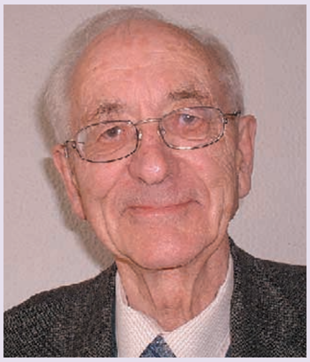
E. Geoffrey Walsh

1922 - 2003



Geoffrey Walsh was born in Cheltenham on 25 November, 1922. After education at Cheltenham Grammar School (1932-1940) he won a Scholarship to Exeter College, Oxford University to study medicine. He graduated BA with 1st class Honours in Animal Physiology in 1943, winning several undergraduate prizes.

Geoff began his research career in neurophysiology in 1944, still at Oxford, and published a Physiological Society communication with David Whitteridge that year. He then spent two years as a Rockefeller student at Harvard University, gaining an MD. Returning to Oxford, he graduated MA, BSc and BM BCh in 1947, and pursuing further clinical training gained the DTM & H at Liverpool University in 1948, worked for a while as a ship's surgeon, and qualified MRCP (London) in 1950. The next year he joined David Whitteridge, who had moved to the Chair of Physiology in the University of Edinburgh, as a Lecturer in the Department of Physiology.

His research was focused on the challenges of investigating neuromuscular control in humans, with a particular interest in the effects of vestibular dysfunction, and thus in the neurophysiological basis of balance, and of tremor. His research aims were generally directed towards understanding clinical neurological disorders, and to this end he was a part-time electroencephalographer in the Royal Infirmary of Edinburgh (1951-54), then an Honorary Consultant for the South East Scotland Regional Hospital Board (1957-63), later studying paraplegic patients, and in his last years he was Honorary Neurophysiological Specialist at the Royal Hospital for Sick Children, Edinburgh. This last appointment recognised his long interest in the motor control problems of spastic children, and led to studies on the shaken baby syndrome.

Meanwhile, his original research and scholastic contributions, ably described in Martin Lakie's tribute, and including his book *The physiology of the nervous system* (published first in 1957, and in a 2nd edition in 1964; translated into several languages) led to promotion to Senior Lecturer and finally Reader in 1967. His original contributions to human neurophysiology were recognised by Fellowship of the Royal Society of Edinburgh, in 1959, and his continuing interest in clinical problems by the award of Fellowships of the Royal Colleges of Physicians of both London (1967) and Edinburgh (1968). For example, in 1963-64, while a WHO visiting Professor at the Baroda Medical College in India, he advised the Tuberculosis Chemotherapy Centre in Madras on testing to identify vestibular damage from anti-tubercular drugs.

All the while Geoff was an active and loyal member of the Physiological Society, very frequently giving oral communications, and especially demonstrations at meetings of the Society. He was a member of the Editorial Board of *The Journal of Physiology* (1965-1972), a member of the Society's Committee (1983-86), and played a key role in the organisation of Society meetings in Edinburgh.

Geoff was bemused and dismayed by the academic leadership problems that beset the Edinburgh Medical School's Department of Physiology in the 1980s, and were still unresolved at his retirement in 1990, but, keeping close links, he enjoyed seeing the Department subsequently recover and flourish in the next few years. Geoff's valued contributions to teaching undergraduates, and the fact that he was continually research active for nearly 60 years, as evidenced by his publications, led the University of Edinburgh Medical School exceptionally to repeatedly renew his post-retirement Honorary Fellowship, which he still held on his death on 26 March, 2003 at the age of 80 years.

Geoff was particularly pleased to be awarded an extra-mural Professorship by the University of Central England in 1998, and the title of his inaugural lecture makes plain the multiple facets of his interests in human neurophysiology, including his late-developing interest in the fine control of finger movements in musicians, alongside his own learning of how to play the flute and the saxophone: '*Movement control in normals, the disabled and musicians: muscles, medicine and Mozart*'.

Geoff's wife, Penny, a charming, strong and supportive companion, died in 2000, and they are survived by three of their four daughters, and grand-children.

