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COMMENTARY

Confessions of a colour blind physician

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The author describes his experiences due to his inherited colour vision deficiency, as a child, as student and as a medical practitioner, when he had certain difficulties in clinical work. He quotes from the literature on the clinical skills of physicians with this deficiency and gives an account of his own research that involved meeting and testing other doctors of medicine. This revealed a wide range of difficulties experienced by colour vision defective doctors in their practice of medicine with a potentiality for errors. Although there is a number of publications on this subject, the profession has made little response to them. This suggests that it is facing a dilemma that is inhibiting appropriate action. It is suggested that colour vision scientists and medical practitioners need more understanding of each other's discipline if progress is to be made. The advantages of screening of medical students and advising those found to have a deficiency are discussed and lines of research are proposed.

Key words: colour vision deficiency, deutanope, protanope, trichromat physician

Readers will notice that I have not confined myself to the subject of the title. Although I have given a personal account that could be called a confession, I have been tempted away from this named topic to write about the larger subject of the effects of inherited colour vision deficiency on the performance of medical practitioners in their clinical work. This brings forward issues that have implications for the medical profession as a whole. Without this, the article could be dismissed as an account of private experiences from which it would be difficult to draw any general conclusions. In fact, it was my personal experiences of this deficiency that led to a concern for other medical practitioners with this condition, so that I give these experiences some importance in the development of my thoughts on this subject.

I have come to believe the deficiency affects our performance in the practice of medicine, unfavourably in some situations, and my main purpose in writing this article is to give evidence for this conclusion and analyse some of its implications. If my belief is correct, it presents the profession with a sensitive and complex series of questions that certainly have not been faced. They are sensitive because the health of patients and the careers of physicians are involved; they are complex because in medicine causal relationships are not always easy to establish and because different specialities and procedures may present different types of problems. These may be reasons for there having been so little debate within the medical profession on this subject. Another is certainly the lack of awareness of the effects of this condition that is so characteristic of individuals with it. The developments in the science of colour vision in the past few decades and the more open attitude to mistakes by medical practitioners may make debate possible in the future.

As for confessions, yes, I have made mistakes in medical practice. Who has not? While I believe that some were due to my colour vision deficiency, I have little guilt about them because I believe they are largely due to a system that allows us to practise medicine with no support or advice on dealing with the effects of this deficiency. I also admit to having listened carefully to what other medical practitioners have to say on the subject.

Much but not all of the evidence presented in this article is anecdotal. Such evidence has value in indicating lines for future research and, perhaps more importantly, in giving a human meaning to the findings of science. John Dalton's first scientific paper about his own deuteranopia read to the Manchester Literary and Philosophical Society in 1794,[1] illustrates this. The greater part of it was anecdotal but it is now seen to have been remarkably influential.

My personal experiences

I can recall the surprise and disappointment I felt when, aged seven, it was explained to me that the painting I had just made of a pink rose was green. Playing rugby at school, I could not tell the green stripes from the purple on our jerseys and tackled the wrong person. As a young man walking in the French Alps with my brother, who had inherited the same deficiency as myself, we failed to notice a small red arrow on the rock and so took the wrong path that led us to a crumbling ledge above a profound drop. We had already been warned that a young man had died there a few weeks earlier.

Another kind of end-point was encountered in practical chemistry, when I was never sure when the colour change had occurred. In physiology class, the Ishihara Plates showed that I had a colour vision deficiency but did not indicate its severity and no advice was offered about its practical implications. In microscopy, looking at stained slides of bacteria, blood cells and tissue, I was not seeing as much as I should.

In my first job as a house surgeon, the gynaecologist was upset because I had failed to see the extreme pallor of a woman waiting for surgery. 'Anyone could see it,' the gynaecologist said but I could not. The operation was delayed for a week while the patient received a blood transfusion. On occasions, these experiences and others later in practice gave me a vague sense of unease but I was not the kind of person who seeks help readily so I kept them to myself.

Throughout my 25 years in general practice, I believed that my condition was mild and gave it little attention. In most cases, I did not connect these events with my colour vision deficiency. Just after retirement, having at last become inquisitive about it, I contacted a well-known teacher of optometry who tested me and said that my condition was graded as severe and that I was a dichromat with a middle wavelength deficiency, called deuteranopia. I learned that one per cent of males have this form of abnormal colour vision and that eight per cent in all have some form of the inherited deficiency. I then decided to study the matter more closely and soon found that there were other physicians with experiences similar to my own.

