disease of the posterior ciliary arteries, and the two cases that I have quoted might well have been caused by this.

In now bringing my lecture to an end I do not wish you to think that I have exhausted the whole subject of the relation of arteriosclerosis to the eye. There is the question of optic atrophy and retrobulbar neuritis caused by pressure of the thickened wall of the carotid artery, and probably other complications that will occur to you. What I have endeavoured to do is to set forth the results of my own observations, at the same time quoting largely from recognized authorities on the subject, but what I did not wish to do was to copy out of a book all the facts that I could find and retail them to you.

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COLOUR BLINDNESS AND YOUNG'S HYPOTHESIS

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IT has been pointed out frequently as an objection to Young's hypothesis of vision that individuals who confuse red and green, and who, therefore, should be classed as either red blind or green blind, when they are told to describe a pure prismatic or diffraction spectrum, do not state that the end occupied by colours of long

wave length appears to them to be red (if green blind) or green (if red blind) as it might be supposed that they would, but on the contrary both classes are unanimous in describing it as yellow. This has been held to constitute not only a powerful objection to Young's hypothesis, but also to advance definite evidence in favour of Hering's views. Thus Dr. Pole, who was green blind, in describing his own case¹ says that one of the most forcible objections to Young's theory is "that it does not accord with the experiences of the colour blind. If there is one fact more unequivocally deducible from their evidence than another, it is that the less refrangible colour they perceive corresponds to the yellow and not to green. In my own case, which I believe is a typical one, my long wave colour is most vivid and positive, and it is an absolute certainty that its maximum splendour is excited by the buttercup, or by the pigment chrome yellow, or by the sodium line, whereas

objects that I hear called green give me no definite impression at all; sometimes they assume a debased, dirty or washed-out buttercup colour; sometimes they look black or grey, and sometimes they even give my opposite sensation, blue. How, therefore, it can be argued that my most brilliant buttercup sensation is excited by green objects rather than yellow ones is to me unintelligible."

These personal experiences thus clearly stated by Pole have been quoted by many authors⁽³⁾ ⁽⁴⁾ ⁽⁵⁾ ⁽⁶⁾ as objections to Young's hypothesis of colour vision. Thus Edridge-Green says² "according to this theory (Young's) a colour blind with the red perceptions absent ought to see green as the most representative colour of the first unit, but the simple two unit (individuals) invariably say that

yellow is the colour which they see, and, as they are speaking of spectral light, there can be no question about the purity of the colour."

These facts, which have been held to discredit Young's hypothesis of colour, are, however, completely consistent with it.

In the above figure are reproduced Abney's equal area red, green, and blue sensation curves. These curves diagrammatically represent the facts that in the normal sighted the extreme less refrangible end of the spectrum to 6,600 A.U. arouses the red sensation alone. From 6600 A.U. to 5850 A.U., both red and green sensations are aroused in increasing amount, the former increasing less rapidly than the latter as the spectrum is passed through towards rays of shorter wave length. At 5850 A.U. a new variable is introduced by the rays beginning to excite the blue sensation. At 4850 A.U. the red sensation ceases to be affected, and at 4700 A.U. the green sensation suffers in a similar manner, leaving the blue sensation practically pure. Suppose now that we are considering the case of a person with green blindness, the red sensation alone will be excited by rays from the red end of the spectrum to 5850 A.U. at which wave length the blue sensation commences to come in. The whole of the less refrangible end of the spectrum as far as this wave length will appear of one uniform colour which gradually increases in intensity as the wave length corresponding to the summit of the sensation curve is reached, namely at a wave length of 6000 A.U. After reaching its zenith the intensity commences to fall till at 5850 A.U. the blue sensation commences to be excited and the purity of the sensation begins to suffer. The ray that most powerfully excites his red sensation has therefore a wave length of 6000 and its colour to the normal sighted is a pure yellow of slightly longer wave length and therefore very slightly more orange than the sodium lines.

If, therefore, he is asked to indicate the part of the spectrum which most typically arouses his long wave length sensation, he will point to a position in the spectrum near the sodium lines; if asked to name a pigment like it in colour, he will say "chrome yellow," and if a flower, he will say "the buttercup." The answers that he gives will be those of Dr. Pole. If now he were asked to say what colour the less refrangible end of the spectrum appeared to him, he would reply, the colour of the buttercup, of the sodium lines and of the pigment chrome yellow. But as persons with normal colour vision call these objects yellow, he also will do so, because he (like all of us) has learnt his colour names from them.

