DORSAL COLUMN
From The Archives


One of the more enigmatic neurologists of the Victorian age died 100 years ago. Henry Charlton Bastian (26 April 1837–17 November 1915: Fig. 1) was appointed to the staff of the National Hospital Queen Square in 1868, 9 years after the hospital was founded by Johanna Chandler (1820–75) and her two siblings. Bastian encouraged (Sir William) Gowers (1845–1915) and (Sir Victor) Horsley (1857–1916) to concentrate on neurological research. John Hughlings Jackson [(1835–1911): although Hughlings Jackson is unhyphenated, there was a brief period in the 1880s when Jackson requested use of the hyphen in linking his surnames. Bastian uses a hyphen throughout his article. We have followed subsequent convention in omitting this] often quoted Bastian’s work approvingly but this generosity was not reciprocated; and Macdonald Critchley (1900–97) concluded that Bastian failed to understand the depth of Jackson’s ideas on aphasia. Despite making a number of accurate observations of lasting value and writing several influential treatises on neurological disease, Bastian’s manner and ability to communicate reduced his influence in the hospital. (Sir) Gordon Holmes (1876–1965) recalled that Bastian was an unpopular teacher because his scientific rigidity ill-fitted ‘elementary clinical practice which…requires a judicious amount of dogmatism’. Eventually, Bastian refused to lecture or teach on ward rounds although house physicians profited from his comments during examination of patients and the logical approach he took to diagnosis.

Perhaps Bastian was viewed as eccentric and maverick because he espoused a biological doctrine, designated abiogenesis, which stated that living organisms can be generated from non-organic material, in much the same way as life had originally emerged from the primeval soup. Despite being part of a group that included Herbert Spencer (1820–1903: a close friend and for whom he acted as Trustee), Charles Darwin (1809–82), Alfred Russell Wallace (1823–1916) and T.H. (Thomas Henry) Huxley (1825–95), Bastian did not succeed in persuading these prophets of evolution on the validity of his views. Wallace, a believer in spiritualism, concluded as an old man that although Bastian had one of the most acute intellects he had encountered, it was incomprehensible how a man such as he could believe in abiogenesis. In turn, Bastian spoke of Wallace as a remarkable scientific observer but asked ‘how can such a man believe in spiritualism?’ Bastian also argued for heterogenesis, a concept that postulated interchangeability between the lower forms of animal and vegetable life both amongst and between species. Obsessed by this work on biology, Bastian erected a screen within his consulting room in Manchester Square behind which he retired to conduct investigations in the intervals between seeing patients. That Bastian was at times uneasy with his ideas on the nature and origin of living matter is revealed in an unpublished letter dated 17 July 1880 to Dr (Sir) Thomas Oliver (1853–1942) from 20 Queen Anne Street, London W (Fig. 2):

‘Dear Sir, I regret that I am unable to comply with the wishes of the Council of the Literary and Philosophical Society of Newcastle. I have not now lectured on the origin of life question for about 5 years, not that my interest in the subject is in the least aborted as I am now making some experimental observations bearing upon one important side of the question, but that it becomes more and more difficult for me to get away from London to keep such engagements, and also because in the present phase of the question I do not think lectures best fit it to advance the subject. Pray convey to the committee my regret therefore at being unable to comply with their wishes. I hope you will continue to do further work in this direction. I am Dear Sir, faithfully yours, H. Charlton Bastian.’

