

Journal of the History of the Neurosciences

Basic and Clinical Perspectives

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/njhn20


The trial of David Ferrier, November 1881: Context, proceedings, and aftermath

Ian Bone & Andrew J. Larner


To cite this article: Ian Bone & Andrew J. Larner (28 Mar 2024): The trial of David Ferrier, November 1881: Context, proceedings, and aftermath, Journal of the History of the Neurosciences, DOI: [10.1080/0964704X.2024.2324809](https://doi.org/10.1080/0964704X.2024.2324809)

To link to this article: <https://doi.org/10.1080/0964704X.2024.2324809>

 © 2024 The Author(s). Published with license by Taylor & Francis Group, LLC.

 Published online: 28 Mar 2024.



 Submit your article to this journal [↗](#)

 Article views: 342

 View related articles [↗](#)

 View Crossmark data [↗](#)

The trial of David Ferrier, November 1881: Context, proceedings, and aftermath

Ian Bone ^a and Andrew J. Larner ^b

^aHonorary Senior Research Fellow, Institute of Cardiovascular and Medical Sciences, University of Glasgow, Glasgow, UK; ^bHonorary Senior Research Fellow, Department of Brain Repair & Rehabilitation, Institute of Neurology, University College London, London, UK

ABSTRACT

In November 1881, the eminent physiologist and physician David Ferrier was prosecuted under the Cruelty to Animals Act 1876. The prosecution was raised by the Victoria Street Society, formerly known as the Society for the Protection of Animals Liable to Vivisection, through its activist founder, Frances Power Cobbe. This article examines the legislative context prior to Ferrier's trial, the personalities involved in the prosecution, and its course and outcome. The resultant impact, both personal, on Cobbe and Ferrier, and professional, on experimental neurophysiology, is discussed, in particular the foundation of the Association for the Advancement of Medicine by Research (AAMR) and the provision of legal support for medical practitioners subject to litigation.

KEYWORDS


Cortical localization; Cruelty to Animals Act; David Ferrier; Frances Cobbe; trial; vivisection

Introduction

The early medical vivisectionists

In his study of antivivisection and medical science in the Victorian era, Richard French drew attention to the role of vivisection in the ancient world as well as by the physiologists of the sixteenth and seventeenth centuries, in particular the works of William Harvey (1578–1657) in the elucidating the circulation of the blood (French 1975). He also noted Samuel Johnson's (1709–1784) disdain for animal dissection in advancing physiological knowledge: Writing in *The Idler* in 1758, Johnson commented, "It is time that universal resentment should arise against these horrid operations, which tend to harden the heart."

Both French (1975) and Stahnisch (2010) have provided comprehensive accounts of the history of the medical advancements owed to the vivisectionists and the many animals on which they experimented. In France, the research of François Magendie (1783–1855) and his former collaborator Claude Bernard (1813–1878) resulted in intense antivivisectionist opprobrium. Magendie was first to recognize and promote vivisection as an essential tool of modern physiology. He provoked outrage when, during a demonstration at London's Windmill Street Anatomy School, he pinned a live dog to the table and proceeded to dissect

CONTACT Andrew J. Larner  andrew.larner2@nhs.net  Honorary Senior Research Fellow, Department of Brain Repair & Rehabilitation, Institute of Neurology, University College London, London WC1E 6BT, UK.

© 2024 The Author(s). Published with license by Taylor & Francis Group, LLC.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

it (Anon 1837, 805–806). This widely publicized incident was credited with mobilizing the British antivivisection movement.

In contrast to his acclaimed bedside manner, many who observed Magendie's animal demonstrations felt him callous and inappropriate (Olmsted 1944, 221–222). At the Collège de France in Paris, where he was the first physiology professor, Magendie regularly experimented on domestic animals such as puppies, rabbits, cats, and pigeons purchased from local street markets (Stahnisch 2010, 139). Magendie's laboratory assistant and protégé Claude Bernard also became a major practitioner of vivisection. His works on pancreatic function and homeostasis were based on animal experimentation with the methodology set out in his book *An Introduction to the Study of Experimental Medicine* (Bernard 1865). Here he contended that experimentalists had the right “wholly and absolutely” to use animals. His wife and daughters, so upset at his vivisection of a family dog, campaigned against the practice and became active members of the Parisian Society for the Protection of Animals (Midgley 1998, 28).