John A Russell
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Martin Lakie adds:

I first met Geoff Walsh 30 years ago. I was then a callow undergraduate student of physiology at Edinburgh. At this time I first entered the rather gloomy basement which housed the Human Neurophysiology Lab, and the intriguingly named Special Senses Lab, which were presided over by Dr E.G. Walsh and his technician Mr G. Wright (no first name status in those days). The labs and his office were very often home to Geoff's Dalmatian dog, Tasha. Experimental classes for students were overseen by the two gentlemen. For these teaching sessions, Geoff would often wear his off-white lab coat which resembled, and might well have been, a nightshirt of the Victorian period. Centre stage was occupied by a huge parallelogram action see-saw by which recumbent subjects could be propelled through a distance of a couple of metres towards the ceiling or floor. This apparatus had been built in order to test the vestibular sensitivity to linear acceleration in the saggital plane (Walsh, 1964a). These experiments, and others involving rotational vestibular stimulation were naturally popular with students who competed to achieve the highest velocities. Some years earlier there had been another apparatus that measured vestibular sensitivity in the transverse direction. To reduce shear forces on the skin the supine subject (breathing through a mouthpiece and valve) was entirely immersed in a deep coffin shaped tank of water suspended from the ceiling. In action, the water would slosh about and to minimise this disturbance it was rendered more viscous by the judicious admixture of wallpaper paste and sawdust. The subjects indicated that they had detected the stimulus by tapping with a hammer on the floor of the tank. Their reaction to the procedure is not reported (Walsh, 1961)

I remember at the time being impressed equally by the ingenious nature of the experiments and by the discovery that most of the apparatus had been cleverly constructed from a combination of vehicle, aircraft and marine scrap. There was, as I later discovered, an even deeper basement packed with gleanings from scrap-yards and surplus stores. Geoff's main early interests had been the sensory nervous system and he had an impressive number of publications on this work under his belt, and his erudite, entertaining and eclectic book (Walsh, 1964b) enjoyed a wide readership.

Working with Horace Barlow he had published two papers in 1947 on electrical and magnetic stimulation of the visual cortex (Barlow et al. 1947a, b). Half a century later Magstim experiments are now much in vogue. There was an early paper in *Nature* with Heinz Wolff (Walsh & Wolff, 1951) on the design of a novel beam splitting spectrophotometer. There were many papers on various aspects of vestibular sensation in animals and man. From this basis, his attention had broadened to encompass standing and balancing mechanisms, postural stability and instability and in particular, tremor.

I subsequently came to know Geoff well as I did a PhD under his supervision and worked with him as a postdoc for a number of years and we kept in touch thereafter. His industry, intelligence and enthusiasm were formidable and a little frightening at first. Fortunately, these characteristics were offset by a delightful sense of humour which was without doubt the driest that I have ever encountered. Although possessed of a dry sense of humour there was nothing arid about the man who had the most genuine curiosity about, and interest in, all aspects of life. He was in the true sense of the word a polymath. He once declared that it was his ambition to understand all scientific subjects to at least first year undergraduate degree level. As well as working hard in his spare time to achieve this ambition he also painted and played the flute. He was to some extent an iconoclast who cared little for uninformed opinion. It is hard perhaps to remember a time before the ubiquitous Walkman clamped over the ears became a commonplace. Many years ago I watched Geoff waiting in a busy public area of the Western General Hospital in Edinburgh as we whiled away the time before starting an experiment. He had over his ears a large pair of bright red earphones. Between the earphones was a centrally mounted radio receiver and a short vertical whip antenna sprouted from his head. The strains of Radio 3 were just audible. He gave every appearance of being oblivious to the interest that he was creating.

Although he was a scholar who loved to read and to write it is perhaps for his experimental work that he will be best remembered. He was an enthusiastic radio amateur and a very skilled builder of electronic apparatus, often of a high degree of complexity. The seamless transition from valves to transistors to integrated circuits and latterly to computers cannot have been easy to make. His electronic design ability was remarkable and he built a great number of novel circuits to carry out often complex analogue processes. While the design was invariably excellent, the standard of construction was often less perfect. Experiments would sometimes be punctuated by flashes, bangs and blue smoke as wires made accidental contact. On one memorable occasion a Physiological Society demonstration very nearly came to grief when widespread short-circuiting was found to have occurred because several of the rubber bands holding the circuit boards in place had perished. Such a technical malfunction would invariably trigger a reaction resembling that of a parent exasperated by a non-cooperating child. There would be an initial astonishment at the unexpected event, followed by a period of tutting and mild irritation as repairs were effected. This was characteristic; although an individual of very strongly held beliefs and principles he never publicly expressed more than a puzzlement and irritation at life's tribulations.