Bastian was born in Truro, Cornwall, and educated at Falmouth School and University College London where he graduated MA (1861), MB (1863) and MD (1866). He was first appointed assistant physician and lecturer on
pathology at St Mary’s Hospital, London, resigning these posts in 1867 to become professor of pathology at University College and assistant physician at University College Hospital. There Bastian became physician and professor of medicine from 1887—the year in which he was appointed physician to the National Hospital for the Paralysed and Epileptic. He acted as Referee for the Crown in cases of questionable insanity (1884–98). Bastian was elected to Fellowship of the Royal Society (1868) in recognition of his zoological investigations on anguillulidae, a family of worms in which he described several new species. Soon after, he started to write on aphasia, describing word deafness and word blindness 5 years before Carl Wernicke (1848–1905), now better remembered for accounts of these disorders. Bastian’s work on *The various forms of loss of speech and cerebral disease* (1869) was followed by *Aphasia and other speech defects* (1898)—an ultra-disconnectionist account based on his three Lumleian lectures to the Royal College of Physicians of London given in April 1897. On 25 February 1890 Bastian read a paper to the Royal Medical and Chirurgical Society on the *Symptomatology of total transverse lesions of the spinal cord* showing that muscle tone and tendon reflexes are lost below the level of an acute spinal cord lesion. Bastian wrote conventional accounts *On paralysis from brain disease in its common forms* (1875); *Paralyses: cerebral, bulbar and spinal. A manual of diagnosis for students and practitioners* (1886); *Various forms of hysterical or functional paralysis* (1893); and a book for the general reader on *The brain as an organ of mind* (1880) published as Volume 29 in The International Scientific Series (Fig. 3). In 1867 he described degeneration in the spinal cord in a structure, which from 1880, was designated ‘Gowers’ tract’. Bastian abandoned neurology from 1897 in order to resume his studies on abiogenesis attracting indifference and then ridicule but with no weakening of position prior to his death at Chesham Boys, Buckinghamshire in 1915, aged 75 years.

Whilst at the height of his powers, Bastian led a debate held on 16 December 1886 at the Neurological Society of London on the muscular sense in which he challenged the work of (Sir David) Ferrier (1843–1928: Fig. 4) and sought to debunk the concept of the cortical motor centre. His presentation and an account of the exchange of views with those present including Ferrier, Hughlings Jackson and Horsley was later published in *Brain*. Bastian hopes to illuminate a topic on which opinion amongst ‘thinkers’ is unsettled: ‘I say “thinkers” advisedly because this is eminently one of those subjects on which observation and experiment alone will not suffice’. It is axiomatic that all movement—‘reflex…secondary-automatic…instinctive…ideo-motor…or volitional’—is guided by sensation or afferent impression, whether this be actual or revived from memories of previous actions. Movements that are reflex respond to afferent impulses through a line of least resistance; and the same is generally true of ideo-motor movements in which a well-formed beaten path exists between cells of the perceptive centre generating the idea or revived sensory process and the movement that follows. Simple and familiar voluntary movements such as ordinary speech require so little conscious activity as to be broadly similar. Only with new or unfamiliar activities are the full blaze of consciousness and attention of the performer required; and practice is needed to make these perfect. Bastian is mainly concerned with the process through which this concentration of attention upon active and revived sensory experience—or, for him, ‘consciousness’—leads to motor skills that in time become so familiar as to be considered secondary-automatic or ideo-motor. In turn, volitional movement depends on the laying down of well-trodden pathways from the centre that receives afferent stimulation and from which is derived the molecular and anatomical energy that guides efferent outflow. This approach to motor learning leads Bastian to conclude that a single anatomical structure subserves movement. This is sensory and not the so-called motor centre. Necessarily this area of cortex displays emerging levels of organization as perfection and automatism are achieved for behaviours that were initially unfamiliar. Over time, the
role of ‘consciousness’ diminishes even for movements that are highly skilled such as dancing or playing a musical instrument.

Fundamental to this process of motor learning is kinaesthesia, or the sensation and memory of movement. Kinaesthesia is complex and not confined to impressions from cutaneous structures and muscle, tendons, fasciae and articular surfaces; it includes knowledge of the position of the limbs and differences in resistance and weight by means of which the brain derives unconscious guidance in the performance of movements. Bastian defends the anticipated criticism of his concept of kinaesthesia: he is gathering items into an artificial whole by arguing that this synchronous and fused collection of intrinsic and extrinsic impressions, engaged in the workings of the nervous system during every moment of every hour of every day, serves a special purpose in guiding movements that differs from other sensory impressions. But the distinction is subtle since activity involving the five primary sensations is also often the prelude to purposive movement—that is, the behavioural response to visual, auditory, tactile, gustatory and olfactory stimulation. Given the level of activity, it follows that the area of cortex to which fibres dedicated to the kinaesthetic sense project must be large.