Personal accounts from four physicians

Four doctors have written personal accounts that are very similar. All describe early life experiences, then difficulties in clinical work and all but one recommend screening and advice for medical students.

In 1973 Anthony Seaton,[2] a chest physician, wrote, 'I have been able to avoid fields in which colour vision needs to be "normal" and fortunately, I am no longer required to undergo the torture of chemistry in its various forms and its titrations and identifications of various substances by mysterious colour changes. I am sure that a colour blind person is at a disadvantage, at least as a student, in these subjects'. He points out that for some tests and for rashes he relies on nurses.

In 1979, Logan,[3,4] a physician, gave an account of a wide range of difficulties that he experienced as a student and in clinical practice. Obviously, he became a careful observer. He refers to four factors of importance: awareness of the effects of the deficiency, the difficulty of scanning for visual objects, the need for good illumination and the severity of the deficiency. He recommended the screening of medical students and made this significant statement: 'The difficulties are overcome by awareness, self-training and effort'.

My own account was published in 1994[5] and after describing my experiences, I wrote, 'People tend to be baffled by the subject and the resulting handicap, whether they have the deficiency or not but it is still surprising that we in the medical profession do less for our colleagues than is done for many in other professions.'

Later in the same year, Robert Currier,[6] a neurologist, gave an interesting account of his life events and difficulties as a colour vision deficient student and practitioner. He questions whether a medical practitioner with the deficiency, at least if severe, should become a surgeon or a pathologist but recommends psychiatry. Neurology he calls 'a great choice' and he writes 'Prevocational screening? Certainly,' and he agrees to the counselling of medical students.

Early reports

In his 1794 paper,[1] John Dalton reported that he could scarcely distinguish mud from blood on his stockings but there is no evidence that he considered the medical significance of this, that is, of the failure to see blood when it presents as a clinical sign.

In 1881, William Little[7] reported on a physician with a colour vision deficiency attending a course of private instructions in ophthalmoscopy, who had difficulty using the ophthalmoscope and in observing inflammation of eyes. He knew of no other reports of this problem. He had heard of several medical students with a deficiency, whom he planned to study.

In the same year, Jeffries[8] referred to a physician with faulty colour vision who had trouble with the colour of throat ulcers, gangrene and some sores.

In his book on colour blindness, published in 1885, Wilson[9] reported on four doctors with the deficiency. He referred to the difficulties one had in chemistry classes and in observing the redness of lips, cheeks and inflammation and he described the difficulties of the other three in observing nature.

In 1907, Hans Haenal,[10] a clinician, published an account of his experiment of inducing snow blindness in himself when in the Swiss Alps and observing the effect on his colour vision. He described his surprise at the effect of this red/green colour blindness, when he looked at his patients. Their skin had become waxen pale with a hint of icterus, their lips and cheeks cyanosed and their optic discs very pale.

In 1933, Tocantis and Jones[11] published a careful study of colour vision deficiency as a handicap in medicine. Using the Ishihara Plates, they identified nine medical

Defect	Comments of medical practitioners
PA Sev	I wonder if I struggle as a doctor because of my deficiency.
PA Sev	I am so glad that I was able to be a doctor and to have a wonderfully fulfilling profession. As far as I am aware, my disability has harmed none and perhaps the knowledge of it has sharpened my senses.
DA Mod	It has made me think more deeply about skills due to defective colour vision in general practice and I believe these need much more attention.
DA Sev	I would not have known I had a defect if I had not been tested.
DA Mod	My loss of confidence might have been more sympathetically handled had they [my teachers] been on the lookout for this problem.
DA Sev	I did a year in pathology but did not realise that stains showed different tissues—no one told me. My eyes pick up very fine physical features of rashes et cetera. I feel this and body language are major advantages I have developed. I frequently ask my colleagues for advice, especially over babies with rashes and fevers et cetera. and the chance of a red ear or throat. I feel very vulnerable at the end of a busy surgery. I believe there are times when patients describe red rashes and the nurse points to the invisible spots. I cannot believe that I could be guided to two careers, which depended so heavily on colour, namely, pathology and dermatology. The profession offers no guidance and I feel vulnerable at times.
D	I do not trust my colour vision. I look and listen more carefully in those areas.
D	The problem is that I do not know what I am missing.
PA Mod	I have difficulty recognising the pallor of anaemia or leukaemia. I have missed anaemia on several occasions.
DA Sev	I once diagnosed haematemesis as bile.
D	Nowadays, I am a trainer for young physicians in vocational training and I advertise my own handicap to teach the young people to do the same. For example, we consciously develop methods to overcome the problem, this is, when we recognise a problem even better without colours, for example, scarlatina, or when we know that we cannot see anything at all and should call for help.

