Thomas Graham Brown (1882–1965): Behind the Scenes at the Cardiff Institute of Physiology

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Thomas Graham Brown undertook seminal experiments on the neural control of locomotion between 1910 and 1915. Although elected to the Royal Society in 1927, his locomotion research was largely ignored until the 1960s when it was championed and extended by the distinguished neuroscientist, Anders Lundberg. Puzzlingly, Graham Brown's published research stopped in the 1920s and he became renowned as a mountaineer. In this article, we review his life and multifaceted career, including his active neurological service in WWI. We outline events behind the scenes during his tenure at Cardiff's Institute of Physiology in Wales, UK, including an interview with his technician, Terrence J. Surman, who worked in this institute for over half a century.

Keywords physiology, spinal cord, locomotion, motoneurons, interneurons, neural control, mountaineering, sailing, medical school politics

Introduction

Thomas Graham Brown (1882–1965) was head of the Institute of Physiology in Cardiff, United Kingdom from 1920 to 1947. Postretirement, he lived alone in a vast room at the top of the Gothic tower of the institute until 1961. Lord Tangle (1889–1973) (E.S. Herbert) described him as the most complex personality he had ever known. A rigorous scientist and Fellow of the Royal Society (FRS), he displayed a touchiness that sometimes made him a difficult companion, a deep capacity for friendship, and an ability to go on mountain

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climbing indefinitely without apparent fatigue (Herbert, 1966). In fact, Graham Brown's name is frequently associated with Mont Blanc (altitude, 4810 m) on the Italian/French border and he had a fierce ambition for the world to know that three of the pioneering Mont Blanc/*Brenva* climbs were his discoveries (Graham Brown, 1944).

Lord Edgar D. Adrian (1889–1977), a co-1932 Nobel Laureate and neuroscience colleague of Sir Charles S. Sherrington (1857–1952), observed that Graham Brown was a formidable opponent (Adrian, 1966).¹ He did not conceal the pleasure in the fight and victory, but Adrian noted that his published research mysteriously and sadly stopped after a few years in Cardiff and his reputation as a research physiologist began to languish. Instead, he became famous as the most outstanding British climber in the Alps during the interwar years (Herbert, 1966). However, a 1969 monograph by Anders Lundberg (1920–2009) and a recent review reveal how much his research influences contemporary thought on the contribution of the spinal cord to control of locomotion (see Lundberg, 1969; Stuart & Hultborn, 2008). A recent article (Wiesendanger, 2011) suggests that Graham Brown was also a pioneer in the value of active rehabilitation² after brain injury in humans. This idea, too, was ahead of its time.

In this article we outline events behind the scenes during Graham Brown's extraordinary and often turbulent tenure at the Cardiff Institute of Physiology (CIP). We include an interview³ with his technician, Terrence J. Surman (1904–1997), who worked there for nearly half a century. Next, we revisit briefly his accomplishments as a neuroscience investigator and then proceed to his mountaineering days, which were interrupted briefly by some additional and quite remarkable movement neuroscience research that was never published despite its originality and potential importance.

The Cardiff Institute of Physiology (CIP)

In 1893, when the preclinical part of what was later to become the Welsh School of Medicine first opened, University College Cardiff (UCC) housed the Departments of Anatomy and Physiology in its forbidding entrance block (Figure 1a) on Newport Road (A. Roberts, 2008). J. Berry Haycraft (1857–1922) was the founding head (1893–1920) of the Department of Physiology at UCC and he saw this arrangement as a prelude to a magnificent new medical school for Wales. Haycraft and others persuaded a local industrialist Sir William James Thomas (1867–1945) to fund the building of the entire medical school (Anonymous, 1915). But political infighting between UCC and the University of Wales, followed by the outbreak of WWI, interfered with this ideal. When the building opened in 1919 its fourteenth-century English Gothic style, with fifteenth-century French Renaissance nuances, resembled a Hollywood stage set (Figure 1b). Only the massive

¹Adrian's 1966 biographical memoir includes a full list of Graham Brown's published work with the exception of his 1912 MD thesis, available at the library of the University of Edinburgh, a tribute to Sherrington (Graham Brown, 1947), and various articles in the *Alpine Journal*, some of which are discussed in the text. Note that this memoir also includes the comments that "Graham Brown cherished his independence and led a rather lonely bachelor life in Cardiff . . . he found little time for personal relationships. . . . To old friends he was a charming host and a welcome and undemanding guest" (Adrian, 1966, p. 26).

²Active rehabilitation is defined as the diligent and sustained use of the impaired body parts after a brain injury rather than a *passive* (simply resting) recovery process.

³The transcript and tapes of this interview, which is quoted throughout, are currently in E.M.T.'s possession and will shortly be deposited in the Archives of the Physiological Society in the Wellcome Library, London.

Figure 1. The UCC and CIP in 1955. (a) Medical students fronting the Department of Anatomy at the entrance block to UCC. The professors (front row, seventh–ninth positions from left) include James S. Baxter (1896–1969) (Anatomy), Peterson (Physiology), and Pryde (Biochemistry). This photograph is available from J.G.J. upon request. (b) The CIP viewed from the west. Used with permission of the Institutional Archive, Governance and Compliance Division, University of Cardiff.

tower and CIP had been completed. Other dilapidated college buildings, including the original entrance block seen in the left side of Figure 1, still occupied the site of the unbuilt western half of the medical school.

Remarkably, the appearance of the CIP was completely unchanged 36 years later when one of us (J.G.J.) first entered it as a medical student. This was not through the imposing front entrance, which was permanently closed, but through an inconspicuous back door into a vast hall with Escher-like flights of stairs. One flight descended to the gloom of a basement lecture theatre and an annex, called “the snake pit.” Ascending flights were lined with impressive photographs of mountains and mountaineers. The latter were a legacy of Graham Brown who, although long retired, still lived at the top of the institute’s tower in a single, 1000 sq. ft., room with seven floor-to-ceiling lancet widows overlooking the Bristol Channel. At that time, the CIP housed the Departments of Biochemistry with John Pryde (1898–1977) as professor and Physiology with John M. Peterson (1901–1996) as professor.

Terrence J. Surman (“Nam”) (1904–1997)

One of us (E.M.T.), while studying the roles of physiology technicians in the United Kingdom (Tansey, 2008a, 2008b), interviewed Surman in 1996. He became Sherrington’s “lab boy” at the University of Oxford when he was 14 years old, and he soon became expert in animal experimentation. Graham Brown was a frequent visitor to Sherrington in Oxford and, in 1925, he invited Surman, then aged only 20, to be his senior technician in Cardiff. Surman recalled that Graham Brown had a photograph in his office of himself with the Prince of Wales (1894–1972; then Duke of Windsor, later King Edward VIII,) when the latter formally opened the CIP in 1921. The Professor of Anatomy was also present but Graham Brown had him inked out and the picture rephotographed! (Surman had seen the original unretouched version.)