Charlton Bastian rehearses the history of kinaesthesia acknowledging Sir Charles Bell’s (1774–1842) first description of the ‘muscular sense’; and the experiments of E.H. (Ernst Heinrich) Weber (1795–1878) on resistance or weight as the basis for the ‘sense of force’. He emphasizes that the ability to discriminate change in weight is much enhanced by impressions from muscle; and when kinaesthesia is lost, alteration in knowing the location or position of the limbs leads to lack of coordination with the eyes closed. The modern reader will understand Bastian’s frustration but not get much too involved with his attempts to explain, in mechanistic terms, the many inconsistencies in cases where alteration in the muscular sense forms part of a more complex set of symptoms in female patients diagnosed with hysteria. Nor will they share Bastian’s astonishment that (Jean-Martin) Charcot (1825–93) has demonstrated to (Charles) Rouget (1824–1904) of Montpelier and himself a case of hysteria with hemianesthetic loss of muscular sense is whom no defects of movement or ability to perform complex motor skills are apparent during hypnosis. One insight he makes is to emphasize that cutaneous sensibility and the impressions of muscular sense may be dissociated in these cases. But in making this general point, he has to make clear in a footnote that:

‘Such facts have been strangely lost sight of by Prof. Ferrier when seeking to interpret the results of his experiments upon the cerebral cortex of monkeys. It is difficult to understand how he can make such statements…[as] “the muscular sense may continue though cutaneous sensibility is abolished”…“tactile sensibility is not entirely abolished though there may be insensitivity to pain and temperature in the cases where the muscular sense really continues”…“the same condition which abolishes cutaneous sensibility also entirely annihilates the so-called muscular sense”…[and] “there is no connection between the power of directing movements and the muscular sense as has been...'}
erroneously assumed by (Charles Édouard) Brown Séquard (1817-94) and others”. Loss of the muscular sense never occurs without general anaesthesia of the limb. No one has even furnished the slightest evidence of impairment, or loss of the muscular sense apart from profound impairment or total abolition of the common sensibility of the limb...I should be extremely glad if Prof. Ferrier would give us some references to...cases...multitudes of which he says...are to be found in [the] medical literature.' 

Dr Bastian considers cases under the care of Horsley, Hughlings Jackson and Ferrier that, he argues, support his position on the relative merits of the centre for kinaesthesia and ‘Ferrier’s so-called “motor centres” for the arm’. Although that part of the Rolandic cortex that harbours the centre for kinaesthesia has been removed, these examples represent a missed opportunity for ‘such cases require to be examined with the greatest care in order to obtain trustworthy information concerning the “muscular sense”.

Thus far, Dr Bastian has shown that loss of the muscular sense results in defective knowledge of active or passive movement and position of the limbs; difficulty in discriminating differences in weight or degrees of resistance when muscles are active; and loss of accurate movement with the eyes closed. Bastian challenges the view that, in addition to the muscular sense, kinaesthesia requires information derived from skin and joints by pointing out that position and movement of the limbs may be lost in the presence of intact cutaneous sensation, as—for example—in cases of locomotor ataxy. The careless examiner will make errors of interpretation by failing to register that cues inevitably come from stimulation of cutaneous sensation through
passive movement of the limbs whilst testing position sense. Now Bastian extends his analysis to advance the concept that muscular sense impressions previously experienced can later be revived as ‘ideas’. This is apparent in the phantom movements of amputees, and is comparable to the recollection of images in people with acquired blindness or sounds in those who become deaf. But these memories of movement are crude and more in the way of vague hallucinations than accurate sensory revivals of skilled activities. As (Silas) Weir Mitchell (1829–1914) has explained, phantom movements can be elicited by will or through faradization of nerves in the retained part of the limb eliciting the impression of movement in the previously innervated part. The ease with which phantom movements are elicited relates to the health of the stump: ‘The kinaesthetic centres in relation with a lost limb are apt to drop into a condition of functional inertia but…they are easily roused from this state by the advent of afferent stimuli’.