D = deuteranope, P = protanope, PA = protanomalous trichomat, DA = deuteranomalous trichromat, Sl = slight, Mod = moderate, Sev = severe.

Table 1

students out of a class of 70 and compared them with six normal students as controls. The students with a deficiency made many errors in observing stained bacteria and blood cells, making titrations with phenolphthalein and naming colours seen through a spectroscope. The authors recommended that the students should avoid certain types of work in medicine.

Later studies

In 1951, Hienz Ahlenstiel,[12] a physician with a red-green deficiency, published a detailed report on the information that the colour vision deficient person should know about his colour vision. He wrote, 'Slight reddening of the skin, as in blushing, is overlooked by the red-green blind. Growing pale is also overlooked, as is a very slight scarlet rash. Stronger reddening of the skin is labelled as dark grey shadow by the red-green blind. It is in this manner that the inflammatory lymph streaks associated with blood poisoning are recognized. Reddening of the interior parts of the body, in the throat, nose, ears and epiglottis, are more difficult to recognise. The bluish discolouration of the lips and nails in circulatory disorders remains imperceptible. Blood spots are imperceptible to the red-green blind on dark materials.'

A study by Janet Voke[13] gave some details about the problem of detecting physical signs of illness by quoting physicians and nurses and an article by Poole and associates[14] demonstrated the problems of microscopists. Another by Reiss and colleagues[15] from the USA demonstrated by using photographs the difficulty of detecting blood in body products. There has been a number of articles published on other aspects of medicine that are referred to in my review article.[16] The review gave evidence of the prevalence of the condition in the medical professions of western countries and shows it to be likely to be the same as for the whole population.

My questionnaire study

I sent questionnaires to 42 medical practitioners who had responded to letters I wrote in the medical press. All 42 replied and 40 (38 men and two women), of whom 37 were general practitioners, completed it. The aim of this study was to discover the range of their difficulties and their attitude to them. A difficulty was defined as a problem, regardless of whether it was overcome.

The medical practitioners reported a wide range of difficulties.[17,18] The most common were recognising widespread body colour changes of pallor, jaundice, cyanosis and cherry red (26 practitioners); rashes and erythema of skin (25); coloured charts, slides, prints and codes (24); problems with microscopy, chemistry, clinical examination and teaching methods when students (23); problems with test-strips for blood and urine (22); ophthalmoscopy (18); seeing blood or bile in urine, faeces, sputum or vomit (18); and observing signs in otoscopy (14).

To overcome their difficulties, 17 reported using close observation, seven asked for help from others and four reported paying close attention to the history given by the patient. It is notable that five with a severe deficiency reported no or very few difficulties and gave them no or very little significance. This contradictory evidence is reflected in the selected verbatim comments that I give below and I will attempt to explain this later in this article. Two practitioners only knew of their problem with colour six months after graduation and for one doctor it was six years after graduation. Later he reported a large number of difficulties in his practice as a physician.

Table 1 lists some of the comments of these medical practitioners.

A study using photographs

Later, I worked with John Campbell, Jennifer Birch and Fraz Arif Mir in an attempt to use clinical photographs[19] to demonstrate in a more objective way the effect that the deficiency has on observations in medical practice. My own deficiency was helpful in choosing the photographs. Fraz Arif pointed out the colours that I could not see and, of course, these were the ones we needed. In addition, while the photographs of blood in body were being taken, I realised that I was unable to see the blood on the samples if it was on a dark background, even though I had placed the blood on them just a few moments earlier.