Surman was always called “Nam” in Cardiff (i.e., “Namrus” or Surman in reverse). He helped with the faculty’s research but also had to prepare the kymograph drums, benzene soot burners, and shellac baths for the students’ laboratory classes where they used Sherrington’s practical text book, *Mammalian Physiology*. Surman was the first technician in the country to be awarded a Home Office Licence for nonrecovery animal experiments. His job was to anaesthetize cats, dogs, and even monkeys, to set up perfusions, to do the decerebrations, and to dissect and stimulate the splanchnic and vagus nerves. “There was little I couldn’t do. I had seen it done and assisted so many times that I couldn’t help but be an expert at it. I enjoyed every minute.” (This and subsequent Surman quotes are from his interview by E. M. T.) Graham Brown ran these classes, “which he never missed.” Paradoxically, Cardiff was more elitist than the far more prestigious Oxford, with a wide gulf between technicians and lecturers. Pryde was “pretty pompous before he got married.” Ivan de Burgh Daly (1893–1974), a lecturer in 1923–1927, was also “snobbish” but he went on to achieve much in professorships in Birmingham, Edinburgh, and finally Cambridge (Barcroft, 1975). Surman recalled that when WWII broke out in 1939, Graham Brown became alarmed that pipe tobacco might become scarce. “He mustered the technicians and set off to buy out Cardiff’s tobacconist shops. Many tins were acquired and carried back to the department. He opened the departmental safe, swept all the papers onto the floor, put the tobacco inside, locked the door and put the key in his waistcoat pocket and walked off” (Personal Communication to J. G. J. from Robert Maynard).

The mechanical workshop was such a crucial part of the department’s activities that it was located next door to Graham Brown’s office and his research lab. So well-known was it for precision work that Surman remembered it being used during the war to manufacture aeroengine parts for Beaufighter bombers.

Surman remembered Francis W. Beswick (1926–2011) and Stuart Lawrence Stone (1916–1973) when they were Cardiff medical students.⁴ Stone was a senior lecturer in the CIP until he died at the age of 57 years. “He really knew his stuff and everybody in the department came to him if they wanted a problem solved. . . . He worked on a liver without a dog, a dog without a liver and a liver with a dog.” Stone started the UK Liver Club with Professor Dame Sheila P. V. Sherlock (1918–2001) and was always surrounded by a host of friends at the Physiological Society (Figure 2). Peterson, for whom Surman was chief technician from 1947 to 1966, “was extremely good at cardiovascular experimental work.” He worked “like a machine and was a fairly easy going sort of bloke.” Surman thought Graham Brown was “a second Sherrington” (i.e., in interests, talent, and drive in the 1920s). He went on, however, to opine that “the big problem was that he [Graham Brown] lost interest in physiology and spent the last part of his life mountaineering for weeks at a time.” After Graham Brown retired in 1947 Surman noted that the relations between the CIP technical and academic staff became much more relaxed.

Thomas Graham Brown

A 1920 photograph (available upon request to J.G.J.) was taken at the impressive front entrance tower of the CIP. It showed Graham Brown, by then the Professor of Physiology,

⁴Beswick, after 14 years as lecturer, became head of the secret Ministry of Defence Medical Division at Porton Down, UK, which elucidated the 1978 KGB-implicated umbrella-gun murder of Georgi Markov (1929–1978) in London. The tiny inflammatory site from Markov’s leg was sent to Porton Down, where a 1.5 mm diameter platinum iridium ball was found. It had two holes drilled through it giving an X-shaped cavity containing ricin sealed with a sugar that melted at body temperature.

Figure 2. T. J. Surman (right) and S. L. Stone (left) on the day of Surman's retirement in 1972. In the background are some of the original physiological equipment that they used in their teaching and research. Presented with permission of Dr. Robert Maynard, UK Environmental Agency.

other staff, and second- and third-year medical students. The students included the father and an uncle of one the authors (J.G.J.). They, like Graham Brown and many others in this figure, were recently discharged from active service in WWI. Figure 3 shows a photo of Graham Brown from about the same time.

Graham Brown was born in Edinburgh in 1882. His father, Dr. John James Graham Brown (1854–1925), was an Edinburgh medical graduate, later a lecturer in neurology, then in 1912 President of the Royal College of Physicians of Edinburgh. He was a lifelong friend of Sherrington.⁵ As a schoolboy, Thomas Graham Brown was sent to Wiesbaden, Germany, in 1898 for six months treatment of an eye condition and to learn German. His authoritative father wrote to him frequently. One letter urged him to “get on without English

⁵Other distinctions of John J. Graham Brown included physician at the Edinburgh Royal Infirmary 1897–1919 and Senior President of the Royal Medical Society. In the summer of 1885, Sherrington, Charles S. Roy (1854–1897), Professor of Pathology, the University of Cambridge, and John J. Graham Brown were deputed by the Association for Research in Medicine, in conjunction with the Royal Society and the University of Cambridge, to go to Spain to investigate an outbreak of cholera then prevailing in that country (Liddell, 1952, p. 244). Before going to Cambridge, Sherrington was briefly a student at Edinburgh and his friendship with J. J. Graham Brown may have started then.

Figure 3. Graham Brown in probably the 1920s at the age of ~40 years. This was the frontispiece photo in Adrian (1966) and it is of unknown origin.

as much as possible.” Others said “do your very hardest to avoid spelling mistakes” and “Enjoy seeing the Kaiser.”⁶

Graham Brown graduated with honors in medicine at the University of Edinburgh in 1906. He then went to the University of Strasbourg, Germany, to learn more about physiological research from the renowned physiologist and icon of otolaryngology, Julius Ewald (1856–1921) and to improve further his German. It is clear in a letter from Sherrington to Graham Brown in 1907 that they had met in Edinburgh and that this visit to Strasbourg may well have been arranged by the former (Jones, 2010). In 1907, he became assistant to Professor Noel Paton (1859–1928) at the University of Glasgow and in 1910–1913, he was awarded a Carnegie Fellowship for research at the University of Liverpool. Here, he worked largely alone in Sherrington’s department but he collaborated with the latter on several projects⁷ and was awarded an MD (dissertation equivalent to a PhD in the United States) with a Gold Medal in 1912 at the University of Edinburgh. Liverpool was then the main British bridgehead to North America and no month went by without American or Canadian visitors staying in Sherrington’s home (Eccles & Gibson, 1979). His thesis did not require a director, and the examiners were not listed. He continued his own research in Manchester in 1913–1915. The outbreak of war saw him by March 1915 in the Royal Army Medical Corps at Maghull Military Hospital, Liverpool. Here, he studied recovery of the sensory effects of brain injuries

⁶National Library of Scotland, Graham Brown Collection. Acc. 4338, Correspondence Item 1.1.