Impressions of the muscular sense, revived as ideas, form the basis for judging the relative weight of objects lifted in sequence or guessing the approximate weight of a single object based on prior experience. The idea is generated in the same parts as those where the original muscular sense was registered. Appreciation of weight, or the sense of resistance, implies engagement with the external world. One view, articulated by (Alexander) Bain (1810–77) and to which Hughlings Jackson also subscribes, is that the sense of resistance derives from the ‘outgoing stream of motor energy’. Others, such as (Jean Baptiste Octave) Landry (1826–65) prefer the view that the efferent activity furnishes only an idea of movement but precision and adjustments to the degree of contraction are dependent on afferent activity or the muscular sense. Bastian is in no doubt that once the kinaesthetic cortex has initiated the concept of action and the slavish physiology of movement has been dispatched down motor pathways, all sense of resistance and adjustments in force needed to manoeuvre in the external world are derived from the movement itself through sensory impressions both conscious and unconscious, emanating from many structures including muscle and joints and supplemented by vision, hearing, taste and cutaneous sensation. In this afferent-only doctrine, Bastian has the support of Dr William James (1842–1910); and, in the revised edition of Functions of the Brain (1886), of Ferrier (Fig. 5). But, Bastian differs from most other commentators, including Ferrier, in insisting that all movement is derived from sensory impression and entirely kinaesthetic in origin. In short, there are no motor centres.

Bastian accepts that the cortex plans the strength, extent, rapidity, direction and co-ordination of movement and is involved in any voluntary correction acting through ‘nerve-connections in the spinal cord and medulla’. These learned motor skills are not achieved by consciously engaging specific muscles in sequence but, rather, by thinking only of the movement itself and waiting for the alignment of orchestrated subconscious activity in the brainstem and spinal cord to carry it out. That is not to say that skill is independent of complex afferent feedback, which informs the cortex of its success or otherwise in achieving the motor goal and the need for adjustment if the planned movement turns out to be inadequate. Locomotive instinct and recall of kinaesthetic impressions initiate the force. Afferent activity registers the activity; vision is the initial guide, later replaced by kinaesthetic sensations derived from muscle and joints as the movement becomes more familiar. But it is the revival of kinaesthetic impressions with which the chain of cerebral processes that determines motor activity begins. James has added the dimension that:

‘Every representation of a motion awakens the actual motion which is its object unless inhibited by some antagonistic representation simultaneously present to the mind…the motor originally aroused the sensory, so the sensory may now arouse the motor provided no outlying ideational tracts in connection with it prevent it from so doing.’

Now Dr Bastian considers the anatomy of kinaesthesia. His evidence derives from animal studies and lesions of the human brain. The situation is more complex than suggested by Ferrier’s destructive lesions of the Rolandic cortex in animals (Fig. 6). Only in man can a sophisticated analysis of defects of sensibility be observed reliably. How, asks Bastian, can a blindfolded animal be asked to judge passive movements of one limb and its exact position in space, or differences in weight and resistance of the limbs? These
aspects of the ‘muscular sense’ depend on self-reporting and complement the crude testing of ability to perform certain movements with the eyes closed which can usefully be assessed in animals. For Bastian, information derived from lower animals is ‘altogether valueless’ and only through observations in man can we ‘throw any true light upon this side of the question’. The muscular sense depends on intact posterior columns. What happens in the brainstem is less clearly mapped but the relevant fibres traverse the posterior part of the internal capsule and project to the cortex. Bastian argues that the same motor pathway, excited by revival of ideas derived from kinaesthetic impressions, serves all voluntary, reflex and emotional movements. What differs are the sensory impressions that trigger these respective movements; and the extent to which the cortex is required to engage primitive structures in the medulla and spinal cord. But even where sensory information connects directly with the motor pathway at a low level to elicit a reflex movement, the influence of the cortex is still apparent if that same movement is enacted voluntarily. In man, the kinaesthetic, visual, auditory and tactile centres are maximally developed and most important in the generation of skilled movements. The emerging dominance of the cerebral cortex with evolution means that a greater proportion of movements in humans are voluntary than in animals. Therefore fewer coordinated movements survive lesions of the kinaesthetic centre, which paralyse voluntary movements of the opposite limbs leaving reflex activity intact, in man than lower species. However, some movements that are impaired improve over time if they were already partially habituated.