The English physiologist Marshall Hall (1790–1857), in his researches on spinal cord and capillary blood vessel functions, was frequently subjected to accusations of animal cruelty in the press. In response to this, he attempted to introduce a voluntary code of practice in which animal experimentation must be deemed useful, free of pain, and independently witnessed to be accepted as justifiable (Bates 2017, 203; Hall 1847). Hall's suggestions were not adopted by his peers, nor was his recommendation of governance through a society formed specifically for physiological research. Such was the level of complacency at that time that the *Lancet* responded to accusations of animal cruelty by claiming that the practice “does not exist” and that professors of medicine “*very rarely* prove by such experiments that they feel themselves warranted in thus testing theories which hold forth a promise of ulterior benefit to man” (Anon. 1835,1836, 391; italics in the original). Not all, however, supported vivisection as essential for the advancement of medical knowledge. Sir Charles Bell (1774–1842), first professor of anatomy and surgery at the Royal College of Surgeons of London, believed that anatomy and clinical observation were of greater importance, commenting, “It is but a poor manner of acquiring fame, to multiply experiments on brutes and take the chance of discovery; we ought, at least, to get at truth without cruelty, and to form a judgment without having recourse to torture” (cited by Taylor 1892, 9).

Hence, up until this time, vivisection might be subjected to moral censure but not to any form of legal sanction. This was to change with the development of a robust antivivisection movement and the passage in Great Britain of the Cruelty to Animals Act in 1876 (French 1975; Ozer 1966).

The introduction of legislation and the first prosecutions

Prior to the early-nineteenth century, legislation related to livestock alone, with the only enforceable offense being that of harming an animal that was the property of others. The eccentric Irish member of the British Parliament representing Galway, Richard Martin (1754–1834), introduced the *Improper Treatment of Cattle Act* in 1821. Although initially met with derision from fellow parliamentarians, Martin's wit and flamboyance saw that the bill was passed (Niven 1967, 61–62). In 1835, Parliament extended the provisions of Martin's Act to domestic pets and prohibited bull-baiting and cockfighting. Disquiet at the lack of police funding to enforce Martin's Act led to the formation of voluntary societies

whose purpose became that of gathering evidence to bring prosecutions. The world's first animal rights charity, the Society for the Prevention of Cruelty to Animals (SPCA), was founded in 1824 and obtained royal patronage through Princess Victoria in 1835, with full royal status in 1840 (RSPCA), sometime after Victoria's coronation (Moss 1961, 20–22). The Queen's support provided an unchallengeable respectability and the Society was soon to have its attention turned to the issue of animal experimentation. The early RSPCA prosecutions were against impoverished drovers and farm hands, with the experiments of scientists ignored and felt necessary for genuine scientific enquiry (Obenchain 2012, 34).

The Annual Meeting of the British Medical Association (BMA) held in Norwich in August 1874 offered the RSPCA—under its secretary, John Colam—the opportunity for a high-profile prosecution that might reassure those critical of the Society's seeming reluctance to confront scientific experimentation with animals. Three local BMA members invited Dr. Magnan of Paris to carry out an experiment into the convulsive effects of absinthe when injected into the veins of two conscious but restrained dogs. The resultant uproar resulted in the summoning of a magistrate. The demonstration went unreported in the account of the Meeting published in the *British Medical Journal* (*BMJ*) and Dr. Magnan's name appeared only as an attendee, dinner guest, and for a communication on the anatomical lesions of general paralysis (Anon 1874a, 1874b, 1874c). Colam, under Martin's Act, initiated proceedings against Magnan, who had now returned to Paris, and the organizers of the demonstration. The prosecution—which was reported widely in the *Norwich Chronicle* (Anon 1874d), *Medical Times and Gazette* (Anon 1874e, 1874f), the *BMJ* (Anon 1874g, 1875), and the French press—took place at Norwich Petty Sessions. The *BMJ* report stated the summons was taken against “Dr. Eugene Magnan” (Anon 1874g, 751), a nomenclature followed by French (French 1975, 55), but there is no reason to believe that it was not, in fact, Dr Valentin Magnan (1835–1916), director of the Paris Asylum at Sainte-Anne, as his research interests in absinthe were well known (Eadie 2009); certainly, Snow (2008, 157) stated that Valentin Magnan was the defendant in the Norwich case.