⁷Between 1911 and 1913, Graham Brown and Sherrington coauthored three abstracts and four full-length articles (one on the pilomotor system, one on spinal reflexes, and two on the motor cortex of nonhuman primates; citations in Liddell, 1952).

with Roy M. Stewart (1869–1964), a fellow Scot who later became a prominent neuropsychiatrist and neuropathologist⁸ (Walshe, 1964). He also worked here with William H. R. Rivers FRS (1864–1922), a well-known “expert” on shell shock (Pearce, 2008; Webb, 2006). From 1916–1919, Graham Brown was sent on active service to Salonika, Greece, where he noted⁹ “The smells are picturesque.” His diary also records borrowing a steel helmet to go for a walk. Suddenly there were explosions all around. “Run Sir, you’re under observation and they are shelling.” His diary continued, “Not very dangerous because the Bulgars don’t often shell a single man.” In the Neurological Department (also with Stewart), he met Professor Ernest H. Starling (1866–1927), who emphasized that “I’m just out as a gas expert.”⁹ On October 18, 1916, after a discussion on shell shock at the thirtieth Stationary Hospital in Salonika, Graham Brown noted in his diary that Rivers had previously admitted to him in Maghull that he “didn’t think that any of his patients who recovered [from shell shock] benefited from his treatment” and “It looks as if Rivers was frankly dishonest.” River’s admission obviously fuelled Graham Brown’s long-held scepticism, as one of the few clinical neuroscientists who actually saw such patients, about the extravagant claims made for the wide range of treatments for shell shock.¹⁰ (For his later reflections on shell shock, see Graham Brown, 1927).

During the period 1909–1920, Graham Brown produced a remarkable series of papers, most as sole author and several actually written and/or proofed in the war zone.¹¹ For example a 100-page article (Graham Brown & Stewart, 1916¹²) was proofread in Salonika with 8-inch Howitzer shells bursting around his mosquito-ridden tent (Jones, 2010).

⁸Stewart focused on neurological psychiatry and neuropathology after WWI in which fields he was a leading and highly regarded figure while Medical Superintendent, Leavesden Mental Hospital (1922–1946), London, United Kingdom. This hospital closed in 1995 (Walshe, 1964). Today, he is possibly best remembered in clinical circles for the *Morgagni-Stewart-Morel Syndrome*, a hereditary malfunction consisting largely of hyperostosis frontalis interna, adiposities, virilism, and hirsutism. Stewart (1928) was his major contribution to this syndrome’s description, which was originally described in part in 1719 by the renowned Italian pathologist Giovanni B. Morgagni (1682–1771), and in more detail in 1930 by the Swiss neuropsychiatrist, Ferdinand Morel (1888–1957).

⁹National Library of Scotland, Graham Brown Collection. Acc. 4338, Salonika Diary, Item 23.

¹⁰The Webb (2006) and Pearce (2008) articles were about Craiglockhart, Edinburgh, perhaps the most famous shell-shock military hospital set up during WWI. Its fame originated from the writings of two war poet patients, Wilfred Owen (1893–1918) and Siegfried Sassoon (1886–1967). The latter nicknamed the place “Dottyville” and wrote about his doctor-patient relationship with Rivers, who had been transferred from Maghull hospital where he worked with Graham Brown in 1916.

¹¹Graham Brown published 69 abstracts and full-length articles between 1909 and 1920. While the majority of this work was on (a) spinal reflexes and (b) his now widely recognized ideas on the spinal contribution to locomotor control (see Stuart & Hultborn, 2008), it also included his studies (c) with Sherrington (see Footnote 7), (d) with Stewart on active rehabilitation (see Footnote 12), and (e) WWI soldiers’ spinal cord injuries (Graham Brown & Stewart, 1919), and his single-author articles on (f) the excitability of the sensorimotor cortex, (g) the physiology of the basal ganglia, (h) respiratory motor control, (i) “heteraesthesia,” and (j) the psychic function of the brain.

¹²The Graham Brown and Stewart (1916) article is a hospital study on a single soldier who had sustained gunshot brain damage in the left-side sensorimotor cortex. The investigators showed that a daily tactile discrimination task undertaken for several weeks by the soldier on his right index finger (*active* rehabilitation) improved substantially the tactile discrimination of this body part whereas a similar task undertaken but twice (beginning and end of the same several-week hospital stay; i.e., *passive* rehabilitation) for spots on the soldier’s other fingers and right arm evoked but modest discriminatory improvement. This finding, which is reviewed in depth in Wiesendanger (2011), was preceded and presumably motivated by a study on a single nonhuman primate that had been undertaken previously by Graham Brown and Sherrington (1913).

Graham Brown and the Cardiff Medical School

Graham Brown was appointed Professor of Physiology in Cardiff in 1920 and he lived alone, for his entire tenure up to 1947, at the Royal Hotel about 1300 m from the CIP. This hotel was the venue of the first dinner in Wales of the UK Physiological Society when it met under Graham Brown's chairmanship in Cardiff. Afterwards, the Great Western Railway Company laid on a special coach to take the delegates back to London.

The number of Cardiff physiology students had trebled after the war and Graham Brown constantly complained of a shortage of teaching funds allocated by the UCC and the University of Wales. Then, following letters to the local newspapers complaining about his minimal role in teaching, professors in the UCC science faculty orchestrated a vendetta in an attempt to dismiss him from the chair (A. Roberts, 2008). There may have been some substance in these complaints but, from Surman's above-mentioned comments, his attendance in the student mammalian laboratory classes was unimpeachable. The Medical Research Council (MRC) held him and his department in very high esteem and their independent examiner gave "High praise for the management and teaching in the Institute" (Roberts, 2008, p. 229). One of his strongest supporters was Sir Thomas Lewis FRS (1881–1945), the most famous alumnus of the Cardiff Medical School. Graham Brown stayed on!

As Professor of Physiology and Dean of the Medical School between 1924 and 1926, Graham Brown was also involved in a bitter conflict between the University of Wales and UCC about the future status of the school and its preclinical departments. A Royal Commission chaired by Lord Richard B. S. Haldane (1856–1928) had recommended in 1918 that the medical school should eventually become an independent institution within the University of Wales, a move strongly opposed by UCC. Throughout the 1920s, Graham Brown and his colleagues within the medical school actively worked for the implementation of Haldane's recommendations. Into this fire was thrown the fat of the Infirmary Consultants. Concerned that UCC was parachuting professors into the infirmary to erode their private practice, they launched a destructive campaign that eventually closed the Clinical School from 1928 to 1929 (A. Roberts, 2008). Members of the academic staff started leaving for other medical schools and there was concern in London that Graham Brown would follow suit (A. Roberts, 2008). Exhausted by years of acrimony, a compromise was eventually reached in 1931 whereby the clinical departments formed an independent Welsh National School of Medicine but the preclinical departments of anatomy and physiology remained within UCC. Graham Brown, totally opposed to the separation of physiology from the clinical medical departments, fought on to prevent this outcome, begging the MRC to intervene and even petitioning the Privy Council, but all his efforts were in vain.