He was interested in travel and transport. Well known in Edinburgh was the steam car that he had designed and built although when I first knew him he generally travelled by motor-bike. There was a spare crash helmet and he would sometimes offer the unwary or naïve a lift on the pillion seat. With a group of researchers he measured head oscillations of volunteer railway passengers in a train consisting of different models of carriage (Walsh, 1966). This train was specially run for the purposes of measurement on the East Coast line between Edinburgh and Newcastle. (He was particularly fond of the account of this work that appeared in *The Times* under the neat caption 'Heads roll on the 09.45'). He investigated in person the motion sickness caused by the effect of swaying gait of camels.

It is perhaps difficult to say what his main scientific interest was, but I would judge that his research always centred on recording and measurement, usually employing some highly original technique and self-constructed apparatus. If Geoff's research programme was perhaps less focussed and more curiosity-lead than would be generally approved of nowadays he nevertheless pursued important and complicated problems. Working sometimes on his own, but more commonly with a small number of colleagues, he made and is remembered for fundamental discoveries in four important areas.

First (Marshall & Walsh, 1956), there was his suggestion very nearly 50 years ago that physiological tremor represents in the main filtered noise which is generated by random motor unit activity. To this might be added the subsequent demonstration that it is the resonant properties of the limbs that imparts a colouration to the noise and gives it the appearance of a tuned oscillation. He was dismissive of 'tremor generators'.

Second (Walsh, 1969), he was one of the first to investigate the entrainment of pathological tremors using torque motors to 'drive' a limb. This ingenious approach can, in principle, distinguish between an oscillator which is autonomous and one which results from a process of self-re-excitation by a feedback mechanism. However, the resulting analysis is fraught with difficulties.

Third (Walsh, 1970), he was the first person to employ positive velocity feedback (negative damping) in order to make the human musculoskeletal system unstable and resonant. This technique has been recently used to study the operation of the CNS controller.

Finally (Lakie et al. 1984), following some pioneering work on the measurement of human muscle tone, he was able to demonstrate that human muscles behaved thixotropically, that is they had a stiffness which depended not just on the size of a movement but also on their history of movement. The implications that thixotropy has for the control of movement and the cause of the phenomenon are subjects which are currently receiving widespread attention.

Geoff maintained an active interest in research beyond retirement. He wrote his second book and finished a draft of a third. He had a laboratory built in his garden and he vigorously pursued the study of skilled finger movements in musicians and others. His findings were published on a regular basis right up to the time of his death. The possessor of an excellent memory, he was a fascinating source of recondite information on many aspects of neurophysiolog to the end of his life.

He was a colourful inhabitant of an earlier more colourful world. A world where the scope of scientific investigation was usually limited by the apparatus that could be constructed and the skill and intelligence of the investigator rather than by the size of the research grant that could be obtained. A world where intended learning outcomes, research assessment exercises, cost centres and teaching quality audit did not exist, yet good research was done and students were taught well. He once told me that he loved his job because he was paid for doing what he enjoyed most. That made him an amateur in the best sense of the word. Neurophysiology has lost one of its pioneers and the world is a greyer place for his death.

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Special senses teaching in Edinburgh

Andrew Packard reminisces on some of Geoffrey Walsh's ingenious additions to the Physiology Department's basement

My last 'phone call with Geoff Walsh in early March was about a version of the 'Asher Box' (Asher, 1950) (Fig. 1) I had built for students at Stanford University's Hopkins Marine Station. This box illustrates the simultaneous contrast illusion and opponent processing that takes place at the level of the retina.

Geoffrey, with his gift for resurrecting practical demonstrations from the literature, had had a copy of the original built by George Wright for small class teaching in the Special Senses lab at Edinburgh. The apparatus had a bulb in each of four chambers, those in the front chamber – the 'surround' of the visual stimuli – being operated by separate switches. I thought he would appreciate my cut-price version made out of a shoe box with only a single, external, source of illumination. Apart from its ease of construction, the subtleties of centre-surround phenomena can be better demonstrated by dispensing with fixed light sources. Tracing paper in the cut out lid diffuses light from a lamp at the viewing end and students can see for themselves the effect of screening one, and not the other, of the front chambers, while leaving the rear ones, providing the 'centre', unchanged.