Because of the confounding effect of touch, which may cue the kinaesthetic sense, the ideal test conditions for examining human subjects are ascertaining whether the patient has or has not a complete knowledge of the position of the limb on first awaking from sleep and before any movement has occurred; testing the ability to appreciate differences in weight; and, using a method adopted by (Karl Friedrich Otto) Westphal (1833–90) and Horsley of examining the patient’s ability with the eyes closed to bring the forefinger of the unaffected hand in contact with a particular part of the affected limb. This leads Bastian to conclude that electrical stimulation of the kinaesthetic centre induces spasms and convulsive movements of the limbs; with destructive lesions characterized by paralysis and loss of muscular sense. But since these are precisely the properties described for the so-called ‘motor centres’ of the cerebral cortex [based on the work of (Theodor) Fritsch (1852–1933) and (Eduard) Hitzig (1839–1907); Ferrier, Horsley and (Sir Edward) Schafer (later, Sharpey-Schafer: 1850–1935); and (Charles) Beevor (1854–1908)], Bastian concludes that Ferrier’s motor centre is in reality the kinaesthetic centre in which the muscular sense is located and on which all voluntary movements ultimately depend. Despite Dr Ferrier’s protestations in the second edition of The functions of the Brain (1886: pp. 379–81): ‘The necessities of the case compel me therefore to be frank concerning Dr Ferrier’s position in regard to, and his treatment of, this question to which I have given considerable attention.’ Therefore, the views held by Bastian and Ferrier on voluntary movement and the kinaesthetic sense are directly opposed. Ferrier fails to distinguish properties of the centre for muscular sense from loss of afferent information to the cortex and, in so far as he offers an opinion, suggests that loss of muscular sense leads to ‘ataxy’ rather than
paralysis. This and other statements in *The functions of the Brain* convince Bastian that:

‘Dr Ferrier has given no adequate consideration to the subject. Let me say definitely that in accordance with my views, paralysis should result from the destruction of these centres; and that inaccurate and more or less disordered movements when the eyes are closed (ataxy) should be the effect of cutting across the paths of muscular sense impressions whether near the hinder part of the internal capsule or in the spinal cord...[He writes that] “it is also certain...that in paralysis from cortical disease the patient although unable to move his arm voluntarily is perfectly aware of every movement passively communicated to it and can state with exactitude whether his arm is flexed or extended...his muscular sense, as well as every other form of common sensibility, is absolutely unimpaired”...in short, it seems to me perfectly obvious that Dr Ferrier has never thoroughly thought out this portion of his subject, and that his expressed opinions have been, and still are, most inconsistent.’

Bastian reads the first edition of *The functions of the brain* as Ferrier assuming that the recall of movement occurs in the motor centres, and sensations resulting from movement reach the brain through afferent channels; moving in his second edition to the position that idea and recall of movement does occur in sensory centres but without admitting ‘a gleam of recognition of their importance for the execution of voluntary movements’ and even repudiating their influence by means of ‘two assertions which are almost wholly at variance with clinical teaching’. Ferrier makes the ‘extraordinary statement’ that loss of tactile sensibility carries with it loss of the muscular sense and that these are invariably affected together in neurological disease. For Ferrier, the motor centres are separate but connected by association fibres with corresponding regions of the sensory centre located within the falci-form lobe. Ferrier has expressed some difficulty in ‘comprehending [the] precise meaning [of Bastian’s analysis]’. ‘These difficulties I trust he will now no longer experience.’ In criticizing Ferrier’s concept of the motor cortex, Bastian reasons that its exact same properties belong to that part of the cortex that registers kinaesthesia and the muscular sense: ‘so far, then, there is nothing which may not be explained by my hypothesis with just as much ease as by the more fashionable notion’. Ferrier has argued that descending degeneration in the pyramidal tract shows conclusively that efferent fibres pass from centres in the Rolandic and marginal cortex to the medulla and spinal cord. For Bastian, this has nothing to do with organization of the cerebral cortex into a kinaesthetic centre determining voluntary movement since, self-evidently, there are efferent motor fibres in the pyramidal tract irrespective of their point of cortical origin. For him, arguments in favour or against identity of the motor and kinaesthetic centres are not helped by discussion of the descending motor pathway and whether or not voluntary and reflex movements are retained in the presence of pyramidal tract degeneration.

