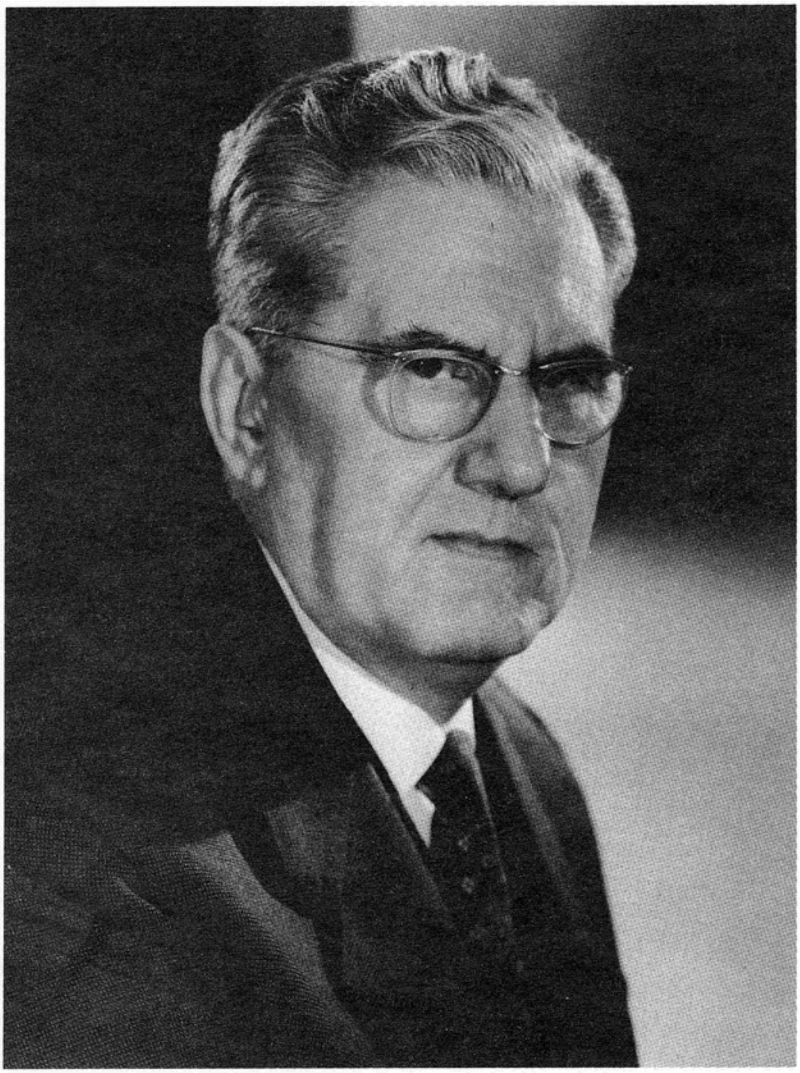

W. S. Stiles.

Perception, 1986, volume 15, pages 657-666

Walter Stanley Stiles 1901-1985

Stanley Stiles (as he liked to be known) was born on 15 June 1901 and died on 15 December 1985. He was one of the most distinguished visual scientists of our century.

Stiles was educated at the Polytechnic Secondary School, Regent Street, London. He entered University College London, with an Andrew Scholarship in 1918 and graduated in physics in 1920. After continuing at University College for two years as a Demonstrator under Sir William Bragg, he spent the year 1922-1923 reading mathematics at St John's College, Cambridge. He joined the National Physical Laboratory in 1925, and—though often tempted to move when promotion was slow during the nineteen forties—remained there until his retirement in 1961. He was created OBE in 1946 for his wartime work on visibility, visual search, and the defensive use of dazzle. He was elected to the Royal Society in 1957, and was awarded the Tillyer Medal of the Optical Society of America in 1965. He served as General Secretary of the Commission Internationale de l'Éclairage from 1928 to 1931, was Chairman of the Colour Group of Great Britain from 1949 to 1951, and was President of the Illuminating Engineering Society from 1960 to 1961.