Graham Brown's Research

Graham Brown is best known in movement neuroscience today for his 1910–1915 experiments supporting what are now called "central pattern generators (CPGs)" for the neural control of movement.¹³ Figure 4 captures his two key contributions on CPGs. First

¹³Wilson and Wyman (1965) coined the term "central pattern generator (CPG)." It was preceded by the term "oscillator," which is still used by some investigators. Both terms describe an ensemble of interneurons and possibly motoneurons (but to far less extent), whose combined operation produces the fundamental spatiotemporal patterns of a wide variety of rhythmic movements including the various forms of aquatic, aerial, and terrestrial locomotion. Higher brain centers have now been shown to send command signals to CPGs but they do not control a CPG's fundamental rhythmicity.

Figure 4. Graham Brown's key pre-WWI contributions to current understanding of the spinal contribution to the neural control of stepping. (a) His first demonstration of the spinal control of the stepping rhythm in a spinalized and de-afferented decerebrate cat. The alternating movements are those of the tendons of the ankle flexor, tibialis anterior (upper traces), and the ankle extensor, gastrocnemius (lower traces), with contractile shortening upwards and relaxation from contraction downwards. The original published record had several more traces of other variables and was a faintly white-on-black kymographic recording. Excerpted and modified substantially from Figure 1 in Graham Brown (1911) with permission of the publisher. (b) Graham Brown's half-center model for the spinal contribution to the control of stepping. An earlier version of this model was discussed in Graham Brown's MD thesis (1912; see pp. 148–155) and expanded upon on pp. 741–743 in Graham Brown (1916). The model shows reciprocal innervation between a spinal flexor (F) half-center (composed of both motoneurons and interneurons) and a spinal extensor (E) half-center (similarly composed of other motoneurons and interneurons) in the extension phase of the step. The term “D” is for stronger inhibition in this phase from E to F and “d” is for weaker inhibition in the reverse direction. The term “G” is for “fatigue” of this inhibition as D is imposed upon F and “g” is for less fatigue of inhibition as the smaller “d” is imposed on E. From Figure 84 in Graham Brown (1916) with permission of the publisher.

(Figure 4a), he showed that stepping movements of near-normal rhythmicity could be made by the spinal cord of the guinea pig and cat without command signals from supraspinal structures and sensory reflex feedback.¹⁴ Second (Figure 4b), in several articles, his 1912

Similarly, sensory input can certainly influence strongly most aspects of CPG rhythmicity but the fundamental CPG rhythm is maintained. The overall neural control of locomotion and other rhythmic movements is considered to involve continuous interactions between (a) descending command signals, (b) a brainstem-spinal cord “program” involving largely a collation of interacting CPGs, and (c) sensory feedback. For further details on CPGs, see Delcomyn (1980) and Stuart (2007) for their history and Grillner and Jessell (2009) for current ideas on their circuitry and operation.

¹⁴Graham Brown (1911) is the most seminal and widely cited (together with his 1914 article) of his articles on the neural control of locomotion (Stuart & Hultborn, 2008). (For the fullest post-1960 review of his pre-WWI research on locomotion see Wetzel and Stuart [1976] who discussed 13

MD thesis, and particularly in Graham Brown's 484-page *tour de force* review (1913, 1916),¹⁵ he proposed mutually inhibitory connections between a pair of flexor and extensor "half-centres" on each side of the spinal cord. This focused on motoneurons and sometimes adding interneurons, which were poorly understood at that time. These half-centers were thought to produce the rhythmic stepping pattern of alternating bursts of flexor and extensor muscle activity.

Graham Brown's ideas on the neural control of stepping were then revolutionary because the prevailing viewpoint was that spinal reflexes generated the stepping rhythm (Stuart & Hultborn, 2008).¹⁶ So novel were Graham Brown's ideas on the spinal contribution to the neural control of locomotion that for many years Sherrington waxed and waned (possibly agonized) about their significance (see Stuart et al., 2001; Stuart & Hultborn, 2008). Adrian, in his generally sympathetic 1966 obituary of Graham Brown, questioned their importance (p. 25) saying that Graham Brown's work "cannot be said to have had much influence on the progress of physiology." This viewpoint might be Adrian's perception of physiologists' reactions to Graham Brown's findings only when they were first published in 1910–1915 and the immediate following decade (cf., however, Footnote 18 in Stuart & Hultborn, 2008). Indeed, the prescience of Graham Brown's overall 1910–1915 contributions, which are reviewed in depth in Wetzel and Stuart (1976) and Stuart and Hultborn (2008), was not recognized until the early 1960s. Then Lundberg and his group in Göteborg, Sweden, used intracellular recording in spinal motoneurons and an indirect technique to assess interneuronal activity to provide a spinal interneuronal substrate for Graham Brown's half centers. Lundberg's "resurrection" of Graham Brown quickly gathered momentum because by the early 1960s Lundberg was a highly respected and widely known spinal cord neurophysiologist (Alstermark et al., 2010).¹⁷

of the articles.) Graham Brown's concluding 1911 summary's last two points (4 and 5) have stood the test of time. In his own words, (p. 319) "4. The rhythmic sequence of the act of progression is consequently determined by phasic changes innate in the local centres [i.e., spinal interneurons and motoneurons], and these phases are not essentially caused by peripheral stimuli. 5. The proprioceptive stimuli which are generated by the contraction of muscles taking part in the act (when the appropriate posterior spinal roots are intact) play a regulating and not an intrinsic part in the act. Their chief importance may be in the grading of the individual component movements to the temporary exigencies of the environment."

¹⁵Graham Brown wrote a two-part review (1913, 1916) that expanded considerably on his 1912 MD thesis. It was written in German and published in a German journal, with the first part focusing on his early locomotion work and the second part more on his concept of spinal half-centers for the control of stepping. Its potential impact may have been diminished by being written in German and the second part appearing during WWI. At that time and subsequently, the journal, *Ergebnisse der Physiologie*, was particularly influential. Many scientists, including Graham Brown, were then fluent in German. His selection of this journal was probably based on the fact that it would accept a review of such massive length (in all, 484 pages). The 1922 Nobel laureate and famous London physiologist, Archibald V. ("AV") Hill (1886–1977), published a long article in the same 1916 issue in which the second part of Graham Brown's review appeared.

¹⁶The work and viewpoints of the Belgian physiologist, Maurice Philippson (1877–1938) has often been portrayed inaccurately, including in the writings of Graham Brown. In his classic paper, Philippson (1905) showed how interlocking sequential spinal reflexes could contribute to the control of spinal stepping. His work on chronic spinal dogs, however, convinced him that "the spinal cord controlled locomotion using both central and reflex mechanisms" (Clarac, 2008, p. 16). (See Footnote 4 in Stuart and Hultborn [2008] for some of Philippson's original discussion of this point in the French language and its translation into English by Clarac.)