Twenty-eight physicians, aged 60 years or younger from the original 40 who responded to my questionnaire, were age-matched with normal controls and shown 40 clinical photographs.[19] They were asked to describe them by using the names of colours, outlining certain features, matching the changes in a test-tape for blood glucose[20] and counting acid fast bacilli. They were also asked to estimate their confidence in each decision. The normal controls performed much better and showed more confidence than the medical practitioners with a deficiency. It became obvious that under the conditions of this study there was a failure to make certain observations but this was less when the deficiency was slight.[19,20] How far the use of photographs relates to real practice is open to question, but my own experience in preparing the samples of body products and the correlation with the questionnaire findings suggest that they are relevant.

Attitudes in Japan, India and Taiwan

Knowing what happens in other countries helps to give a better understanding of the issues involved and may be a guide for future action. Japan did not adopt the *laissez-faire* policy of the medical profession in the west. Many of the colleges in that country refused admission to applicants with colour vision deficiency for a wide range of subjects that included medicine but in some colleges, surprisingly, even music and languages. These restrictions were nearly all removed by 1992, due in large part to the work of Takayanagi,[21] an ophthalmologist, who informed me of the situation in her country. Early in the 20th century, Professor Ishihara was largely responsible for that policy but this was in the context of a widespread prejudice in that country against people with this deficiency (Takayanagi, personal communication). In other countries in the Far East, policies vary. In 2002, one student (personal communication) in India with a deficiency needed to take court action to be accepted by a medical college and in Taiwan (personal communication) at least one medical college does not accept students who fail the Farnsworth D15 test.

DISCUSSION

The evidence outlined in this article shows that medical practitioners with a moderate or severe colour vision deficiency can have a wide range of difficulties in clinical work and that these difficulties are a potential cause of errors. It is not known how frequently errors occur but it seems inevitable that they do occur. With appropriate advice, it is likely that most are avertable. There has been virtually no open debate on this subject and only a little research. While this is in some ways understandable, for reasons that I will explain, it results in medical students and practitioners not receiving needed advice.

The problem is complex and I will discuss three aspects:

1. observations of colour in the diagnosis and care of patients and how this relates to difficulties in clinical work
2. the failure of a response to the problem on the part of the medical profession
3. the help that medical practitioners and students with a colour deficiency need and what should be done by way of future research.

The role of colour in medical diagnosis

It is not surprising that medical practitioners with colour vision deficiencies report difficulties in clinical work. The colours of the human body and its products in health and disease are commonly unsaturated (for example, pallor, jaundice, cyanosis and many rashes) or dark (for example, blood and motions) and these are the colours that those with a deficiency find difficult to discriminate, name and match, not just for red and green but across most of the spectrum. The names so commonly used in medicine indicate the importance of colour to the physician: melaena, rubella and scarlet fever are examples, yet it is difficult to be precise in many cases about the part that observations of colour play in arriving at a diagnosis. Colour seems to be more a sign that there is something wrong that needs attention rather than forming an integral part of the diagnosis, although the actual colour may give a clue to the nature of the pathology.

Some specific points concerning the work of the medical practitioner will illustrate the significance of this analysis in practice. The physician uses a scanning process as part of the examination of patients and their body products. It is known that it can be impossible for a person with a severe colour vision deficiency to distinguish by scanning some objects or variations in colour against certain backgrounds if they subtend an angle of less than two degrees at the eye.[22] In addition, cues to colours, so often used by those with a deficiency, are of no help if the colour cannot be discriminated from its background in the first place. With total body colour changes there can be an inability to recognise normality and to detect the milder cases of cyanosis and jaundice, and pallor even when severe. Sometimes these signs are pivotal,[23] in that if the sign is missed, the correct course of action will not be taken.

The visual display of information in charts and on computer screens often uses colour. This is a technology that is constantly changing and the changes do not necessarily conform to the needs of those with a colour vision deficiency.

It is possible that the primary care medical practitioners will be more challenged than the specialist because, when visiting a patient, he can often find himself working alone and in poor illumination. In

general, they have less control over their working environment than the specialist. There are many ways of overcoming these difficulties, for example, taking care over examinations and asking for help from others. Clearly, these could be useful but analysis suggests that they are not always practicable and there is evidence from the questionnaire study[17] that they are not always used. If aware of their difficulties, many experienced medical practitioners may have established by trial and error a *modus vivendi* with the effects of their deficiency but this must take time to learn and the question can be asked: is this at the expense of the patient? Clearly medical students may need help with the learning process.