Dr. Magnan did not attend, and the prosecution could not prove that the other defendants played any active role in the experiment. The case was dismissed with the defendants denied costs. Both the general and medical press were divided over the outcome. The eminent surgeon Sir William Fergusson, castigated by his peers for being a prosecution witness, concluded that he doubted as to whether such an experiment would benefit science, “as it was not likely that one person would inject absinthe or alcohol into the vein of another” (Anon 1874h, 828). A later correspondent noted that the same experimental demonstration had received an award at the annual meeting of Academie des Sciences of Paris, and “M.D. of 1834” called for further investigations “in countries where the lives of human beings are more valued than the comforts and luxuries of their dogs” (Anon 1875).

In addition to the furor that surrounded the Norwich case, another issue that provoked the antivivisectionists, and that proved to be one of the most powerful arguments for their movement, was the publication of the *Handbook for the Physiological Laboratory* (Burdon Sanderson 1873), which described many experiments to be undertaken by ongoing classes of students but made little reference to the anesthetizing of animals undergoing such experiments. The principal mover in this enterprise—John Burdon Sanderson (1828–1905), Professor of Physiology at University College London (O'Connor 1988, 141–146)—was one of only three academic physiologists in Britain at this time, the others being Michael Foster in Cambridge and Arthur Gamgee in Manchester (Ozer 1966, 162).

These various factors converged to prompt the setting up of the Royal Commission on the Practice of Subjecting Live Animals to Experiments for Scientific Purposes under Lord Cardwell in 1876 (for its contents, see Hornsby 2019). This eventually led to the 1876 Cruelty to Animals Act (39 and 40 Vic., cap. 77). The Act was the first to regulate the treatment of live animals in medical research and was alternatively known as the “Vivisection Act.” It prohibited painful experiments on animals, although with certain restrictions, and the public exhibition of experiments; set out a registry of places where these experiments might be performed; and established the power to certificate all practitioners. The Home Secretary was to oversee licensing of experiments and the periodic inspection of all sites at which they were conducted. Experiments were to have scientific validity and could be performed without anesthesia if there were scientific reasons for doing so. The self-regulatory and essentially permissive nature of the Act did not satisfy many in the antivivisection lobby.

The first successful prosecution under the Vivisection Act took place in Sunderland in the northeast of England, far from the medical mainstream, and involved Dr. Gustav Adolph Abrath, a little-known Westphalia-born medical practitioner (Anon 1876a, 1876b, 1876c; French 1975, 201). The *BMJ*, in a brief account of the case, stated, “The Vivisection Act has been put to a very useful and desirable purpose in Sunderland.” It reported that Dr. Abrath had advertised a lecture during which he proposed to carry out an experiment that involved the administration of antimony to unspecified animals. Although the experiment did not take place, the advertisement was sufficient to be an infraction of the Act. The *BMJ* reported that Abrath refused to express regret through his solicitor, as a consequence of which he was “fined a shilling and costs.” The *BMJ* account concluded, “we cannot at all regret that the law was enforced” (Anon 1876b).

Dr. Abrath responded through the letters page of the journal to correct the narrative and proclaim his innocence. The placard, for public display, announcing his intention to conduct the experiment, was printed within three days of the Act being passed. Stating that, “I am a German, therefore can scarcely be expected to know the provisions of every new law passed at Westminster,” he nevertheless abandoned the experiments as soon as his attention was drawn to the Act. He claimed he was “fined by the Sunderland magistrates for publishing my intention, my abandoned intention.” He felt he had been used as an example, “as they would pursue a hare,” by those in London who had assisted in introducing the Act “to show the world what a wonderful instrument for the suppression of cruelties they have badgered the legislature into giving them.” He concluded that he was “a subscriber to the local branch of the Society for the Prevention of Cruelty to Animals who, I may add, declined to prosecute me” (Abrath 1876).

A further, more high-profile, prosecution under the Vivisection Act was to follow some five years later, orchestrated by one of the most formidable of antivivisectionists, Frances Power Cobbe.

