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ON THE PERCEPTION OF COLOUR. By Sir GEORGE GABRIEL STOKES, Bart., M.A., D.C.L., LL.D., F.R.S., *The President.*

ON a former occasion I expressed the opinion that in furtherance of the objects of the Victoria Institute, it would be a useful thing from time to time to take stock, as it were, of what is known in particular branches of science; with the view of assisting the general public in discriminating between well-established scientific theories and hypotheses still on their trial, or it may be mere conjectures, going far ahead of actual evidence. At the Annual Meeting in 1895 I introduced the subject of the luminiferous ether, a medium so mysterious in its nature, and yet one through the intervention of which some effects are brought about which have received a thoroughly satisfactory explanation. In the following year I brought forward the subject of the perception of light, a subject about which we know far less than about the nature and laws of light objectively considered; I mean than about such subjects as interference, diffraction, polarisation, &c., in the study of which the eye is used merely as an instrument of research, and may in certain cases be replaced by a photographic plate or some other appliance. Even when the subject was limited to the perception of light it was still much too extensive to be gone into in the Annual Address, and the branch I propose to notice to-day was dismissed in very few words. I said (page 20),* "We do not see light merely as light, but we see a great variety of colour. We can distinguish one light from another light by its colour, and not by its intensity only. It would take me a great deal too long to give you any idea of what is known (which after all is not much) as to the way in which that is effected."

To bring such a subject before the Institute seems ill to accord with the proposal I mentioned to "take stock" of what is known in some particular department. Still, little

* *Transactions*, vol. xxix.

as we really know relating to the perception of colour, something has been done experimentally, partly in the way of establishing certain laws as to the direct perception of colour, partly in the way of investigating other perceptions which may guide us by analogy towards forming some conception of the requirements which are demanded in our bodily organisation in order to the perception of colour. The subject lies on the border-land between physics and physiology, or indeed more properly belongs to the latter, though physical considerations relating to the nature of light largely come in. I have no claim whatsoever to be a physiologist, and in consequence felt some hesitation in venturing to bring before this meeting the subject I have named. Still, I have read something even on the physiological side bearing on the question, and so far as my knowledge extends, it seems to me that there is one theory which appears to have by far the greatest probabilities in its favour. That is the one known as the Young-Helmholtz theory.

It is now universally admitted that light consists of vibrations, somewhat in the manner in which sound is produced by vibrations in the air; and in the early days of the study of the theory of undulations in light, very great assistance was obtained from what was known of the analogous phenomenon of sound. But while there is a good deal in the theories of light and of sound that is common to the two, still there are some wide differences; and we must not lean too strongly on the analogy of light to sound in our attempt to explain the phenomena of light, and more especially in our endeavour to explain, so far as any explanation can be given at all, the manner in which the objective state of things (vibrations) is perceived by our senses. We must not lean too strongly on the analogy of sound lest we should be led into error. One great point of difference is the nature of the vibrating medium in the two cases. In the one case there are vibrations of the air—a substance which we can weigh and examine chemically and so forth—and in the other case we have vibrations of the mysterious medium, which we believe to exist between us and the remotest fixed star, to which we have given the name of luminiferous ether. Now when sound acts upon our bodies there are certain portions of the structure of our bodies which are thrown into vibration, and which vibrate sympathetically with the vibrations of the air, such, for example,

as the tympanum of the ear. It is not apparently essential to the perception of sound that the tympanum should be thrown into vibration, for if we press a watch against our skull and stop our ears, we hear the ticking. In that case the skull is no doubt thrown into vibration; and whether it be the tympanum or the skull which acts on the nerves of hearing, they are apparently in that manner excited, and they carry a certain stimulus, which passes along them into the brain, which somehow or other becomes to us the means of our sensation of sound.

Now we must not go too far here in our analogy of light with sound. We have no reason to believe—but quite the contrary—that when light falls on the body or any portion of the body (when it falls, for example, on the eye) a portion of the structure of our bodies is thrown into vibrations which synchronise with the vibrations in light which fall upon us. I do not say that there is nothing in our bodily organism which receives vibration—what I said was that we have no reason to suppose that any part of *the structure* of our body is thrown into vibrations in the manner of the tympanum of the ear when sound is heard. What is thrown into vibration, what is disturbed, as we have reason to believe, when light falls upon the eyes is, in the first instance, some of the ultimate molecules of which, we have reason to believe, matter consists. These differ from a structure as the individual bricks in a heap differ from a house.