The nature of the difficulty can be better understood by examining some specific problems. Retinal pigment and small retinal haemorrhages cannot always be distinguished by a protanope, even when a red-free lens is used in the ophthalmoscope. This lens will help the deuteranope. Therefore, it has been suggested that a protanopic ophthalmologist should not do retinal work.

The discrimination of blood from motion or dark vomit is not always possible for those with the deficiency. One practitioner with deuteranopia was told that she might sometimes find that she was not able to discriminate blood against the dark background of a body product. A year later, she wrote this to me, 'For the first time, I felt I could not tell what was in a bucket with vomit. I was not sure whether it was bile or blood—Oh dear! How many times have I been unaware of this?' The use of a peroxidase dip-stick might help but would produce a false negative, if a dark area not due to blood were tested when the blood was elsewhere in the sample. Photographic studies[19] suggest that this can occur. These studies also showed errors in matching colours in the use of Glucostix (Bayer Diagnostic), when testing blood glucose levels. Obviously, numerical display of readings would be a safer alternative but are not always used by the colour vision deficient physicians.[17]

The questionnaire study also revealed a group of medical practitioners with severe deficiencies, who believed that they had no or very few difficulties and that the few they had reported were of no significance. They did not give ways of overcoming difficulties and the above analysis suggests that it is likely that they were not aware of their failures of observation. Their seemingly contradictory viewpoint is one of the more compelling pieces of evidence that a real problem exists.

Failure of the medical profession to acknowledge and respond to the problem

There is a number of reasons for the profession not responding more actively to the problem presented by medical practitioners with colour vision deficiencies. There is an apparent conflict of evidence because of differences in severity and the varying demands of different types of work. There is the lack of awareness on the part of those involved, perhaps in part due to the lack of an audit of their performance in relation to this problem. There is also the sanguine attitude of many[17] who, despite their difficulties, believe that they are working effectively. In comparison with their challenging work, their problems due to colour vision must seem minor. I believe that the main reason is because a person who wishes to raise the topic and perhaps investigate it is presented with a dilemma. On the one hand, he will be reluctant to imply that his colleague has an innate tendency to make mistakes, particularly if that colleague's deficiency becomes public knowledge. On the other hand, if he does not act, errors may have harmful effects on patients. I hope that an understanding of the nature of the dilemma will at least initiate a process for resolution.

The help needed by practitioners with colour vision deficiencies

It is clear that medical practitioners would benefit from advice that enables them to work more effectively towards finding the best solution to their difficulties. Giving help depends on convincing them that it is needed and confronting the beliefs of those who claim that their condition causes no difficulty. Screening and testing for severity are the first steps. A manual of photographs[24] has been published with the aim of helping individuals become aware of the limitations caused by their deficiency. Some form of written advice would be helpful and there is a published article that gives advice on counselling[25] for the condition but it is not specifically for medical practitioners. If a medical student with a moderate or severe colour vision deficiency asked if it should influence his plan to become a general practitioner, my advice would be that it is not a wise choice and that there are many other branches of medicine that would be more suitable.

As for future research, assessment of the performance of physicians in practice may seem an obvious way of looking for objective evidence of errors. However, the problem with such a study is that it is unethical if the subjects are not aware that they are being studied and if they are aware, it might affect their behaviour so that the results would be unreliable. Medical students would provide good subjects. Their work is already being observed and judging by the comments of practitioners about their experiences as students, they would welcome it.

I believe that there is now sufficient evidence to show that colour vision screening is needed for entry into medical schools but the Japanese experience sounds a warning against a rigid attitude to the results. At present, the desire for harder evidence is standing in the way of needful action but, clearly, more evidence is needed. There should be a separate study of the colour vision requirements of each of the specialities in which colour plays a significant part: computer graphic methods of testing should become the preferred method. The quality of illumination in hospitals and surgeries also requires further study. Finally, I express the hope that the worlds of colour vision science and medicine will work more closely together on the subject of colour vision in the medical profession. They have a lot to learn from each other.

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