¹⁷Lundberg's first published electrophysiological support of Graham Brown's pre-WWI views on locomotion was in Jankowska et al. (1965) and Lundberg (1965). In 1967, he participated in a

Adrian (1966) was correct that Graham Brown failed to advance understanding of mechanisms underlying his half-center observations. Graham Brown certainly had the experimental talent to acquire the electrophysiological techniques used in the 1920s (e.g., Adrian & Bronk, 1929). It seems to us, however, that he felt that further work on his half-center observations would add nothing new for the then-foreseeable future. Indeed, the field had to wait until the early 1960s onwards for there to be intense experimental effort on CPGs using much more advanced electrophysiology (Stuart, 2007). This is now combined with mathematical modelling (see, e.g., Orlovsky et al., 1999; Marder et al., 2005; Grillner & Jessell, 2009) and applied to the rhythmic movements of many species. As this effort continues (see, e.g., Figure 1 in McCrea & Rybak, 2008) the pioneering 1910–1915 work of Graham Brown continues to grow in stature.¹⁸

Between 1920 and 1927, despite his involvement in the political infighting between the UCC and the University of Wales, Graham Brown published more research papers than all his other Cardiff colleagues put together,¹⁹ and, in 1927, he was elected Fellow of the Royal Society (FRS). His exceptionally powerful London backers may have used this rare distinction not only to recognize his research but as an inducement to stay and weather the political storms in Cardiff. After the FRS his publications immediately stopped but he stayed on in the CIP while others at the institute remained busy. For example, J. W. Tudor Thomas (1893–1976) was later awarded a knighthood for pioneering research initiated at the institute on corneal grafting. Copies of Tudor Thomas' reprints, signed by the author were presented to Surman, who assisted in the animal work but whose contribution was not acknowledged. In 1932–1934, John H. Shaxby (1879–1948), the CIP's expert on sound localization, collaborated with William S. Tucker (1877–1955) of the UK Air Ministry developing massive concrete acoustic mirrors on the English coast for detecting distant enemy aircraft. When this acoustic method was superseded by radar, their system for linking these detectors was adopted for the United Kingdom's wartime radar air defense. In addition, de Burgh Daly, Albert Hemingway (1902–1976), Peterson, and Pryde all became professors.

It would not be surprising if (a) intensely frustrated by his long and fruitless battle with UCC, (b) the sudden death following surgery of his influential father in 1925, (c) his failure to advance his half-center concept in the 1920s with the techniques available to him

symposium in Los Angeles where he interacted with some leading invertebrate workers, including Theodore Bullock (1915–2005), Graham Horridge (1927–) Donald Maynard (1929–1973), Donald Kennedy (1931–), Lasdislav Tauc (1926–1999), Cornelius Wiersma (1905–1979), and Donald Wilson (1933–1970). In a personal communication to D.G.S., he found it ironic that most of them were then far more aware of the work of Graham Brown than were most of his colleagues who worked on mammalian locomotion. This point is supported in the subsequent reviews of Delcomyn (1980) and Stuart (2007).

¹⁸Recently Duan, Rubin, and Rybak (2009) quoted two of Graham Brown's 1910–1915 articles when expanding on his ideas by the use of modern mathematical and computer simulation approaches to show how half-center models contribute to CPG activity during treadmill locomotion. They showed how intrinsic cellular features incorporated in different CPG models such as (1) sub-threshold *activation* based on a slowly inactivating persistent sodium current, (2) *adaptation* based on a slowly activating calcium dependent potassium current, and (3) postinhibitory *rebound excitation*, all contribute to the control of an oscillation period and phase duration in half-centers.

¹⁹Graham Brown's publications between 1920 and 1927 comprised 22 abstracts and articles on again a wide variety of topics, which included (a) spinal reflexes and locomotion, (b) the above-mentioned "heteraesthesia," (c) psychic function of the brain, (d) inhibition and excitation in the central nervous system (CNS), (e) sensory/perceptual, instinctual, and unconscious phenomena, (f) visual neurobiology, (g) shell shock, (h) a major review on the cerebral hemispheres, and (i) an obituary on Haycraft (Graham Brown, 1923).

Figure 5. Graham Brown's work on cat treadmill locomotion. (a) The professor is shown demonstrating aspects of the sophisticated treadmill built in his Cardiff laboratory in the late 1930s for the analysis of the walking, trotting, and galloping gaits of high (precollicular) decerebrate cats (see Lundberg & Phillips, 1973). (b) Surman demonstrating the apparatus, which included a device for changing neck angle $\pm 90^\circ$ in the vertical and horizontal planes and for moving the treadmill's belt at variable speeds and grades. (c–e) Examples of a decerebrate cat running as the treadmill's angle was changed manually. We thank Larry McAlister (Media Specialist, University of Arizona) for extracting the three still frames in this figure from Graham Brown's unpublished 1941 film (see text). The figure is available from J.G.J. upon request.

at that time or (d) his increasing interest in mountain climbing, that the prestigious FRS recognition was a “get out of research” card, which he played with long lasting ill effect on physiology in Cardiff.

Graham Brown's research did take on a brief new lease on life prior to WWII because Alpine climbing became difficult for other than Germans and Italians. With the gifted help of Surman and A. L. Sims (1901–1969), the CIP's workshop engineer, he built an ingenious tilting treadmill and turntable to study the walking, trotting, and galloping movements of high decerebrate cats (Figure 5). He wrote, excitedly, to Sherrington on 4th January 1938 describing his experiments, particularly the technical difficulties in building the treadmill. He had an immediate, and enthusiastic, reply dated 9th January 1938 saying “My Dear Tom, How delightful! And the description in your letter makes it “live”. One sees the observation in progress. . .etc.” followed by suggestions for further experiments (Jones, 2010). Another innovative aspect of this research was that the locomotion experiments were filmed as were the wing beat movements of decorticate and decerebrate pigeons.

At least one film presentation of his treadmill and pigeon findings was made to the Physiological Society in Cambridge in 1941, but none of this original and important research was published. Charles G. Phillips (1916–1994), a distinguished Oxford

neuroscientist (Porter, 1996), was present and fascinated by the Cambridge presentation. Much later (early 1961), he obtained a copy of the film from Graham Brown via Peterson at the CIP and was given permission to make another copy for his colleague, Anders Lundberg, who was also permitted to use the Institute treadmill. Lundberg lacked the time to exploit this collegial offer, however, but kept thinking about the intrinsic value of the film. Accordingly, eight years after Graham Brown's death, Lundberg and Phillips presented their examination of the film to the Physiological Society that happened to be meeting again in Cambridge (Lundberg & Phillips, 1973). Their abstract described the movements of the cats on the treadmill and a turntable. No attempt was made to speculate on underlying mechanisms.