Frances Power Cobbe: Antivivisectionism and The Physiological Society

Frances Power Cobbe (1822–1904) was an Anglo-Irish free thinker and social reformer who had a significant impact in the antivivisection debates of the late-nineteenth century (Cobbe 1894; Hamilton 2006; Mitchell 2004; Obenchain 2012; Williamson 2005). Born into wealth at Newbridge House in County Dublin, Cobbe could count bishops and parliamentarians as

antecedents and the famous and influential among house guests. One of five children, she had four brothers, and her solitary childhood was exacerbated by home education followed by finishing school in distant Brighton, England. She rebelled against being “finished” and prepared for a good marriage, writing that it prepared women only to be an “ornament of society” and that if “a pupil in that school should ever become an artist or authoress it would have been looked upon . . . as a deplorable dereliction.”

From this experience, Cobbe rose to become one of the best-known female intellectuals of her day. She became an advocate for women’s suffrage, a critic of the place of women in Victorian marriage, and championed improvement in women’s education and employment opportunities. She published widely in periodicals and produced many books and pamphlets on women’s rights, science, and medicine, and she became a key figure in the anti-vivisection movement. As a young woman from a hunting, shooting, and coursing heritage she was not expected to participate in such activities, but nor did she condemn them. She wrote, “From the close of 1874, when I undertook the anti-vivisection crusade, my literary activity dwindled down rapidly to small proportions” (Cobbe 1894, 388).

The refusal of Pope Pius IX (1792–1878) to grant support for an animal protection society on the basis that it was “a theological error to suppose that man owes any duty to an animal” (Cobbe 1889, 9) led Cobbe to write a critique entitled, “The Moral Aspects of Vivisection,” published in the *New Quarterly Magazine* and later as a pamphlet (Cobbe 1875). Therein she addressed her contradictory views on hunting, writing, “it is almost ludicrous to compare a fox-hunt (for example) with its free chances of escape, and its almost instantaneous termination in the annihilation of the poor fox when captured, with the slow, long-drawn agonies of an affectionate, trustful dog, fastened down limb by limb, and mangled on its torture trough,” adding, “I refuse even to entertain the question ‘Whether the torture of animals can be justified on the plea of benefit to humanity’” (Cobbe 1875, 12–13, 16).

Soon afterward, as a reaction to the perceived weakness of the RSPCA to tackle vivisection, Cobbe with her colleague, Dr. George Hoggan, founded the “Society for the Protection of Animals from Vivisection” [*sic*] with its inaugural meeting held at Westminster Palace Hotel on June 10, 1876 (Cobbe 1894, 490). Hoggan, a former naval officer who subsequently studied medicine in Edinburgh, had spent four months in Claude Bernard’s laboratory in Paris and had thus witnessed vivisection first hand (French 1975, 68). This society later became known as the Victoria Street Society (VSS) and enjoyed the patronage of Queen Victoria. Anthony Ashley Cooper—seventh Earl of Shaftesbury (1801–1885), parliamentarian, and reformer—was its first president, and its earliest members included the Bishop of Westminster, Lord Coleridge the Chief Justice of England, the poets Lord Tennyson and Robert Browning, and the writer and art critic John Ruskin (Cobbe 1894, 570). Cobbe’s ability to place well-written articles in a host of leading periodicals kept the vivisection issue in the public domain and, even though she did not testify to Lord Cardwell’s Royal Commission (French 1975, 101–102), her powerful connections were instrumental in easing the passage of the Cruelty to Animals Act through Parliament, receiving its Royal Assent on August 15, 1876.

In the same year, the Physiological Society was founded. Conscious of the Act then passing through Parliament and keen to promote experimental physiological research, John Burdon Sanderson invited interested parties to a meeting at his house, 49 Queen Anne Street, London, on March 31, 1876, to consider “whether any, or what steps ought to be taken with reference to the Recommendations of Lord Cardwell’s Commission.” A proposal

“That an association be formed under the name of ‘The Physiological Society’ for promoting the advancement of Physiology and facilitating the intercourse of physiologists” was supported, and at a subsequent meeting on April 26, 1876, the Draft Constitution was submitted and adopted as the Rules of the Society. Among its founder members were the scientific luminaries Thomas Henry Huxley, Michael Foster, Francis Galton, and George Henry Lewes, as well as other distinguished physiologists, such as William Rutherford, Arthur Gamgee, and Emanuel Klein, along with David Ferrier; Charles Darwin was an Honorary Member (Sharpey-Schafer 1927, 12–13). Klein, assistant professor at London’s Brown Institution, had given evidence to the Royal Commission and had expressed his disregard for animal suffering and his avoidance of anesthetics unless to stop him being bitten, testimony that had caused outrage and provided manna from heaven for the antivivisectionist lobby (French 1975, 103–105). Huxley (1876) wrote to Michael Foster that Klein had “done more for our enemies than they could have done by their joint efforts.”