In my experience, Asher's psychophysical demonstration of the simultaneous contrast illusion is more effective than any of the better-known ones appearing in textbooks on vision.

Over the years, EGW and Hugh Begbie had added several ingenious pieces of apparatus to the special senses lab in the Physiology Department basement. At the bottom of the stairwell stood a huge swinging bed – a left-over from the period when EGW had a project on motion perception with British Rail. (They had lent him a train for a week operating out of Waverley station). On the bed would be a blindfolded student with a second in attendance recording sensations.

When I joined them in 1969, I was particularly intrigued by the things for vision - Begbie's speciality. There was a large bright (? xenon) lamp with filter in the far blue to see one's pulse and the trails of circulating rouleaux, while fixating a cross in the middle of the screen. When the blue

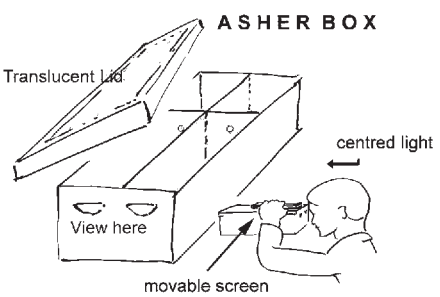

Figure 1. The Asher Box

The 'Asher Box' (Fig. 1), for demonstrating centre/surround properties of visual units, is made of two cardboard shoe boxes, with grey (or white) interiors, one for viewing and the other cannibalised to make internal partitions.

The viewing box is divided longways down the middle by one partition, and crossways by a second three-fifths from the viewing end to make four rectangular chambers. Two circular holes (c. 6 mm diameter) are punched in the cross partition with a leather punch or cork borer about two thirds up from the floor of the box on either side of the middle partition. [Find cork borer sets hidden away in old lab cupboards]. The flat part of the lid of the shoebox is cut out and replaced by tracing paper to act as a diffuser of overhead light. Spectacle-shaped apertures are cut in the end wall of the box for looking into the larger (front) chambers. The viewer sees one hole through into the rear chamber with the left eye, the other hole with the right eye.

In Asher's original design [as used in Edinburgh], the chambers were illuminated by four lamps: the two rear chambers by a 'pea-lamp' from a torch battery, the two front chambers by brighter lamps each with its own switch. In my version, illumination is from an overhead light, the relative positions of lighting and box being so adjusted that left and right sides are lit equally and the front chambers are brighter than the rear ones. The two holes in the cross partition should then appear of equal grey level. In the main experiment, illumination of the two rear chambers remains equal and unchanged.

The version created for teaching in Edinburgh had a stereoscope in the place of the peepholes for the two eyes, and one hole in the cross partition was higher than the other, but I find stereospecs are not necessary.

Uniformity of surfaces in the apparatus is unimportant; contrast is all-important. (A miniaturized photographic greyscale can be placed, for reference, on each of the 'surrounds').

Experiment 1 (the main experiment) demonstrates the centre/surround organisation of visual units. The viewer (participant observer) is asked a) to judge the relative grey levels of the two holes in the cross partitions, b) to comment on the effect of reducing the illumination of one of the front chambers with a screen – i.e. darkening the 'surround' on that side, c) to say whether his or her judgement changes when it is revealed that the absolute grey levels of the holes have not changed. By arranging that the two halves of the simultaneous contrast illusion were seen separately by the two eyes, Asher was able to argue that the units reponsible are at the level of the retina – a finding subsequently confirmed by neurophysiological experiments on monkeys.

Other experiments include demonstrations of red/green and green/red opponent processing (obtained by replacing the grey, or white, 'surrounds' by green and red partitions.

screen is viewed through a moving pinhole, the retinal capillary network supplying the fovea jumps sharply into view – complete with a gap at the centre corresponding to central fovea seen dimmer than the rest, where rods as well as capillaries are missing. (Of course the same effects can be achieved by looking at a blue sky on a bright day, but that is more difficult to arrange in Edinburgh).