If Graham Brown had published his treadmill work, the field of movement neuroscience may have quickly accepted the concept of a flexible, tripartite control of locomotion in the face of changing environmental demands. This concept implies a continual and varying interaction between (a) descending command signals, (b) the brainstem-spinal cord locomotor program, and (c) sensory feedback. As it was, the field had to wait another 20 years for the mid-1960s' work of a group of young Moscow, Russia (then USSR) workers, Mark Shik (1934–), Fyodor Severin (1942–1968), and Grigori Orlovsky (1932–), who tested the ideas of the renowned Russian neuroscientist, Nikolai Bernstein (1896–1966) (see Bernstein, 1947). They used electrical stimulation of the midbrain of high decerebrate cats (i.e., preparations presumably like those of Graham Brown) to study locomotor control during treadmill locomotion (Shik, Orlovsky, & Severin 1966; Shik, Severin, & Orlovsky, 1966). Both articles had immediate international impact (Stuart & McDonagh, 1998). The second of them (Shik, Orlovsky, & Severin, 1966) cited Graham Brown (1914), one of his key articles on spinally controlled locomotion, at a time when the majority of movement neuroscientists in the West were still unaware of the importance of his work!²⁰

Mountaineering

By 1930, after 10 years of turmoil with his Cardiff University colleagues, Graham Brown's published research had stopped. The exclusive Alpine and Athenaeum clubs, respectively, in London's Mayfair and Pall Mall now provided more convivial diversions and the FRS became the entrée to the Royal Society at St James's. The kymograph was suddenly much less appealing than the crampon. His introduction to mountaineering had begun in 1907 when he read a fictionalized account of the original, but indirect, ascent of Mont Blanc in a novel by Alfred E. W. Mason (1865–1948) entitled *Running Water* (Mason, 1907; Graham Brown, 1944). Climbing the rocks and crags of the English Lake District then "opened out a new world of pleasure" (see Figures 6 and 7; this and the subsequent 3 Surman quotes are from pp. 13–14 in Graham Brown's 1944 book, *Brenva*). Three of his early climbing companions, killed in WWI, are commemorated on the Great Gable War Memorial in the

²⁰Some Western neuroscientists were aware, however, in the 1950s and early 1960s of Graham Brown's pre-WWI work. Among these, a most striking and yet rarely cited example was William Landau (1924–), a distinguished American neurologist. In his article on movements produced by stimulation of the medullary pyramidal in the cat (Landau, 1952), 12 of Graham Brown's articles were cited, including all the key ones on the spinal control of stepping. Other influential reports were those of G. Viala and Buser (1969), who cited four of Graham Brown's locomotion articles, and D. Viala and Buser (1969), who cited some Lundberg articles that addressed Graham Brown's contributions. By the early 1970s, reference to Graham Brown's pre-WWI findings was commonplace, including an historically important article by Grillner (1973).

Figure 6. Graham Brown, the mountaineer. (a) A January 1925 photo of members of the Gritstone Club, Flying Horse Shoe Inn, Clapham Station, Yorkshire, Graham Brown is 3rd from the left in the back row. (b) Graham Brown on Mont Blanc in about 1948. Used with permission of the Trustees of the National Library of Scotland.

Figure 7. Graham Brown, aged 70, resting in the hills of Entrèves, Courmayeur, Italy in 1952. He is shown sitting between two of his hiking friends, Basil Goodfellow on the left and Peter Lloyd on the right. Used with permission of the Trustees of the National Library of Scotland.

heart of the English Lake District. *Brenva*, dedicated to friends killed and “marked” by the war, describes how *Running Water* first suggested the question “Might a direct route to the summit be made over the Brenva face of Mont Blanc?” Thoughts of his *Brenva* project helped “relieve the never ending weariness” of war after which his climbing resumed with the Yorkshire Gritstone Club (Figure 6, left side).

Realizing the “deep sense of satisfaction from bodily exertion and the accurate execution of the action,” Graham Brown climbed every summer from 1924 to 1938 either in the Alps (Figure 6, right side), Alaska, or the Himalayas. The sheer number of expeditions illustrates his intense, sustained, energetic application to an activity that was of absorbing interest to him (Evans, 1966). He was a conservative climber, deploring “illegitimate climbing aids such as Teutonic ironmongery of pitons and what not,” (*Brenva*, p. 75) although he himself used crampons on ice (Graham Brown, 1944). The essential characteristic he brought to the sport was a force of will with an outstanding strategic aptitude. His approach was scientific. During the winter, in his room in the CIP, he meticulously thought out new routes after careful study of the available evidence. *En route*, each expedition was recorded in detail including times and photographic records using his Leica camera. He was short in stature and over 40 before starting his Alpine career. But his tireless endurance is exemplified by his ascent in 1933 of the difficult *Via Della Pera*. This was from the Torino Hut up the new route to Mont Blanc and all the way to Courmayeur, continuous climbing and hiking for 26 hours (Lloyd, 1982).

In 1936, he co-led with Charles S. Houston (1913–2009) a remarkable Himalayan expedition to *Nanda Devi* (Anonymous, 2009; D. Roberts, 1986).²¹ A small bag of heather from this expedition remains in his collected papers. Also remarkable was his climbing the Matterhorn by the Hörnli ridge in his seventieth year (Evans, 1966).

***Brenva* and the Feud with Smythe**

Graham Brown’s famous campaign to find direct routes to the Mont Blanc summit is detailed in *Brenva* (Graham Brown, 1944; for contemporary Mont Blanc photographs see <http://www.summitpost.org/custom-object/344264/Big-routes-of-Mont-Blanc-group.html>). The first successful assault was made with Frank S. Smythe (1900–1949), whom he had met by chance a few days before. They were the first to climb the *Red Sentinele* route in September 1927. Again with Smythe, he climbed the *Major Route* in August 1928. After these climbs, he fell out with Smythe and years of bad weather

²¹ *Nanda Devi* is the highest mountain in India (7816 m) and until 1950 the highest peak climbed by a human. The first successful assault in 1936 was also the first Anglo-American Himalayan expedition. The participants were: United Kingdom – Graham Brown, Noel E. Odell (1890–1987), H. W. “Bill” Tillman (1898–1877), and Peter Lloyd (1907–2003); United States – Charles Houston (a medical student who later became a high-altitude physiologist and member of the Harvard Mountaineering Club (HMC), H. Adams Carter (1914–1995), W. F. “Farney” Loomis (1914–1973), and Arthur B. Emmons (1910–1962). Emmons, also a medical student, had previously lost all his toes to frostbite on *Minya Konka*, Tibet. (See illustrated account in *Life Magazine*, July 19, 1937). In 1935, before the climb, Houston and Emmons, who could walk only on his heels, had dinner with Graham Brown in the Monte Rosa Hotel in the Italian Alps and decided to initiate the 54-year-old as an honorary member of the HMC. After lots of wine, they blindfolded Graham Brown, roped him up and made him cut steps up the paths of the hotel’s gardens, using a mountaineer’s ice axe! Then, still blindfolded, he was ordered to rappel out of a window on the second floor and bivouac on a chair tied to a tree in the main street. Graham Brown was horrified when they removed the blindfold and he found himself high over the street, which was filled with over a 100 people, including the leading (and raucous) lights of the British Alpine Club (D. Roberts, 1986)!

delayed until August 1933, the third and most difficult route, the *Via Della Pera*, which he climbed with two guides, Alexander Graven (1901–1982) and Alfred Aufdenblatten (1897–1975). He called these three routes *The Triptych* and immediately started to write *Brenva*, which occupied him until it was published in 1944. Each chapter opened with his own philosophical poems and the preface acknowledged the advice of Adam Fox (1883–1977), former Oxford Professor of Poetry and Canon of Westminster Abbey, now buried in the Abbey's Poet's corner. Pryde was the only UCC member named in the preface and he was referred to as "my friend and colleague from another happy field" (in *Brenva* preface).