Next, Bastian tackles Hughlings Jackson for developing the original concept of a motor centre for voluntary activity. Jackson has always subscribed to the view of Bain that the feelings of movement are ‘concomitants of the outgoing current’; and, here, Ferrier gets another wigging for clinging to ‘a theory which is the natural associate of such rejected doctrines. His position is a very inconsistent one’. Bastian has particular difficulty with a concept of movement being dependent on activity in a part of the cortex specialized for volitional activity that fails to explain how movements that become learned and automatic are ‘registered’ in regions remote from this ‘motor centre’. It follows that movement should be elicited by electrical stimulation of the cortex at two separate sites; yet Ferrier has only been able to demonstrate one—for him, the motor centre, for Bastian the
kinaesthetic centre. And in castigating Hughlings Jackson for writing of ‘motor ideas’, Bastian dismisses all concepts of aphasia—his other main topic of interest—that embrace the notion of words being revived as ‘motor processes’. He concludes his part of the debate:

‘It seems to me to be a matter of extreme importance to recognise that the excitable areas in the Rolandic and marginal regions of the cortex are in no proper sense of the term “motor centres” and that the evidence at present in our possession makes it extremely probable that they are termini for kinaesthetic impressions derived from muscles so that their excitation in this or that region is the immediate precursor of this or that kind of voluntary movement.’

The next 50 pages of the paper report discussion at the debate where some of those present offer their own opinions, and to which Bastian then responds. Ferrier accepts that the wording changed between the two editions of The functions of the brain but not his meaning. He is dismissive of the concept of a centre for muscular sense and its designation as a sixth sense regarding kinaesthesia as an assembly of many different categories of primary sensation. His comments turn on clinical facts: the sense of movement accompanies all movements; movement may lack coordination without any loss of the muscular sense; and muscular sense can be altered without incoordination. Ferrier is ‘amazed at Dr Bastian’s statement’ that there is often no appreciable loss of muscular sense in cases of hemianaesthesia. Ferrier is:

‘[unaware] of a single observer, with the exception of Dr Bastian, who has ever seen a case of hemianesthesia in which the muscular sense was not abolished… the power of directing movements has no necessary connection with the muscular sense, and may be perfectly well retained when there is not a vestige of any sense of movement.’

Ferrier is not in doubt that all sensation is localized to the falcial gyrus and separate from the motor centre located in the Rolandic cortex. This is obvious from cases of cerebral disease with complete paralysis in which all forms of sensation, including the muscular sense, are entirely normal.

Dr (James) Ross (1837–92) is sympathetic to the view that the sense of muscular movement depends on afferent and not efferent activity. He attempts to calm the debate by arguing that everything under discussion is a matter of interpretation not fact, with the exception of the claim that the muscular sense may be preserved in cases of hysterical hemianaesthesia with paralysis. To the modern reader, this is a sterile debate. But Ross is more direct in stating that in his use of terminology, Dr Bastian uses ambiguous terms and ‘favours every species of fallacy and confusion’. He is especially critical of Bastian’s analysis of voluntary movement becoming reflex through repetition and habit; and his use of the term ‘impressive’ [impression] to denote both stimulation of nerve endings by muscular contraction and the sensation of muscular contraction. This is an ambiguity that, according to Dr Ross, is comparable to the claim by Mr (George Henry) Lewes (1817–78) that the spinal cord is conscious. For Ross, the critical issue is where transition occurs between the afferent (centripetal) and efferent (centrifugal) fibres. His answer is the large pyramidal cells in layer 3 of the cortex; these are remote from the sensory cortex and, as Bastian has argued, efferent activity cannot account for the consciousness of muscular effort:

‘I… give my unhesitating adhesion to Dr Bastian’s opinion, when he says that the kinaesthetic centre is the last centre which must be excited anterior to the movement in any psychical action… Dr Bastian would say that the kinaesthetic centre and the cortical motor centre are identical…I think it likely that [they] coincide in so far as the former are situated in the two outer and the latter in the third layer of the cortical cells of the parieto-frontal area of the cortex… my mind is quite open to accept this opinion or [the one]…favoured by Dr Ferrier… that the kinaesthetic centres are situated along with the centres for all forms of cutaneous sensibility in the falcial lobule.’