Now it may be (I do not say it is, because we know very little about it) that it is bound up with this difference, that we have in the case of sound one phenomenon which has absolutely no counterpart in light. If two musical notes are sounded together, if there is a simple ratio between the times of vibration we experience a pleasing sensation which we call harmony; if, for example, the frequencies are as two to three we have a perfect fifth, and so forth. Now we have nothing in light answering to the sensation of harmony in sound. People talk it may be of colours harmonising with one another, but that is merely a metaphorical form of expression. In sound harmony is a pleasing sensation, and when an assortment of colour pleases us, we sometimes say that the colours are harmonious, using the word in a purely metaphorical sense. But there is actually no phenomenon known in light answering to the sensation of harmony in sound. How then do different lights affect us when they are put together? I am not at present speculating

on the manner in which our bodily organisms are affected. I am not now speaking of physiology, but in the first instance of pure observation and experiment.

We know that by allowing two lights of different colours to mix together, we get a sensation of some other colour differing in general from the two. In certain cases it may be we actually get the sensation of white, in which case the colours are what is called complementary. The study of the effect of mixing colours together was, at first, somewhat impeded by confusing two different things, the colour obtained by mixing together two coloured pigments, and the colour resulting from mixing together the colours which the two pigments exhibit when taken separately. It is probable that even still some misapprehension arising from this source exists in the minds of those who have not studied the subject. The difference is now, however, well known, and there are methods known whereby coloured lights may be mixed together, and whereby we may study the sensations which these mixtures produce, which it would take too long now for me to go into. That subject has been very well worked out by the late Professor Maxwell, who has written some very elaborate papers, giving the results of experiments on the effect of the superposition of lights of different colours. It has long been supposed that in light there is in some sense a kind of triplicity, as if there were three kinds of light which give us all the sensations of colour by mixing them together. This triplicity might be either what I will call objective or subjective. We know that lights of different refrangibility are capable of being separated, forming a spectrum, and as we observe the spectrum we have gradations of colour, red, yellow, and so on, until we get up to the violet. Now, some have speculated on the possibility of there being an objective quality of light, answering, I will say, to redness or greenness or blueness or whatever trio of colours we may take. Sir David Brewster imagined that there was such an objective triplicity, and that really light from a given part of the spectrum, though it cannot be decomposed by the prism, was nevertheless compound, and that there were three kinds of light there coexisting in different proportions, the difference of the proportions varying according to the part of the spectrum we are considering. He supposed that though light of any particular refrangibility could no longer be separated by the prism,

nevertheless three kinds of light, capable separately of exciting three different sensations of colour, there co-existed, and were capable of having their proportions altered by passing through suitable absorbing media, so that the filtered light might affect the eye with a different sensation of colour from the original.

It has been shown, however, that this was a mistake, and he appears to have been led into the error by being deceived by the illusion due to contrast. So far as we know, there is absolutely nothing objectively in light answering to redness as such, or yellowness as such, or blueness as such, although of course at one part of the spectrum there is redness predominant, and so with the other parts.

Dr. Young believed that there were, so to speak, three primary sensations of colour, and that those sensations were called up simultaneously when any colour was presented to us—simultaneously, but in different proportions according to the nature of that colour. Even the colours of the spectrum, which are the purest colours that one can get, are, on his theory, supposed to give rise to three primary sensations of colour which are co-existent, but in different proportions according to the place in the spectrum.

The sensations which Dr. Young supposed to be the primary ones were red, green, and violet. Perhaps it may not be quite right to speak of those as the primary sensations, but you may take them at any rate as three standards of colour, and perhaps they are the best to take as standards, because by their mixtures we can the most nearly reproduce all other colours, of which we have an infinite number of hues. That view was taken up and extended or rendered in some respects more precise by Helmholtz, and so the theory is now known as the Young-Helmholtz theory.

Now, as I said, some very elaborate experiments were made by the late Professor Maxwell in regard to our sensations on the mixing together of different kinds of light, and the result of his experiments showed that not merely qualitatively, but quantitatively, one may express any colour in terms of three colours taken as standards.