While writing *Brenva* Graham Brown became increasingly infuriated with Smythe and a bitter feud developed. Smythe was temperamental, with a checkered reputation as a climber; although he had been on three Everest expeditions (Unsworth, 2000; Ward, 2003). However, intent on a career as a writer/climber, he claimed the lion's share of the credit for the first two *Brenva* climbs. But Graham Brown believed that all three new direct routes to Mont Blanc were his, and only his, idea. Among his 1933 papers a 72-page letter to Edward L. Strutt (1874–1948), then editor of the *Alpine Journal*, is entitled "The Case Against Smythe" (Jones, 2010). Nothing was published! Two years later he wrote a similar letter to Lord Tangle, then secretary of the *Alpine Club*. When Graham Brown asked Pryde's opinion about this the latter wrote, "Judicial. Too much of an ado about too little."²² Lord Tangle, as a friend of both protagonists, rewrote the contentious parts of *Brenva* and helped avoid legal action by Smythe against Graham Brown. But this was far from the end of the matter!

Retirement

Graham Brown retired from the chair of physiology in 1947. The start of his retirement coincided with the ninetieth birthday celebrations of Sherrington. Graham Brown and John F. Fulton (1899–1960) from Yale University were invited to contribute independent appreciations, which were published in the *British Medical Journal* of that year. The Graham Brown (1947) contribution was a remarkable tribute that showed how closely he, himself, had followed Sherrington's career path.²³ He mentioned that both had begun medical studies in Edinburgh (although Sherrington later transferred to Cambridge), both were Alpine climbers, both had early experiences in Germany, and both were proficient in that language. Reflecting on Sherrington's varied interests, Graham Brown noted also that both enjoyed writing poetry and were enchanted by the beauty of a mountain scene, a picture, an experiment, and an ingenious technical method. Following the German academic example, both had greater loyalty to the objects for which an institution was the instrument rather than the institution as such. This clearly reflected Graham Brown's own attitude to, and disenchantment with, UCC.

²²National Library of Scotland, Thomas Graham Brown Collection. Acc. 4338, Item 7.1.

²³Throughout his career, Graham Brown held Sherrington in high esteem. For example, in 1931 Graham Brown played a key role in the nomination of Sherrington for his 1932 Nobel Prize (Eccles & Gibson, 1979, p. 78). Plate 9 in Granit (1966) shows Sherrington with Graham Brown and Fulton at his retirement home, Les Terrasses. Note also the touching eloquence of Graham Brown's comments on Sherrington in his 1947 letter, which was emphasized by Granit in his own glowing appraisal of Sherrington (see Granit, 1966, p. 97). There is a collection of 7 letters from Graham Brown to Sherrington between 1934 and 1940 in the University of British Columbia Library. These were found by J.C. Eccles on June 9, 1969 when he was looking for some old letters of Howard Florey (1898–1968). Between 1907 and the late 1940s there are numerous letters from Sherrington to Graham Brown in the latter's collected paper 6.

Graham Brown continued climbing or sailing until he was nearly 80 years of age. Of his many distinguished friends the two closest (Figure 7) were Basil R. Goodfellow (1902–1972), with whom he had climbed since 1933, and Peter Lloyd (1907–2003), who accompanied him to *Nanda Devi* in 1936. Both were Cambridge graduate engineers who would later be involved in the organization of the first successful ascent of Everest in 1953. Goodfellow, a seemingly “James Bond” character, was in the Special Operation Executive during WWII. A notable photographer who had travelled extensively throughout the world, he was a skilled driver of fast two-seater Alvis cars. Since 1941, Lloyd had been involved in the design and production of one of the earliest jet engines at the Royal Aircraft Establishment, Farnborough, United Kingdom and ultimately the Pegasus engine for the Harrier, vertical take-off aircraft.

In 1947, Graham Brown abandoned his room at the Royal Hotel and his home until 1961 became his library of mountaineering books and newspaper cuttings high in the CIP tower. Surman recalled that “He used to sit in a large arm chair, smoking his pipe continuously and reading under a lamp all day long.” A bucket by the door was surrounded with burnt tobacco, matches, and empty tins of Three Nuns Pipe Tobacco. “I don’t know if he put a roll bed down but he slept in his clothes, probably in his chair.” Surman told endless stories about Graham Brown’s life in the tower: enormous piles of newspapers, an aversion to cleaners entering the room, being shaved by the Porter.²² The only time of the day that Graham Brown was seen in public was about 9 o’clock each morning when Surman would see him on the way to breakfast at a coffee stall under the old railway bridge 100 yards away from the CIP at the town end of Newport Road. He described a splendid image of the FRS (and Member of The Athenaeum) dressed in a three-piece suit (old but expensive) and a homburg hat eating a bun with the laborers! Surman noted “The boys used to get him sandwiches for lunch.”

As a child, Graham Brown was taught to sail by his father and to sketch and appreciate mountains by his mother. His family had a 60-ton schooner, *Thekla*, in which they cruised the west coast of Scotland. In 1947, Graham Brown bought a 36-foot former Hastings Life boat, the *Cyril and Lillian Bishop*, which had previously been used in the Dunkirk evacuation in 1940. With the help of the CIP workshop, he refitted this as a motor sailer and renamed it *Thekla* (Figure 8). It was kept at Mallaig, on the west coast of Scotland, more than 1000 km away from Cardiff by three trains and as many buses. Graham Brown never drove a car. Nevertheless, he and his friends enjoyed 13 years of sailing on the northwest coast of Scotland, including an amazing 1800 km crossing of the North Sea to Tromsø in northern Norway, returning to Scotland in a storm. In the 1960s, after he had left Cardiff for Edinburgh, there was a flurry of correspondence with Peterson whose workshop in the CIP, as well as other contacts in Cardiff, continued their well-established supply of handmade components for the engine, masts, rigging, and sails of *Thekla*.

Graham Brown became editor of the *Alpine Journal* in 1949. This created difficulties for the journal’s readers because Graham Brown was commuting between the CIP, the Marine Hotel, Mallaig, and various mountain peaks around the world. The *Alpine Journal* would never appear on schedule and climbing scoops were never published because Graham Brown could never be found. His Majesty’s Inspector of Taxes also had difficulty in believing that such a distinguished professor had “No fixed abode.” (Personal Communication to J. G. J. from R. N. Campbell). His obsessive animosity to Smythe, and later to Geoffrey Winthrop Young (1876–1958), spilled over into the journal despite the fact that Smythe had died in 1949. Friends of Smythe and Winthrop Young were seething. Rage reached fever pitch after the first successful Mt. Everest ascent by Sir Edmund P. Hillary (1919–2008) and Tenzing Norgay (1914–1986) on May 29, 1953.