Above all, Stiles was a great psychophysicist. G Brindley, when introducing in his textbook the distinction between Class A and Class B observations, took Stiles as the prototype of those psychophysicists who base their arguments only on Class A observations, that is, on matches and thresholds. In his published work Stiles almost always eschewed Class B observations, in which the subject must describe the quality or intensity of his sensations. In his Foreword to Pirenne's *Vision and the Eye* (1948) he applauds the author for "the avoidance of arguments founded on introspective descriptions of sensations, which are notoriously difficult to interpret correctly". His psychophysical doctrine is well captured in an exchange with Dr R Hunt that has been preserved for us by the editors of the Helmholtz Memorial Symposium held at Driebergen [J J Vos, L F C Friele, and P Walraven, 1972 *Color Metrics* (Soesterberg: Institute for Perception TNO), page 118)]:

> "**Hunt:** I think Dr Stiles should explain how he can study colours and dispense with sensations.
>
> **Stiles:** You put a man down behind a colorimeter, you guide his hand to three knobs and let him go ahead.
>
> **Hunt:** This tells you everything?
>
> **Stiles:** Of course not. But you ask him to make certain settings based on the appearance of the colorimeter field. You draw your conclusions from the relations between the stimuli exposed in the fields, and the settings he makes. In expressing these relations it is not necessary to claim one is 'measuring a sensation' or in fact to 'regard a sensation' as having any particular meaning as scientific term. Of course, the word 'sensation' may be used colloquially to explain to the observer what you want him to do."

In his own experimental work, Stiles showed us how powerful could be the conclusions drawn from a structured set of Class A observations. In the increment-threshold technique, novel when he introduced it in 1929 but now part of the standard armoury of psychophysics, a brief test flash serves as a probe to determine the sensitivity of the retina at a particular point in time and space. An important variant of the technique was his two-colour method, in which a monochromatic increment is delivered on a monochromatic field. This method has been widely used to test the presence and sensitivity of individual classes of receptor in normal and abnormal vision.

But the most important of Stiles's contributions to visual psychophysics was the model that lay behind his use of the two-colour method. His concept of a 'mechanism' has subsequently been extended to other sensory dimensions, such as spatial frequency, and it is now commonplace in visual science to test for the existence of 'channels' that are independent in adaptation and in detection. Pamela Fowler, who worked as Stiles's assistant from 1947 until his retirement, recalls above all his reluctance ever to discard an anomalous reading: however aberrant a data point might seem at the time, there had to be a reason for the aberration and the anomaly might later prove significant. Stiles was always the first to point out departures of his own data from his model. These scruples were rewarded. For many anomalies and minor inflexions in Stiles's early increment-threshold results have since turned out to be important phenomena in their own right.

Among the other scientific achievements for which Stiles will be remembered are his discovery, with B H Crawford, of the directional selectivity of the cones, and the change in colour of monochromatic lights when the point of pupil entry is displaced; his concept of the 'equivalent background'; his discovery, with M Aguilar, that the rods saturate at photopic levels; his line-element analyses of colour discrimination; his demonstration, with R M Boynton and M Ikeda, of inhibitory interactions between test flashes of different wavelength—perhaps the first use of Class A experiments to demonstrate opponent processes; and his measurements, with J M Burch, of the large-field colour matches of over fifty observers, measurements that served as the main basis for the CIE 10-deg standard adopted in 1964.