Suppose we take three colours as standards, and call them X, Y, Z, each supposed to be referred to a unit of its own kind, and suppose that a, b, and c are numerical co-efficients, which may be positive or negative. Then any colour whatsoever (C) as regards its effect upon our eyes—not by any means as regards its physical properties,

but merely as regards the colour sensation which it produces —may be expressed by the equation—

$$C = a\,X + b\,Y + c\,Z,$$

where "=" means matches in colour and intensity; "+" means superposed on; and "−" (in case any of the co-efficients should be negative), means that the term must be transferred to the other side of the equation. Mathematicians will understand that, but I will not go further into it. That equation represents the direct result of observation; and moreover different persons arrive at results as to the mixture of colours very nearly agreeing with one another, if we except persons belonging to the somewhat rare, but by no means uncommon class, called "colour-blind." But I will not go into the subject of colour blindness, it would take me too far from the subject I have to bring before you, and therefore I will content myself by merely mentioning it.

Now it would be a natural extension of this law, which has been so carefully verified by Maxwell, and I may mention, by others also, to assume that if you could get at the supposed three primary sensations of colour, pure by themselves, the same law would apply to the mixture of those one with another. In this manner the subject of the effect of mixing colour may be rendered very clear in a general sort of way by means of what is called the triangle of colours, but that would take me a little too much into mathematics, very simple as those are, and I just refer to it in passing.

Now what supposition can we make physically as to these three supposed primary sensations of colour? What laws must any theory obey that we may make, respecting the manner in which those sensations are produced? Set aside for a moment the existence of colour at all, and think only of light. We know that we see separately a vast amount of independent objects in the field of view. There is a very wonderful structure in the retina of the eye, corresponding with that capacity we have of distinguishing one point in the field of view from another. In the back of the retina there is a most remarkable structure, in which the nerves or nerve-fibres which are concerned in vision end, which is called the bacillary layer. It consists of very peculiar bodies of two different forms in most eyes—in the human eye, for instance—which are

denominated rods and cones. The number of these in the eye is enormous. I have here a drawing* giving the facts to which I am now pointing in regard to the retina. You look on the eye from behind so that you see the ends of those rods and cones. Those rods and cones are richly provided with excessively delicate minute nerve fibres, and there is little doubt that somehow or other the ends or end portions of those nerve fibres are excited by the influence of light, and convey the stimulus on through the set of nerves lining the retina further in front, where they are crossed by the light without being affected thereby, and at last unite in a bundle forming the optic nerve, and pass into the brain.

Now it has been found that in the central part of the retina of the human eye, where vision is most acute, and where there are cones only, without rods, the distance between consecutive cones is about ·003 of a millimetre—an excessively small quantity—and we can easily calculate independently the approximate distance on the retina of the images of two visible points which can just be seen as two, supposing, of course, that, in the first instance, we have determined experimentally the angular distance of those visible points. It turns out that the distance of the images corresponds very closely indeed with the distance apart of the cones in the bacillary layer of the retina, so that apparently the stimulation of one of those gives us the perception of a single point in the field of view, the apparent position of which varies with the position in the retina of the particular cone on which the image falls. If we view a star we have the sensation of a point of white light in a particular direction. If we hold a red or green or blue glass before the eye, we have the sensation of a point of red or green or blue light in the same direction. On the theory of three primary colour sensations, whatever those may be, we must infer that the stimulation of the same cone is capable of giving rise to all three of the primary colour sensations, but that the difference of colour sensation does not entail a difference of apparent direction. Can we form any idea as to how these conditions may be fulfilled?

Dr. Young's idea was that there are three kinds of nerve

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* Referring to one of the plates in a paper by Max Schultze in the 2nd volume of the *Archiv für Microscopische Anatomie.*

fibres which, if excited separately, would give rise to the three supposed primary colour sensations respectively, but which usually are excited together. Microscopic examination shows that the same cone or rod is provided, not with a single nerve fibre, but with a whole set of nerve fibres. Therefore we cannot say *a priori* but that it may really be true that there are different nerve fibres appropriated to the different supposed colour sensations; and we have to explain, if we can, two things in order to account for what we observe. We have to explain for one thing—if we can explain it—how it is that the nerve fibres of these three sets respectively are affected in different proportions by the same incident light, according to the nature of that light; so that if light be taken from the red end of the spectrum, those fibres which give rise to the sensation of red (supposed provisionally to be one of the primaries) are the most affected, though the others may be affected to a less degree, and so in other cases. We must seek in the distal ends of the nerves, or in some apparatus connected with them, for something enabling differentiation of stimulation to take place. I do not mean to say that that has been explained yet. It is not, however, incomprehensible that it is a thing which may hereafter be explained. At present we can only form certain conjectures regarding it.