Huxley’s choice of the noun ‘enemies’ revealed how the Physiological Society now regarded the antivivisectionists. Despite the passing of the Cruelty to Animals Act, Cobbe’s crusade had only just begun. The objective remained total abolition, and to her the Act fell far short of that. She believed it ineffectual and wished it rescinded, later writing in her autobiography, “In my despair I wrote several letters of bitter reproach to the friends in Parliament who had allowed our bill to be so mutilated that the ‘British Medical Journal’ crowed over it, as affording full liberty to ‘science’” (Cobbe 1894, 596). Late in 1878, Lord Shaftesbury had written to Cobbe that the Home Secretary, Richard Assheton Cross (1823–1914), and the administration “have failed us, and we are bound in duty, I think, to leap over all limitations, and go in for the total abolition of this vile and cruel form of Idolatry” (Cobbe 1894, 511–512).

David Ferrier (1843–1928): Experimental researches in cerebral physiology

David Ferrier was born in the village of Woodside, now part of the City of Aberdeen, in January 1843, the sixth child of Hannah and David Ferrier Snr (Leyland, 1888, 61–67). Little is known of his background, but he certainly would not have enjoyed the privileged childhood of Frances Cobbe. Ferrier attended Aberdeen Grammar School and then won a scholarship to attend Aberdeen University, whence he graduated in 1863 with a first-class honors Master of Arts (MA) degree in classics and philosophy. While there he was influenced by the teachings of the psychologist and philosopher Alexander Bain (1818–1903), and at the latter’s suggestion, he attended Heidelberg University in Germany to study anatomy, physiology, and chemistry and to visit the laboratories of Helmholtz and Wundt. This visit presumably also afforded him the opportunity to become fluent in German, a faculty that was later of some importance in his scientific endeavors.

After returning to Edinburgh to study medicine, graduating with first-class honors in 1868, Ferrier worked as clinical assistant for Professor Thomas Laycock (1812–1876), which may well have inspired his interest in the workings of the brain. From there Ferrier moved to Bury St. Edmunds in England as an assistant at a general practice, which afforded him time to write a thesis on “The Comparative Anatomy and Intimate Structure of the Corpora Quadrigemina,” which won a gold medal from the University of Edinburgh in 1870. He then moved to London as a lecturer in physiology at the Middlesex Hospital and also worked with Burdon Sanderson, editor of the *Handbook for the Physiological Laboratory* (1873) that so offended Cobbe and her associates.

In London, Ferrier encountered John Hughlings Jackson (1835–1911), whose speculations on cerebral pathology and the cause of epileptic seizures (Jackson 1870) were to have a fundamental influence on his subsequent career. Having moved to King's College Hospital as Assistant-Demonstrator of Practical Physiology in 1871, Ferrier was subsequently appointed Professor of Forensic Medicine in 1872. His sponsor, William Rutherford, then Professor of Physiology at King's College (O'Connor 1988, 188–189), commented that Ferrier should be appointed “not because he was possessed of knowledge of the subject” but because he was a man “possessed of much original powers” (Millett 1998, 286).

The development of Ferrier's ideas on cortical localization (Young 1970, 234–248) advanced during the spring of 1873, when he undertook a program of experimental work in the laboratory of the West Riding Pauper Lunatic Asylum at Wakefield, West Yorkshire. His arrival in this remote location in the north of England, far from metropolitan centers of physiological research, was due to the promptings of James Crichton-Browne (1840–1938), the Asylum Superintendent since 1866 who had inaugurated and equipped the laboratory there around 1870. Both Ferrier and Crichton-Browne were Edinburgh graduates (1868 and 1862, respectively) and both had been influenced by Thomas Laycock. The inspiration for Ferrier's experiments “on over thirty guinea-pigs, rabbits, cats, and dogs” (Ferrier 1873a) came from two sources.