Intermittently from 1928 onwards, and more systematically after 1944, Stiles kept a series of notebooks that constitute an intellectual and scientific journal[(1)]. Pamela Fowler vividly remembers the ever-present pot of paste kept on his desk for the purpose of sticking jottings, cuttings and correspondence into the notebooks. In his lifetime the notebooks became a legend, and internal detail indicates that he intended them to survive him. R A Weale [1986 *Nature (London)*, **319** 623] has described how, during the war, Stiles would amass the notebooks under his arm whenever air-raid sirens sounded. There is indeed much in the notebooks that was published only long afterwards or was never published at all. Here are a few examples:

(i) *March 1932.* Notes on the relationship between the number of quanta absorbed at absolute threshold and the slope of the psychometric function. (Initially Stiles had the mistaken idea that the slope would depend on the wavelength; but this error was corrected by 1934.)

(ii) *March 1945.* Increment-threshold measurements on a cone monochromat. For the condition λ = 480 nm, μ = 600 nm, at high field intensities, there appeared to be two distinct thresholds for the short-wave test flash, a lower one where it was visible as a patch darker than the field and an upper one where it was visible as a patch brighter than the field; in the interval, the target was of "equal density with the field".

(iii) *January 1947.* First proposal for a test-additivity experiment. Targets of 490 and 690 nm would be used to isolate the rods and cones respectively and a weak blue-green background would be added "to knock out with certainty rod vision of λ = 690".

The notebooks, with their many tables, provided a basis for *Color Science* (1967, 1982), which Stiles wrote in collaboration with Günter Wyszecki and which will long

(1) After his death, Mrs Stiles deposited the notebooks, and other papers, with the Archive Room of the Cambridge Psychological Laboratory. The material is registered with the National Registry of Archives and can be examined on prior application to the Librarian, Department of Experimental Psychology, Downing Street, Cambridge.

remain a definitive handbook in the field. Wyszecki was one of Stiles's closest friends, and at the time of his own death, Stiles was at work on a memoir of Wyszecki. The friendship between Stiles and William Rushton—although its public legacy was less tangible—was also critical in the development of visual theory. From Stiles, Rushton drew the Principle of Univariance, which is explicit but unnamed in Stiles's "Spectacle makers" paper of 1948 and which provided the bedrock for so many of Rushton's experiments. And it was Rushton, during the 1960s, who did much to draw attention to Stiles's obscurely-published papers on π-mechanisms. The esteem in which these two visual scientists held each other is witnessed by the many letters from Rushton that Stiles has pasted into his notebooks, sometimes beside his draft reply.

If a man is to be remembered by his friends, then it is proper that his rivals too should be recorded. There was one rival who did bother Stiles, and that was the brilliant Dutch physicist, Hessel de Vries. During the 1940s, de Vries independently worked on issues and methods that were close to those that concerned Stiles: the quantum nature of vision, the effect of temperature on sensitivity to long-wave light, the derivation of cone sensitivities by the two-colour method, Weber fractions and the line-element, the anomalies of the blue mechanism. Two of the devices that became part of the modern Stilesian canon—the auxiliary field and the field-additivity test—were first introduced by de Vries. It must indeed have been disturbing to Stiles to hear so many of his own ideas elliptically expressed in the paper that de Vries gave to the Optical Congress in Paris in 1946. In later years Stiles always changed the topic when de Vries was introduced into conversation, but in his final retrospective essay (printed in this issue of *Perception*) he acknowledges both the cleverness of de Vries and the discomfort he felt about him.

During the war, as a result of his service on the Vision Committee, Stiles came to know Kenneth Craik. When Craik was killed in a road accident on the eve of VE Day, Stiles was prompted to a characteristic note in his journal, a note that we are surely intended to read and one that says something about both men:

> "**10.5.45.** Learnt today that K. J. W. Craik was knocked down and killed in a road accident in K. P. [King's Parade] Cambridge.
> Craik had an active, brilliant mind and unlimited energy. Much of his war work has been necessarily of rather sketchy and slapdash character but he would in all probability have produced work of the finest quality in psychology had he lived. Personally, Craik was most likeable and he seemed to take no pleasure in the gossip and backchat against persons which has unfortunately played a part in the Vision Cttee's activities. We got on well enough, although I felt sometimes that he maintained to me a reserve not apparent in his relations with the younger men (Goldie, Robertson etc). Perhaps I fell short of his high standards or possibly, being human, he felt that our lines of work were so close that he and I must necessarily be rivals despite the great difference of age. He is a loss to science."