We may now ask him to examine the green part of the spectrum and to tell us what he sees. He will call rays of 5500 A.U. dirty buttercup, because, while they arouse his buttercup sensation strongly, they also stimulate his blue sensation as well; rays of

5100 A.U. he will call grey because his buttercup and blue sensations are approximately equally stimulated; while greens of shorter wave length still, he may call blue, because that sensation is the more strongly stimulated. In other words, he will name the green region of the spectrum as Dr. Pole names it; and he will name pigments in a similar manner according to the strength with which they stimulate his "buttercup" or his blue sensation.

Lastly, we may consider his statements concerning "whites" because it has been stated that since he is green blind and has only red and blue sensations he should call white "purple."

Now, he is in exactly the same position that persons with normal vision are, for he has learnt from infancy that certain pigments (e.g., zinc oxide), certain flowers (snowdrop), etc., are given the name "white"; but he finds that they arouse his blue and his "buttercup" sensation in certain proportions, and he therefore calls all other objects "white" which give him a similar sensation.

The statements made by an individual with green blindness are therefore those that would be expected on Young's Theory.

The case of the red blind may now be investigated in a similar manner. On examining the spectrum he finds that the red end is somewhat "shortened," and that the spectrum at this end has a uniform colour from its commencement to 5850 A.U. At this point and onwards the purity of his long wave length sensation is diminished owing to the stimulation of the blue sensation as well. If now he again examines the less refrangible end of the spectrum he finds that the intensity of the pure sensation that he receives increases rapidly as he passes from the end, till at 5850 A.U. it suddenly commences to be impure; if, therefore, he is asked to indicate the part of the spectrum which most vividly arouses his long wave length sensation, he will point to a position of 5850 A.U. near the Na lines. If asked to name a pigment like it in colour he will say "chrome yellow," and if a flower, "the buttercup." The answers that he gives are also those of Dr. Pole, and he, like Dr. Pole, will call his less refrangible sensation buttercup colour or yellow because he also has learnt his colour names from people with normal colour vision. The green region of the spectrum will appear dirty buttercup colour, grey, or bluish grey according to its wave length, as in the case of the green blind individual, green pigments also will be similarly classified. It should be noted that the neutral grey area of the spectrum is shorter in wave length than it is in the case of the green blind. White will be called "white" and not blue-green for a similar reason to that given above in the case of the green blind; namely, that the red blind have learnt from persons with normal vision to call objects white which arouse their green (buttercup) and blue sensations in a certain ratio.

Summary

On Young's hypothesis, a simple explanation can be advanced for the fact that both the red and the green blind call the less refrangible end (long wave length end) of the spectrum yellow, namely, that they have found by experience that their long wave length sensation is most strongly aroused by objects which the normal sighted call yellow. This also explains why they call greens, both spectral and pigmentary, dirty yellow, grey, or grey-blue according to shade. Also why they call white "white" and not purple, on the one hand, (green blind) or blue green, on the other (red blind).

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DR. EDRIDGE-GREEN'S THEORIES OF VISION

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DR. EDRIDGE-GREEN, in his many writings on colour vision and kindred topics, has advanced several theories. He has been indefatigable in his attempts to support these theories by statements based upon, and criticisms directed against, the work of other investigators, as well as by extensive series of observations of his own. It is not unnatural that in his enthusiastic advocacy of his views he should appear at times somewhat to underrate the work of his predecessors and contemporaries in the same scientific field. The sole object of the following remarks is in some measure to restore the balance. In my opinion, the time is not yet ripe for dogmatic allegiance to any of the many theories which have been propounded to explain the phenomena of colour vision. In my "Introduction to the Study of Colour Vision" (1915, Cambridge University Press) I have briefly described and criticized the chief theories, including Dr. Edridge-Green's. The value of a scientific theory depends not only upon its capacity to elicit useful generalizations from established facts, but also to stimulate the imagination to devise new methods of attack. In the latter respect is its utility chiefly to be judged, and therein lies the criterion which distinguishes it from vague speculations.