Sir James Crichton-Browne (1840–1938) asks rather petulantly how anyone plans to explain the sense of fatigue associated with effort if the doctrine of centripetal experience of movement is to be abandoned in favour of Bastian’s formulation; and how can the sense of restlessness or fidgets that many people experience and relieve by moving the limbs be best explained? Nor, through the principles of physiological economy, can he understand why so much of the cortex is devoted to motor activity if movement consists of a preliminary sensory idea, muscular contraction and sensory recognition of motion, leaving the fiat or crude motor impulse as the only component that is dependent on the motor cortex. Rather he prefers to include within the fiat many of the elements involved in planning, effecting, evaluating and adjusting movement; and so is with Ferrier in allowing the existence of the motor centre for movement. Nonetheless, he ‘conclude[s] by congratulating Dr Bastian on the grasp, subtlety and lucidity of his paper, which [will] be heartily acknowledged… by those who differ from him most’.

Hughlings Jackson asks rhetorically whether motor elements are conscious, and answers: ‘I have for many years thought that they [are]’. Just as the lower parts of the nervous system are sensory-motor units, so too are the higher parts. The idea of movement and the subsequent awareness that it has occurred are each acts of consciousness that involve or engage both sensory and motor centres. The motor element is apparent from the confidence with which an amputee moves a phantom limb by engaging the conscious idea of movement that normally releases energy onto the motor cortex. Dr Bastian considers the kinaesthetic centre to be sufficient for this process; Jackson contends that it requires activity of motor elements.
Horsley makes several semantic points. The word ‘sensation’ is not adequate to account for afferent activity that may or may not impinge on consciousness. What Dr Ferrier calls ‘motor’, Bastian terms ‘efferent’; what Dr Bastian calls ‘efferent’, others describe as ‘kinesodic’. For Horsley, activity that acts upon the motor centre is afferent and everything that it does as a result is efferent. The emphasis that Dr Bastian has placed on the cases operated upon by Horsley is misplaced: they are too few in number to add any weight to the debate. But he is persuaded, against Ferrier and for Bastian, that the boundary between afferent and efferent activity occurs at a molecular level within the layers of the cortex and not in gross anatomical separations of sensory and motor centres.

(John Berry) Haycraft (1853–1923) points out that stimulation at the surface of the body elicits a response in muscle that may act only through the spinal cord; or involve a longer loop that passes to the brain and interacts with activity in other cells and circuits. Therefore, for Professor Haycraft, there are no motor or sensory centres, merely sensory-motor loops:

‘As a result of the passage of an impulse through the nervous system, we may have muscular movement and we may have sensation, but in the nervous path through which the impulse passes it is not possible to say that one part is more motor than another, or to localise sensation to a given spot… were we to define a sensory cell merely as one that transmits an impulse from a sensory surface, and a motor cell as one that transmits an impulse directly to a muscle, we are at once met with a difficulty. The cells of the cortex are on a loop between the sensory and motor cells of the cord, and to which do they belong?’

Dr (Charles) Mercier (1852–1919) is dismissive of the entire debate, which he considers no better than a discussion at the Astronomical Society on whether or not the earth is round. Indeed Dr Bastian’s views are best designated the flat-earth or ‘geocentric doctrine of neurology’. Mercier considers that the nervous system acts to manage the relationship of the environment on the organism and the organism’s response to its environment. Life and consciousness require both: neither precedes the other or is dominant; they can be separated only in argument, not in reality. Dr Mercier delights in arguing that, in accepting that the kinaesthetic centre is the turning point of the incoming nerve current and from that centre volitional motor incitations issue that descend to the real motor centres in the cord, ‘I have Dr Bastian on the horns of a dilemma’. And if Bastian’s concept of motor incitations extends to the ridiculous position that mind and the will pass down to the spinal cord, he ‘escapes from one dilemma only to be impaled on another’. For all that can descend is an effert current inspired by a volitional impulse; and Bastian has said that:

‘The idea of movement is a concomitant of the outgoing current, and this doctrine, which he set himself down to disprove, he has laboriously established beyond all risk of confutation. Like Balaam, the son of Beor, he took up his parable to curse, and he has blessed us altogether’.