Then there is another thing concerned with these three primary sensations of colour, viz., that these three classes of nerves being affected, some sort of stimulus appears to be propagated along the nerves to the sensorium, and there gives rise to a sensation differing from one to another of the three classes. How sensation is there produced is a question belonging to that mysterious region in which, so to speak, mind and matter come together, and I do not suppose we shall ever be able to explain how it is that this stimulation of the nerves (if they are stimulated) produces in us these three sensations. But at the other end—the distal end—there may possibly, as I have said, be some chance of our doing something.

Different conjectures might be formed as to how these three sets of nerves might at the distal end be affected in a proportion differing according to the nature of the light. As regards the mode of stimulation, I may mention that the most probable theory seems to be that it is due to the result of a photo-chemical change, possibly it may be in

the molecules of the structure of the nerve itself, but it seems much more probable that it is in something with which that part of the retina is suffused, it may be in the so-called visual purple, which, as experiment shows, is very readily affected by light, changing colour and being ultimately bleached, which indicates a successive formation under the influence of light of different chemical substances. Now it may be that these different chemical substances affect the three classes of nerves differently, and that it is in that way that the differentiation between the stimulation of the different sets is effected at the distal end of the nerve apparatus. If the excitement of the nerves at the distal end is due to substances produced in the photo-chemical action, there must be some difference or other between the three classes of nerves, or between something belonging to them, in order to account for their not being all excited in the same proportion one to another whatever be the nature of the exciting light. It may be that the nerves are differently constituted in some respects; but I do not think it is absolutely necessary to suppose even that. I can conceive that it is possible (it is merely an idea that has occurred to myself, and I hardly venture to throw it out, especially in the presence of Lord Lister, but if I go wrong he will correct me in the end) that if the excitement of these nerve fibres is due to chemical stimulation, produced by products of the action of light on the visual purple or some other substance, and if endosmose comes in as well as photo-chemical action, I can conceive, I say, that without any necessary difference in the structure of the nerves of those three classes, the difference may be made by their position in the outer segments of the rods or cones; by the nerve fibres lying closer to the surface or a little deeper in. The minuteness of the rods and cones is such that any substance which is produced at the outside might very quickly pass in by endosmose, and so sensation might very readily respond to the light as the substance is produced. That, however, is a mere conjecture of my own; but I will ask Lord Lister to tell the members of the Institute it is all nonsense if he thinks it is.

I will now refer to one or two very curious recent experiments, not directly relating to light, but bearing on other sensations, and going to establish, or at any rate to confirm, a law, which if it be true seems to have a very important bearing on the theory of our sensations of colour. My

attention was recently called to some curious experiments by Blix* and Goldschneider.†

In investigating the seat of the perception of heat or cold, they used a small body ending in a surface of very small area slightly warmer or colder (suppose in the first instance warmer) than the skin, and applied it in succession to all points in a selected area of skin, chosen, say, at the back of the hand. It was found that certain points were sensitive to heat, while elsewhere the skin was indifferent. The sensitive points ("heat points" as they may be called), when found, were marked with a particular colour. A similar experiment was then tried with a surface colder than the skin, and a group of sensitive points, "cold points," was thus determined, and marked with a different colour. The marking allowed of the experiments being repeated, it might be, on a different day, so as to make sure of the result. It is particularly to be noted that we have not got a group of points sensitive to a *change* of temperature but two distinct groups, one sensitive to heat but not to cold, the other sensitive to cold but not to heat. Here and there a heat point and a cold point might coincide, or rather lie so close as not to be distinguishable in position.

Similar experiments were tried as to finding out points which were sensitive to pressure, just the gentlest possible touch of a very small body so as not to cover a large area, and a third group of sensitive points, quite distinct from the two former groups, was thus obtained. It appears from these experiments that a different set of nerve fibres is concerned in communicating to the sensorium the sensation of heat from that concerned in communicating a sensation of cold, and a different set again of nerve fibres concerned in the sensation of touch. These nerve fibres seem to be very numerous, and to lie pretty close together in some parts of the body, and in other parts more widely apart. That, therefore, leads us to regard as not incredible the supposition that in the group of fine nerve threads coming from one of the cones or rods of the retina, there might be nerve threads of different kinds that are capable respectively of producing different sensations as to colour. No doubt the microscope

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* *Zeitschrift für Biologie*, vol. xx (1884), p. 141, and vol. xxi (1885), p. 145.