Figure 8. Graham Brown at the wheel of his converted lifeboat, *Thekla*, in about 1960. Used with permission of the Trustees of the National Library of Scotland.

Not only was the journal describing the ascent months late in publication but it omitted an account of the Hillary/Norgay climb up the South Col. (i.e., the lowest point on the mountain's edge). Bizarrely, it included an editorial that “celebrated” the Everest conquest by focusing on the first successful navigation of the North West Passage through the Canadian Arctic Ocean (Graham Brown, 1953/1954)! Within three weeks, five of his enemies wrote independently to Lord Tanglely, who had just taken over the club presidency from Sir Claude Aurelius Elliot (1888–1973), former head master of Eton (where he was nicknamed “The Emperor”). Within days of the first denunciation, Lord Tanglely, rather than give Graham Brown a well-deserved rap on the knuckles, told him (in absentia, because the latter was in the hospital after a climbing accident) to resign from the editorship (Jones, 2010).

This back-stabbing blow came while Graham Brown was collaborating with Sir Gavin de Beer FRS (1899–1972), Director of the Natural History Museum, on their book *The First Ascent of Mont Blanc*. This book demolished the legend that “credit for the first ascent should go to the porter Jaques Balmat (1762–1834) rather than to the leader, Dr Michel Paccard (1757–1827)” (Lloyd, 1982, p. 5). The book (Graham Brown & de Beer, 1957), by vindicating Paccard, suggested a strong link between this travesty and the tendency at that time to give the credit for the first two *Brenva* climbs to Frank Smythe (Lloyd, 1982).

Return to Edinburgh

In 1961, Graham Brown finally moved from the CIP to a flat at 20 Manor Place, Edinburgh, which he had bought in 1958, a few yards from his original home. His library occupied the

garden room with a large composite telephoto of Mont Blanc displayed over the fireplace. The University Mountaineering Club camped in the basement. One of these students was Robin N. Campbell (1946–). He described Graham Brown's last years in an article written for his centenary (Campbell, 1982). Later, in a note to J.G.J., Campbell said "When I lived in the Manor Place basement I often quizzed Graham Brown about his physiological work, particularly the flying of decorticate pigeons, which intrigued me. However, I think he had completely lost interest in this and was wholly focused on Alpine history, particularly Mont Blanc." He was always ready to remove his pipe and to tell improbable stories to the discredit of his climbing contemporaries (Personal Communication to J. G. J. from R. N. Campbell). Frank Smythe bore more than his fair share of these calumnious attacks. Out of the blue, a letter came from Anders Lundberg in Göteborg asking about the film presented at his 1941 Cambridge demonstration. Graham Brown's enthusiastic handwritten reply dated February 17, 1962 is reproduced by Stuart and Hultborn (2008). At 80 years of age, he offered to sail his boat to Göteborg to meet Lundberg and compose captions for the film. Unfortunately, he could not find a ready crew so Graham Brown and Lundberg never met. Surman described a visit made shortly afterwards by Stuart Stone to Manor Place. "Oh you live in luxury here. Carpet slippers, dressing gown, even a resident nurse" (from his interview by E. M. T.). Later Graham Brown was taken to see his boat at Fort William. "He stared at it from the shore for a minute then turned away, unable to get aboard" (Campbell, 1982, p. 8). He died in 1965. He bequeathed 20 Manor Place to the University of Edinburgh as a residence for students.²⁴ After his death, his boat sank in mud in the West of Scotland. It is now in the Dunkirk Little Ships' Restoration Trust Museum in Sens, France.

Final thoughts

Thomas Graham Brown's academic career seems to have been planned by his authoritative father, a lifelong friend of Sherrington. Graham Brown in many ways modelled himself on Sherrington and his fundamental and applied (clinical) neuroscience research, which was highly original and seemed initially to be a controlled frenzy of activity. Even when he was on active WWI duty in Salonika, and in very poor health, he was busy writing, correcting, and proofreading research articles. His arrival in a new department in Cardiff in 1920, and at a relatively new medical school, coincided with a serious dispute between the University of Wales and UCC neither of which had a clear mandate to administer the school. Graham Brown fought a 10-year battle to maintain the independence of the medical school from UCC. Although very strongly supported at the national level, he was left isolated at the medical school and ultimately lost the first long battle of his career. His father died in 1925 and two years later Graham Brown was awarded the FRS. His published research immediately stopped and he devoted the rest of his life mostly to mountaineering and sailing. This coincided with the second battle of his career, with Smythe, lasting nearly 40

²⁴As pointed out in a footnote in Stuart and Hultborn (2008), Graham Brown bequeathed in his will an endowment fund on mountaineering and his rare and valuable library of mountaineering books to the National Library of Scotland. The library produced a small booklet "Thomas Graham Brown 1882–1965" (library shelf mark GNE.2006.1.156) that is now out-of-print to accompany an exhibition that was held on his centenary in 1982. For further details on these aspects of Thomas Graham Brown's life see www.nls.uk/collections/foreign/mountains/index.html. Note also that the National Library of Scotland maintains a substantial inventory of the mountaineering articles and correspondence of Thomas Graham Brown (see www.nls.uk/catalogues/online/cnmi/index.html under the letter "B").

years. There was a brief period of intense and imaginative research activity in the late 1930s and early 1940s but nothing further was published. While Graham Brown's locomotion research still influences today's movement neuroscience, he is well known as the most outstanding British alpine climber in the interwar period.

Graham Brown was motivated at all times by self-interest. Short of stature, frugal, energetic, obsessional, ambitious, cultured but pugnacious, he polarized the opinions of those who came in contact with him, inviting enmity on one hand and intense loyalty on the other. He was indeed a fascinating figure in British academe and culture.

Acknowledgment

We are now in possession of copies of substantial correspondence between members of the Graham Brown family and Sherrington between 1890 and 1940. They all attest to Sherrington's long-standing warm relationship with this family, in general, and Thomas Graham Brown and his father, in particular. The originals of these letters are in the Graham Brown Collection at the National Library of Scotland, Edinburgh. Scotland, GBR and the Charles Sherrington Collection, Charles Woodward Memorial Room, Woodward Library, University of British Columbia, Vancouver, BC, CAN. Graham Brown bequeathed his collection to the National Library of Scotland. It includes many rare and valuable books on mountaineering. The Sherrington collection began in 1964 after a donation of letters from Sherrington's son, Carr E. R. Sherrington, and some donated by John C. Eccles, among others. The Canadian neurologist, William C. Gibson (see Eccles and Gibson, 1979), who was with Sherrington (in 1935-1936) and Eccles (1935-1937) at Oxford (see Eccles and Gibson, 1979), was instrumental in the initiation of this valuable collection. We thank Dr. Lee Perry, UBC Woodward Library, for making the relevant Sherrington collection letters available to us.

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