Armand de Watteville (1846–1925), the editor of Brain, sees the comments of Dr Ross as persuasive and consistent with both Ferrier and Bastian; whereas Dr Mercier:

‘Has given expression, in terms more lively than forcible, to a diametrically opposite opinion…to a termination of his lot with the “outgoing” school…whose number is…limited…his “orthodox view” will…be enforced by every impartial mind as standing on its very last legs’.

Whilst sympathetic to Bastian rather than Ferrier, de Watteville’s remaining comments represent a diplomatic attempt to reconcile their opposing views and decide whether consciousness and the muscular sense are diminished with lesions of the Rolandic or ‘motor’ cortex resulting in paralysis. He offers an olive branch in suggesting that cells generate psychical activity, consciousness, acting either as a terminus for afferent information or as a relay for the further transmission of force.

In replying, Charlton Bastian emphasizes that he is mainly challenging the work and writings of Ferrier denying the functional importance of the kinaesthetic centre and insisting on the existence of motor centres, and of Hughlings Jackson in accepting that awareness of effort relates to consciousness directly attributable to activity of the motor centre and its efferent structures:

‘Doctrines that [do] not hang together at all well…made up of contradictory statements…[those] supposed to be based upon clinical evidence…[are] in reality faulty, being drawn from too narrow a view of altogether exceptional cases, or else resting upon inadequate observation and inquiry…experiments upon animals [that] were quite useless…[failure to] comprehend the all important difference between…cutting…[the afferent tracks for muscular sense impressions and]…destruction of the cortical termini.’

Bastian ruthlessly compares sections of text from the two editions of The functions of the brain and regards Ferrier as disingenuous in failing to acknowledge his volle face or the debt he owes to the writings of Bastian himself [see The brain as an organ of mind (1880)] in amending his position between 1876 and 1886. Dr Ferrier needs to understand that loss of muscular sense causes incoordination of movement with the eyes closed; and not all cases of hemi-anesthesia are associated with loss of the muscular sense. Bastian takes comfort from the analysis offered by Dr Ross but resents the suggestion that repetitive performance never converts a voluntary into a reflex movement; and the general approval of his ideas endorsed by Horsley and de Watteville. He has little time for those who continue to accept the association of psychical processes, or consciousness, with activity of the motor centres and nerves—a view that not even Ferrier continues to
support. Bastian is not charitable when responding to his remaining opponents: on Crichton-Browne’s fatigue and fidgets, ‘I see…the enunciation of a favourite belief rather than evidence in support of its truth’; Hughlings Jackson reiterates his well-known views and makes sense when speaking of the ‘unit of constitution of the nervous system [as] a sensory-motor unit’ but on consciousness and the motor centre ‘merely to reiterate such statements is surely useless when the underlying doctrine is itself fast dying if not actually dead’; ‘I find it a little difficult to appreciate the intended cleverness of Dr Mercier’s contribution…it…impresses me with a sense of its hollowness. Like a bubble, it only requires to be pricked to vanish into thin air’. And even Professor Haycroft ‘a genuine seeker after light…seems to be either obscure or of doubtful cogency’.

Dr Bastian closes the debate by further arguments on the need for two or more sites of motor response to cortical stimulation if the Rolandic cortex is separate from that for kinaesthesia; and the way in which the molecular analyses of Ross and Horsley reconcile that difficulty. But once the notion of the psychical consequences of activity in the motor centres is rejected, ‘there is no longer the faintest need for postulating the existence of cortical motor centres’.

As experimental methods began to supplement the analyses of clinical cases, and empirical data honed their theoretical formulations, neurologists of the Victorian era started to grasp the essence of form and function in the central nervous system. With phrenology evolving into the doctrine of cortical localization, Charlton Bastian thought in terms of centres and connectivity. But in challenging the party line on separate motor and sensory centres and taking 137 pages of Brain to argue that movement is sensation driven by the memory of muscular activity, Bastian was as far ahead of his time as were the formulations of Hughlings Jackson and Ferrier—men that he challenged without reservation or restraint in expressing his views on kinaesthesia.

Alastair Compston
Cambridge