

Portraits in medical genetics

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John Dalton (1766–1844)

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SUMMARY There is no doubt that John Dalton ranks among the great names in science, a position which rests on his enunciation of the Atomic Theory. However, his very first scientific paper in 1798 was concerned with his own affliction of colour blindness and was in fact the first clear description of the disorder. This publication stimulated much subsequent research into the pathophysiology and genetics of the condition. His recorded observations on colour blindness are detailed and precise and betoken the approach which was to characterise all his later research in chemistry.



John Dalton, F.R.S.

John Dalton is famed for his enunciation of the Atomic Theory, that the atomic weights of different elements are not identical and that they combine in specific proportions. Dalton was also colour blind and his account of the disorder in 1798 was the first detailed and lucid description of the condition.¹ In Europe this is still sometimes referred to as 'Daltonism' though earlier English writers objected to this usage as they considered it detracted from his more fundamental and important contribution to science.²

History of colour blindness

There have even been colour blind painters, such as Charles-Pierre Colardeau and Fernand Léger, and since the effects of colour blindness are so obvious it would seem to be a condition that would have attracted much attention and interest from the earliest times. Plato was possibly the first to suggest that different colours do not appear the same to all people, for in his *Theaetetus*,³ a discourse on the nature of knowledge and perception, Socrates makes the point:

“ . . . that what we call a colour is peculiar to each percipient; are you quite certain that the several colours appear to a dog or to any animal whatsoever as they appear to you?”

However, Aristotle in his *History of animals*⁴ was quite content to conclude that, apart from the mole, all animals:

“ are endued with the perception of colours, sounds, smells and taste”.

Despite its apparent novelty the subject does not seem to have been discussed by subsequent authorities until the 17th century. Robert Boyle apparently described a case of colour blindness in 1688,⁵ but I have been unable to trace this reference. The first documented case seems to have been a report in 1684 by Turberville,⁶ an oculist from Salisbury, of a young woman who may have been totally colour blind because:

“ she could see very well, but no colours beside black and white”.

However, it is feasible that she may have had a psychiatric disorder because:

“She had such scintillations by night (with the appearances of bulls, bears, etc) as terrified her very much; she could see to read sometimes in the greatest darkness for almost a quarter of an hour.”⁶

Porterfield in his *Treatise on the eye*⁷ published in 1759 was convinced that colours appeared differently to different people though he makes no mention of colour blindness per se. One G Palmer wrote on colour vision in 1777 and subsequently in 1786 and may well have been aware of colour blindness.⁵ However, the first clearly documented case of the disorder is generally attributed to Huddart in 1777,⁸ who described a Thomas Harris, a shoemaker from Maryport in Cumberland, who at the time was said to have two similarly affected brothers. This family was subsequently re-examined and extended by Crerar and Ross⁹ in 1953 who determined that in fact four brothers had been affected. Furthermore, Thomas Harris himself later had a daughter who had an affected son. Then in 1778, Scott,¹⁰ who was himself colour blind, reported that his father, his mother's brother, his sister, and her two sons were similarly affected (to account for this pedigree his mother was presumably also heterozygous). However, the most detailed and clear description of colour blindness was provided by Dalton.

Dalton's description of colour blindness

Dalton's very first paper was on colour blindness and was read before the Manchester Literary and Philosophical Society on 31 October 1794, the same month in which he had been elected to Membership of the Society. The paper was published in the

Memoirs of the Society in 1798. Since 1790, through his studies of botany, he had become aware that he could not distinguish certain colours:

“I have often seriously asked a person whether a flower was blue or pink but was generally considered to be in jest.”

He goes on:

“I was never convinced of a peculiarity in my vision till I accidentally observed the colour of the flower of the *Geranium zonale* by candle-light in the autumn of 1792. The flower was pink, but it appeared to me almost an exact sky-blue by day; in candle-light, however, it was astonishingly changed, not having then any blue in it, but being what I called red, a colour which forms a striking contrast to blue.”

Later he states:

“Blood appears to me not unlike that colour called bottle-green. Stockings spotted with blood or with dirt would scarcely be distinguishable.”