† *Archiv für Anatomie und Physiologie Physiologische Abtheilung*. Supplement-Band, 1885, p. 1.

fails to reveal any difference in these different nerves; but why should we expect that it should be capable of revealing anything different? For aught we know to the contrary, the nerve threads of these three classes may be just like one another, and the difference in their function may arise from the difference in the mode of stimulation at the distal endof the nerve apparatus, and from some difference in the way in which they affect the sensorium at the other end. In relation to Goldschneider's experiments, I am told that one of the marked heat points and one of the cold points were selected, and self-vivisection in a small way was performed by punching out little bits of skin, so as to catch the ends of the two kinds of nerves. On examining them under the microscope, no particular difference could be made out. Hence, if we cannot make out any difference in the distal ends of the nerve fibres of the retina, we cannot say that there is therefore no difference.

As I said the subject that I have ventured to bring before you is not only out my line but it is rather speculative. Still, I think it leads us to some interesting contemplations, and one thing I think we cannot fail to be strongly impressed with—viz., the astonishing complexity of this marvellous organ, the eye, and the wonderful proof which (to my own mind at least) it gives of design in its construction.

Addition made while going through the Press.

The question naturally presents itself, if there are three primary sensations of colour, brought about by the stimulation of three sets of nerves respectively, how is it that the sensation of unity of direction is preserved? If, when the image of a star falls in focus on the retina there are three classes of nerve fibres excited, leading, it may be, to different places in the brain, how is it that we see but one white star, instead of three stars showing respectively the three primary colours?

The only answer, as I conceive, that it is possible to make to such a question is to show that the phenomenon is in perfect analogy with what we know by experience in the case of other nerves of sensation. Suppose, for example, that a toe or a finger or an elbow is gently pressed, or else that a small warm body is held against it The quality of the sensation, be it that of pressure or of warmth, is alike

in all three cases, but the part of the body to which the sensation is referred is in each case the same, whether the sensation be that of pressure or warmth, or as it may be a mixture of the two; and *that*, although in accordance with experiments already referred to, it appears that it is by two different sets of nerve fibres that the sensations of pressure and of warmth respectively are conveyed. While the character of the sensation (be it of pressure or heat) depends very probably on the part of the brain to which the nerves of the three sets lead, the part of the body to which the sensation is referred seems to depend on the position of the distal ends of the nerves.

It would be in full accordance with this to suppose that when the nerve fibres belonging to a particular cone of the retina are stimulated by the rays from a luminous point which are there brought to a focus, while the character of the sensation as to whiteness or colour depends on the proportion in which the three supposed sets of nerve fibres are stimulated, which itself depends on the character of the light, the part of the body to which the sensation is referred is the particular cone in question, the same therefore for all three of the primary colour sensations. Different luminous points are seen in the same order of sequence in which their images lie in the retina. Furthermore, just as in touching in the dark an object with the forefinger we can judge of the position of the object relatively to our body, of whether it lies right or left, up or down, through the knowledge we have of the position of the arm, so in vision we can not only judge by direct sensation of the position of an object relatively to the point we are directly looking at, but also as to the direction of such an object relatively to a point right opposite to the head, through the knowledge we have of the way in which we have willed to turn the eye-balls when the object is in our field of vision.

The contrast between our perceptions of sound and light may be emphasised by saying that while both phenomena objectively considered depend on undulations, in sound we have a direct perception of frequency, but not of direction, while in light we have a direct perception of direction, but not of frequency. This succinct statement requires explanation, without which it might even be supposed to be untrue. It might be said, we have a continuous change of pitch, from the lowest bass to the shrillest sound that we can hear, and we have a continuous change of hue from the

extreme red to the extreme violet of the spectrum; where then is the difference?

The evidence of the difference lies in the total difference of the result of mixture in the two cases. When two notes of different pitch are sounded together we have the sensation of discord or harmony as the case may be, a sensation altogether different from that of a note of intermediate pitch. The two sensations of pitch retain their individuality in the mixture. But when two lights of different refrangibility, exhibiting separately different colours, are mixed, we have the sensation of a single colour; and in many cases, when the places of the two colours in the spectrum are not too far apart, the mixture gives almost exactly the same sensation as an intermediate colour of the spectrum. And the same compound colour may be produced in an infinite number of ways by mixing trios of colours of definite refrangibility.

The Right Hon. LORD KELVIN, G.C.V.O.—We have all listened with great interest to Sir George Stokes' treatment of one of the most difficult subjects in natural philosophy. In using the term "natural philosophy" here, I mean the study that comprehends physics and physiology—and, something beyond both, the mental perceptions and emotions connecting the physical and external with the psychical and nervous processes and with the wonderful sensorium of which we have been hearing Sir George Stokes speak.

