is necessary before the effects both of the heads and of the knees can be observed, because the face in R looks down more than in L. Of course you have noticed the differing position of the *stool* in the two pictures; that in R being horizontal, while in L it slopes down towards the right hand. Lastly, the distance between the epaulette and the *point of the coat skirt* in L is equal to that between the epaulette and the *angle of the stool* in R, consequently much longer than between the corresponding parts in R. There can be no doubt that if the two pictures *were* intended to be stereographically designed, the artist must have been but *very* imperfectly acquainted with the laws which govern binocular vision; but I confess that, to my mind, the evidence is very insufficient to satisfy me that he knew anything whatever of the subject."

March 18th, 1862.

"I brought Chimenti's pictures before the meeting of the Photographic Society (of London), last evening, and I have no hesitation in saying that, with the exception of one gentleman from Scotland, the whole meeting was fully with Wheatstone in opinion. Several artists present examined the photographs, and all pronounced one to be the original work of *an artist*, and the other a copy by an inferior hand."

April 2nd, 1862.

HENRY GREENWOOD, PRINTER, CASTLE STREET, LIVERPOOL.