And with regard to green:

“I take my standard idea from grass. This appears to me very little different from red. The face of a laurel-leaf (*Prunus Lauro-cerasus*) is a good match to a stick of red sealing-wax; and the back of the leaf answers to the lighter red of wafers. Hence it will be immediately concluded that I see either red or green or both, different from other people.”

He describes in detail how each colour of the spectrum appeared to him both in daylight and candlelight:

“I see only two or at most three distinctions—these I should call yellow and blue; or yellow, blue and purple. My yellow comprehends the red, orange, yellow and green of others; and my blue and purple coincides with theirs. That part of the image which others call red appears to me little more than a shade or defect of light; after that the orange, yellow and green seem one colour which descends pretty uniformly from an intense to a rare yellow, making what I should call different shades of yellow. The difference between the green part and the blue part is very striking to my eye: they seem to be strongly contrasted. That between the blue and purple is much less so. The

purple appears to be blue much darkened and condensed.”

Expert opinion suggests that he was probably a protanope.¹¹

Having described his own colour vision defect in some detail he then proceeds to mention others with a similar peculiarity of vision including his own brother and:

“ out of 25 pupils I once had, to whom I explained the subject, two were found to agree with me; and on another similar occasion, one.”

And in considering cases he was aware of, concludes significantly:

“I do not find that the parents or children in any of the instances have been so, It is remarkable that I have not heard of one female subject to this peculiarity.”

Finally he described the possible mechanism of the defect by supposing that:

“ one of the humours of my eye must be a transparent, but coloured medium so constituted as to absorb red and green rays principally because I obtain no proper ideas of these in the solar spectrum; and to transmit blue and other colours more perfectly.”

He instructed that a postmortem examination should be made in order to verify his ideas. In accordance with his wishes one of Dalton's eyes was examined after death by Dr J A Ransome, a former pupil and later friend and medical attendant, who found nothing to account for the defect and that colours appeared as usual through it.¹² It is now known of course that colour blindness results from a defect in the perception of colour by the retina. Nevertheless, there is no doubt as Bell¹³ concluded:

“Dalton's memoir is of great importance from the historical aspect of our subject, and marks the inauguration of an epoch characterised by untiring efforts to understand the mechanism of colour vision and the source of the defect in the colour-blind.”

Currently, four main types of colour blindness are recognised: achromatopsia (total colour blindness) inherited as an autosomal recessive trait, and protan (red blind), deutan (green blind), and tritan (blue blind) defects due to different closely linked loci on the X chromosome.¹⁴ The subject has recently been

extensively reviewed by Pokorny *et al*¹⁵ and Mollon and Sharpe,¹⁶ though much useful information is still to be found in the short text by Kalmus.¹⁷

John Dalton the man

Much has been written about Dalton, both of the man himself as well as of his scientific researches. Early works with many personal details include Henry,¹⁸ Smith,¹² Lonsdale,¹⁹ Roscoe,²⁰ and more recently Brockbank,²¹ Partington,²² and Greenaway.²³ A detailed, precise, and full bibliography of works by and about Dalton is provided by Smyth,²⁴ honorary librarian of the Manchester Literary and Philosophical Society.

Dalton was born at Eaglesfield, a village near Cockermouth, Cumberland, in 1766, but the exact date does not seem to have been recorded, though later it was presumed to have been 5 September.¹² Both his parents were Quakers, a following to which Dalton belonged all his life. His beginnings were humble: his father was a weaver and his mother eked out the family income by selling paper, ink, and quills. Dalton received his earliest teaching from his father, but later attended the local school where he was said to be steady and persevering but not brilliant. When he was 12 he set up a school himself, at first in a barn and then in a Quaker meeting house. In his late teens he moved to Kendal where, with his brother, he taught Greek, Latin, French, and mathematics as well as English. In fact he wrote a school textbook of English grammar though it never became popular. His interests at this time were mainly mathematical. Like Mendel, he became particularly interested in meteorology, and kept careful meteorological records throughout his life. It was probably around this time that the story originated of Dalton buying a pair of fine silk stockings for his mother which elicited her comment:

“Thou has brought me a pair of grand hose, John, but what made thee fancy such a bright colour? What I can never show myself at meeting in them!”

