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COLOUR PHOTOGRAPHY FOR OPTICIANS.

THE PORTRAYAL OF FUNDUS DETAILS FOR
PURPOSES OF INSTRUCTION.

BY MESSRS. H. A. BOATMAN AND H. C. PATEY.

Paper read April 11th, 1912.

THE object of the demonstration we are bringing before you this evening is to suggest a means whereby the characteristic appearances of the fundus, in the original the work of expert ophthalmoscopic artists, can be most suitably reproduced for the purposes of demonstration and instruction.

It forms no part of our purpose to discuss whether the ability to recognise certain pathological conditions of the fundus should form part of the training of the qualified ophthalmic optician—there is much to be said for and against such training—but, whatever view be taken of this matter, it is evident that methods for disseminating and duplicating the best original drawings of the fundus must be useful to students of this subject.

The details to be recorded in the case of the fundus are very largely those of colour as well as of form, hence the special utility of colour photography. It is, of course, possible to directly photograph the fundus, as has been done, for instance, by Prof. Dimmer, of Grätz.

But there are several reasons why direct methods of photography, whether in colour or otherwise, do not lend themselves to the best portrayal of the fundus details. The difficulties that arise are not only those of illumination and exposure, but are inherent in the nature of the detail to be recorded.

A skilled ophthalmoscopist, such, for instance, as Mr. Head, who is responsible for the beautiful drawings in the various works which have been published by Dr. Lindsay Johnson, will always see more detail than is possible to

the photographic plate. The case is somewhat analogous to the uses of photography in astronomical work. A faint image not appreciable by the eye may be recorded by the *additive* effect of a long exposure, but for the recording of fine detail, dependent on taking advantage of moments of good seeing, as, for instance, in the recording of planetary markings, the human perception is of vastly greater accuracy.

It is rather as an adjunct, therefore, to the work of a trained ophthalmoscopic artist that photography in general, and colour photography in particular, will be of assistance in disseminating a knowledge of the fundus.

The slides shown to-night are, in the main, reproductions from the lithographs in Haab's "Atlas of Ophthalmoscopy," and the results would doubtless be better still if original drawings had been available, for the autochrome process is, as regards, at any rate, the faithful reproduction of colour detail, superior to lithography. This process, by which the slides have been produced, is in itself a very pretty demonstration of the theory of colour vision known as the "tri-colour theory."

According to the theory first put forward by Thomas Young and elaborated by Helmholtz, it is supposed that the eye perceives colours by the stimulation of three primary colour sense-organs affected respectively by red, green, and blue violet light, the joint action of the three stimulations producing the sensation of white light.

The methods of tri-colour photography employed to reproduce colour have nearly all been based on this theory, but up to the time of the autochrome plate the processes have involved, generally speaking, two separate and distinct operations. The first process obtained a *record* of colour, the second produced the colours of the original from this record, but the autochrome plate has united and simplified these two operations, and shows that from a simple basis

of three primary elements all lines and gradations of colour can be represented.

It indicates, perhaps, that no great complication is necessitated in the sensory apparatus of the retina, whatever this may be, which would suffice to give rise to different nerve sensations for the different wave lengths of white light, or, in other words, to produce colour vision.

The autochrome plate consists of an ordinary sensitive panchromatic emulsion not coated directly on the glass support, as in an ordinary plate, but separated therefrom by a layer known as the starch grain layer, in which reside the colour producing properties. This starch grain layer consists of nearly equal proportions of red, green, and blue violet starch grains lying (one-ply) on the glass support, any interstices which may occur between them being filled in the process of manufacture with an opaque black pigment. The starch grains are separated from the sensitive emulsion by a layer of hard varnish, which protects them from any action of the solutions, etc., which are used for developing the plate.

The plate is exposed *glass side* towards the lens which forms the image, and a special yellow screen is used to correct for the greater sensitiveness of the emulsion to blue light.

With the screen in position the autochrome plate is *equally* sensitive to red, green, or blue light. It is now not difficult to trace the action which takes place when a coloured image falls on the starch grain layer.

Suppose this happens to be red light. Then all such light falling on the green and blue starch grains will be absorbed, and none will pass through them to affect the sensitive emulsion behind. Behind the red starch grains, however, the silver emulsion will be acted upon, and when the autochrome plate is developed a black spot will appear behind each red starch grain.

Such development forms the first of the three chief operations to be performed when producing a coloured photograph. If at this stage the plate be fixed and held to the light it will not appear red, as was the colour of the object photographed, but blue-green, the complementary colour of the red; for behind each red starch grain is a black dot which stops all light passing.

The next, our second step, therefore, is to dissolve away the reduced silver behind the red starch grains, and this is done in a solution of potassium permanganate and sulphuric acid. At the end of this operation the original red of the object photographed will begin to appear.

A certain amount of light will still, however, get through the *unreduced* silver behind the blue and green starch grains; and the third and last operation, re-development, completes the process. This is done by exposing the plate to light and developing with an Amidol or Rodinal developer, which blackens the silver behind the blue and green starch grains, and only allows it to pass through the red starch grains, and the object now appears in its pure original colours.

The same action takes place in respect of any other colours, intermediate colours causing partial actions on *two* or *three* of the three primary starch grain elements. Yellow, for instance, is produced by an equal action of the red and green starch grains.

If necessary, the autochrome plate is intensified in order to increase the brilliancy of the colours; and varnishing to protect the very delicate film completes the process.

[At the conclusion of the lecture a remarkably fine series of autochrome slides were projected on the lantern screen, illustrating normal and pathological conditions of the fundus; and the significance of the various pictures shown was fully explained in each case by Dr. Ettles.]