Owing to his mathematical prowess, his reserved nature, and the uncompromising precision that he brought to scientific argument, Stiles was a formidable figure for many visual scientists. From his assistants he expected a formal manner of address. But he showed himself a man of great kindness in the guidance and tactful encouragement he gave to younger workers. On public occasions, he enjoyed the rare talent of being able to express exactly the right sentiment with exactly the right words. He shared 57 years of marriage with his wife, Pauline ('Polly'), the daughter of Judge Henrik Brendstrup, of Hillerod, Denmark. Polly herself died on 6 April 1987.

Although he was celebrated for avoiding subjective description in his scientific work on colour, Stiles privately delighted in the richness of our internal palette. Occasionally he did allow himself to record the appearances of the stimuli in his colorimeter (see the paper by Pugh and Kirk in this issue, and plate 1), and in his retirement he became an accomplished amateur painter. During his working life, however, he had little taste for conventional hobbies or sports. He enjoyed holidays spent with his father at Groombridge in Sussex, and with Polly's family in Denmark. But his main recreations were cerebral. He read widely in modern history, literature and philosophy, admiring Pope, H G Wells, Trollope, Galsworthy, and Eddington. He was a member of the British Psychological Society and records listening to papers by Burt, Thouless, and Eysenck at the Oxford meeting of 1943.

Above all, it was with mathematics that Stiles occupied his spare hours, filling many ledgers with notes. In his wartime journal he wrote:

> "Repairs to binding of Caratheodory's 'Real Functions' and Hardy's 'Pure Maths', two books the study of which has given me more pleasure than any other works of science."

He had left Cambridge prematurely in 1923 after securing only a second class in Part I of the Mathematics Tripos. This always rankled with him, and passages in his notebooks reveal his recurrent doubt as to whether he should leave the backwater of visual science and pursue a career in mathematics or theoretical physics. In July 1944 he wrote of our field:

> "The phenomena are so numerous and apparently incoherent and the difficulties of reproducing results are so great that the interest of any theory can be only very limited. The 'unreal' world of pure mathematics is so much better behaved. Researches on vision entail a lot of hack work—an enormous pudding of rather unsatisfactory observation with one small plum of scientific interest."

But, on this occasion as on others, the doubts passed: by October of 1944 he could write

> "Back at work on threshold apparatus. Something of a thrill again to probing the mysteries of retinal sensitivity"

and by Christmas (despite the night-time distraction of flying bombs and his daytime duties as Chairman of the Goggles Subcommittee) he had established the variation of the cone sensitivities across the fovea, the low acuity of the short-wave mechanism, the slow adaptation of that mechanism to long-wave fields, and the variation between observers in its sensitivity.

Any complete account of Stanley Stiles must record his indifferent health. Over many years he suffered from migraine, from a stomach ulcer, and from tinnitus; and he

Plate 1 (see facing page). A rough chalk drawing stapled into Stiles's notebook for 23.1.55. The coloured discs are clearly intended to represent the appearance of Maxwell's spot when metameric colour matches are made for a 10-deg field. The faint five-digit number chalked against each disc indicates, as a wavenumber, the variable component in the match. The conditions thus are as follows:

Wavenumber/cm^{-1}	Wavelength/nm	
	in upper field	in lower field
16250	615 (+445)	650+526
17000	588+445	650+526
18500	541+445	650+526
19750	506+650	526+445
20750	482+650	526+445
21750	460+650	526+445
24750	404+526	445+650

When a perfect match has been achieved for the outer parts of the field, an inhomogeneity—Maxwell's spot—remains in the centre.