Fortunately, some of these demonstrations survived the cuts and consequent abandonment of small class teaching in the Thatcher years. Suitably modified, they could be used to advantage in a darkened lecture theatre filled with 200 medical students where group reactions considerably enhance their success. We managed the Pulfrich Pendulum for binocular stereopsis suspending it from the pipes in the ceiling above the blackboards. From the back of a lecture theatre the pendulum appears to swing out across the heads in the front benches. We even simulated the Maurice-Ginsborg effect for perceiving one's own mini-saccades. Instead of an oscilloscope trace, the vertically-running spot of light is generated by a rotating slit in front of a stationary one mounted on the slide holder of a long-throw projector. The only trouble with these developments was that George was usually still perfecting the apparatus when the lecture was due to start! Other items can be kept to an inexpensive minimum: black-out paper for pinhole(s) and pieces of red and green acetate supplied to each student or shared between two. The colour filters also doubled up as neutral density filters to introduce the retinal delay (and retinal disparity) required for the Pulfrich Pendulum.

The large class also had other advantages. On one occasion, with the Ishihara charts faithfully reproduced as slides by Medical Photography, we picked up a rare female tritonope. And the colour filters allowed normals to see what it is like to be red-green colour blind, etc. With a class of 200 and everyone

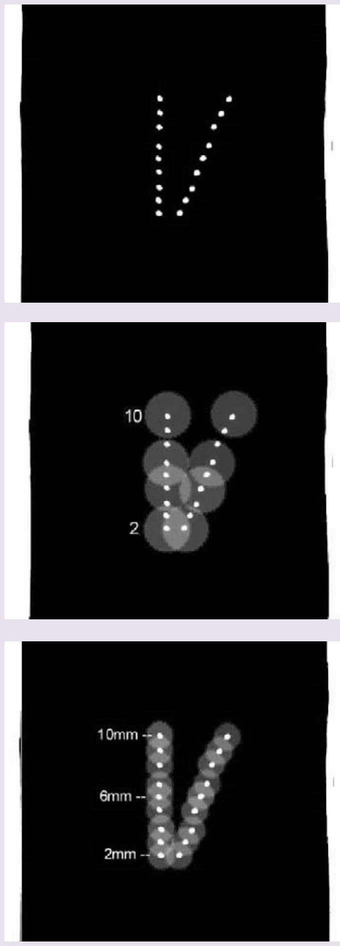

Figure 2. Top, Pupilometer (x1) consists of paired pinholes pricked through black paper progressively further apart: accuracy of pinhole diameters and shapes unimportant. It is held against one eye. Middle, 4 pairs of blur circles seen when contralateral eye is covered. Below, blur circles during consensual reflex, (contralateral eye uncovered).

able to see their own blur circles (Fig. 2) they could measure (and we could do instant statistics on) male and female pupil diameters during the consensual reflex.

As always with teaching, it acted as an incitement to research. One piece of apparatus not suitable for the large class was a pointing experiment – described in Walsh's book on the Nervous System as a 'projectionometer.. Author/unpublished' (Walsh, 1964, Fig. 9.19). It tests the accuracy of locating a brief spot of light imaged at intervals along a scaled board, while fixating a central light. Plotting the responses of a number of subjects I noticed that accuracy was worse on the left side of the board than on the right, irrespective of whether pointing is with the left or the right hand. Most responses fall short of the target, and the shortfall is greater in left visual field than in right – to do with hemispheric separation of the two fields, I suspect. As I enter our darkened living room, my eye movements cause the light of the digital clock on the radio to appear as a bright line interrupted at 50-cycles. When I look to the right, the line is longer, brighter and the regular interruptions more spaced than when I look to the left. I have no reason to believe that this strange difference is because the velocity of my 'look left' saccades is less than that of my 'look right' ones. So I conclude that the perceived difference in the saccades has the same origin as the perceptual 'contraction' of left visual field observed in the pointing experiment.

Has this directional difference on the perceived amplitude of one's horizontal shifts of gaze been noticed by others, I wonder?

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Emiline Lesly Jervis

1927-2002

Emiline Lesly Jervis was recruited to the Department of Physiology at Sheffield University by Professor David Smyth as a Research Assistant in 1955 to join his team investigating the mechanisms of intestinal transport of hexoses and amino