John was somewhat abashed for to him they appeared rather dark and drab but they were in fact cherry red! (Lonsdale,¹⁹ p 99.) He made a similar mistake some years later when he was planning a visit to Paris and needed a new suit. He chose a cloth which seemed of good quality and the right colour, only to be told by the tailor that it was in fact scarlet for hunting coats and of course not at all befitting a Quaker! (Lonsdale,¹⁹ pp 118–9.)

There is evidence that in his twenties he seriously

considered studying medicine at Edinburgh and wrote to various friends and relatives for their advice. The general feeling seems to have been that they thought he would be better continuing his work as a schoolmaster (Brockbank,²¹ pp 8–10). It is not clear how he reacted to this, but at the age of 26 he was appointed tutor in mathematics and natural philosophy in New College, Manchester, where he also taught chemistry. After six years as a tutor in the College he left to do private teaching on his own account and to carry out research in chemistry, a subject in which he had developed a special interest. After a few years, in 1794, he was invited to become a member of the Manchester Literary and Philosophical Society, with which he retained a life long interest, becoming Secretary in 1800, Vice-President in 1808, and President from 1817 until his death in 1844. He read 116 papers to the Society, the first, as we have seen, being on the subject of colour blindness.

Dalton was a self-taught investigator and a dedicated research worker. His apparatus was often extremely simple but effective. For example, he often used ink bottles for his experiments. According to Partington²² he had the true investigator's gift of finding the right result almost by intuition, possibly also like Mendel. For a time he lived with the Rev W Johns, his laboratory being in the rooms of the Philosophical Society. After leaving the Johns in 1830 he lived the rest of his life at 27 Faulkner Street, Manchester, having a housekeeper. He never married though it is clear that he did not find female company unattractive. Once when asked why he did not marry he remarked, "Oh! I never had time." He was a man of very regular habits, leaving for his laboratory each morning at around 8 o'clock to light the fire, returning home for breakfast, then to the laboratory until dinner time, returning when the meal was nearly over, then again returning at 5 o'clock for tea, still in a hurry, and again to the laboratory until 9 o'clock when he returned for supper, after which he smoked a pipe before retiring for the night. Once a week he played bowls with friends and for holidays often went walking in the Cumbrian hills which he so loved. He was well built and enjoyed robust health all his life until April 1837 when he suffered the first of several strokes from which he never entirely recovered. He had further attacks in February 1838 and in May 1844. On the morning of the 27 July 1844 around 6 am he was found dead in his rooms. He had continued to work right to the very end and in fact his last meteorological recording is dated the day before his death.

In his lifetime he had many honours bestowed upon him for his development of the Atomic

Theory. At first he declined to offer himself as a candidate for Fellowship of the Royal Society of London in 1810, but 12 years later he accepted and in 1826 received the Society's Royal Medal. Around this time there were also moves to propose him for a Knighthood but he refused to accede. In 1816 he was elected a corresponding member of the French Academy of Sciences and later, in 1830, one of the Academy's eight foreign associates. In 1832 the University of Oxford conferred on him the honorary degree of DCL (Doctor of Civil Law) and two years later the University of Edinburgh conferred on him the degree of LL.D (Doctor of Laws). After his death subscriptions were collected in Manchester which provided for a monument over his grave in Ardwick cemetery, a bronze statue in the Infirmary, and several scholarships for students at Owen's College, later to become the University of Manchester. The scholarships were in Mathematics and Chemistry, and there was also a Natural History Prize in Zoology, Botany, and Geology, of which the present author was a fortunate recipient in 1952. The promotion of scientific research through these scholarships was, at the time, apparently unique in academic life.²⁰ In 1903 at the centenary of the Atomic Theory, Professor van't Hoff of Berlin laid the foundation of a University laboratory to bear Dalton's name.

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