The theory of the perception of colour which he has so clearly explained (the Young-Helmholtz theory) is, I believe, now universally accepted by scientific men over the world as absolutely true in respect of explaining the different qualities of colour; and as having a possibility of being also mechanically true in respect of this system of nerve fibres by which a hypothetical explanation of known facts is given. I will say nothing on this subject except to express my own intense interest in it, and my desire to know the truth; but I hope Lord Lister will tell us his view in respect of the triplicity of the nervous system, connected with the retina of the eye, and of the beautiful experiments of which the President has told us in respect to the different

effects on certain fibres by which the sense of pressure, and the sense of heat and cold, are produced.

Now I spoke of scientific men. There are scientific ladies also —and ladies who are not scientific—and I am sure they will all thoroughly sympathise with scientific men in their appreciation of this beautiful theory.

Sir George Stokes told us that every variety of colour may be produced by the mixture of red, green and violet, and in Maxwell's practical work on the subject of which he spoke, white and black are added in the mixture, white to dilute the intensity of the colour; and black to diminish the total light emitted by a body exposed to sunlight.

Now in these times when ladies are so well occupied with important work that they scarcely have time for shopping, it would be a great comfort to them, if when they wanted a beautiful blue ribbon, they could simply write down on a piece of paper 2.5.7.3.4. and put it in an envelope and send it to the shop; or 3.4.0.2.0 a brilliant yellow, no black in it—3 of red, 4 of green, 0 of violet, 2 of white to brighten it up a little and dilute some of the colour. Do not imagine that you will get green by mixing yellow and blue—on the contrary, you get yellow by mixing red and green, as was first taught by Young, enforced by Helmholtz, and splendidly put in practice by Maxwell.

Sir George Stokes spoke of design. Is it conceivable that the luminiferous ether should throw out these effects by chance—that the colours of the butterfly or of a beautiful flower should result from a "fortuitous concourse of atoms," and having come by a fortuitous concourse of atoms, they should give pleasure, whatever that may mean, to another fortuitous concourse of atoms constituting myself, and I should—I don't know how to express it. The atheistic idea is so nonsensical that I do not see how I can put it in words. (Applause.) Surely design does not stop short at the production of outside physical influences but includes giving pleasure in the perception of colour. We cannot go further in such thoughts just now. Surely they bring strong evidence indeed of design, and if the Victoria Institute required proof, I think it needs nothing more than what we have heard to-day from the President, and which we all feel in regard to the beautiful effects of colour. (Applause.)

I beg to propose a cordial vote of thanks to the President for his most interesting lecture, and not only to him but to the eleven

other gentlemen who have contributed the papers during the last session which have been referred to by the Honorary Secretary.

The Right Hon. LORD LISTER, M.B., F.R.C.S., LL.D., P.R.S.—I have very great pleasure in seconding the vote of thanks. We learn from the Report that various gentlemen have given what no doubt were exceedingly valuable communications in the course of the session, and it would be our desire that the best thanks of the Society should be given to those gentlemen. But we have all of us had the opportunity of listening to this most beautiful discourse.

Sir George Stokes has appealed to me as to whether I should regard the special hypothesis that he has put forward with regard to the means of the perception of different kinds of colour as heterodox physiology. So far as I am able to judge, merely by listening to his words, there do not occur to me any symptoms of heterodoxy in that hypothesis.

Of one thing I think we may be sure—that the different sensations we experience do not depend on difference of structure of the individual nerve fibres; but that certain nerve fibres being called into action by certain stimuli, the result as regards our sensations depends on the part of the sensorium with which each nerve fibre is connected.

I do not think it is necessary for me at this late hour to detain you with further words, but only to express my own gratification at having been permitted to listen to this discourse, and to second the vote of thanks for it. (Applause.)

LORD KELVIN, G.C.V.O., then put the resolution to the Meeting and it was carried unanimously.

The PRESIDENT.—Speaking for myself I should say, as President, it is my duty to acknowledge the vote of thanks which has been passed to all those who have contributed to the business of the Institute by reading or sending papers to be read during the session. For myself I feel very strongly the kind way in which a very imperfect attempt to bring a difficult and little known subject before the Meeting has been received.

I am glad to see that I have not been charged by Lord Lister with being altogether heterodox.

The Meeting was then adjourned.