Two German investigators, Gustav Fritsch (1838–1927) and Eduard Hitzig (1838–1907), had reported in 1870 on the electrical excitability of an exposed dog's cerebral cortex using galvanic (direct) stimulation, finding localized centers for various movements (Fritsch and Hitzig 1870). Ferrier, who in 1871 had reviewed the Fritsch and Hitzig paper (Fraser, Brunton, and Ferrier 1871, 396), extended their findings both in terms of method (faradic rather than galvanic stimulation of the brain) and extent (species examined, number of cortical centers identified). Ferrier noted that the centers for voluntary movement lay in the front of the brain with distinct areas for each, that these were crossed (under control of the contralateral hemisphere), with the exception of tongue, mouth, and neck movements, which were bilaterally coordinated. In his summative paper published in the *West Riding Lunatic Asylum Medical Reports*, the Asylum's house journal edited by Crichton-Browne, Ferrier was careful to state “once for all, that before and throughout all the following experiments, ether or chloroform was administered” (Ferrier 1873b, 35), perhaps mindful of the evolving antivivisection lobby. Nevertheless, Ferrier's work had a significant influence on the antivivisection movement (Finn and Stark 2015).

The other stimulus to Ferrier's experiments was the opportunity to test Hughlings Jackson's views on the pathology of epilepsy as a discharging lesion, views that were amply confirmed. Ferrier reported that “the proximate causes of different epilepsies are, as Dr Hughlings Jackson supposes, ‘discharging lesions’ of the different centres in the cerebral hemispheres” (Ferrier 1873a, 1873b, 94). In addition to his experimental work, Ferrier also took advantage of the Wakefield Asylum casebooks and pathological records “to show clinical bearings of experimental researches” by comparing symptoms during life with the postmortem pathological condition of the brain (i.e., clinico-pathological correlation) in five selected cases (Ferrier 1874a).

Returning to London, Ferrier extended his work to monkeys (Ferrier 1874b), culminating in presentations and papers at the Royal Society, election to the Fellowship on June 1, 1876 (shortly after his attendance at the inaugural meeting of the Physiological Society), and the publication of a monograph, *The Functions of the Brain*, in the same year, a work

dedicated to Hughlings Jackson “as a mark of the author’s esteem and admiration” (Ferrier 1876). Two years later Ferrier delivered the Gulstonian Lectures at the Royal College of Physicians (RCP) of London, published as *The Localization of Cerebral Disease* (Ferrier 1878), dedicated to the Parisian neurologist Jean-Martin Charcot (1825–1893). Also in 1878, Ferrier was a founding editor, along with Crichton-Browne, Hughlings Jackson, and John Charles Bucknill, of *Brain: A journal of neurology*, successor to the now defunct *West Riding Lunatic Asylum Medical Reports* (Larner 2023a).

The International Medical Congress: August 4, 1881

Ferrier’s work on cortical localization from 1873 onward had created both national and international interest, but his conclusions were not universally accepted, and many were critical of his techniques, particularly Hitzig (Finger 2000). Also among these critics was Friedrich Goltz (1834–1902), Professor of Physiology at the University of Strassburg (now Strasbourg). Goltz believed in the equipotentiality or functional equivalence of brain regions, rather than localization of specific functions, and followed the assertions of the French physiologist Jean Pierre Flourens (1794–1867) dating from the 1820s that large parts of the animal brain could be removed without loss of function. The Seventh International Medical Conference, held in London in August 1881, was to provide the setting for these opposing views of brain physiology to be discussed and investigated, in what has come to be called the Goltz-Ferrier debate (Tyler and Malessa 2000).

The *BMJ* reported the Conference in detail, noting that Section II, Physiology, was constituted on Thursday (August 4) and at 10 a.m., “an introductory address was delivered by the President, Dr. MICHAEL FOSTER; after which, a discussion on Localisation of Function in the Cerebral Cortex was opened by Professor Goltz” (Anon 1881a; capitalization in the original).

Goltz, speaking in German, preferred the methodology of ablation or extirpation of brain tissue to electrical stimulation. He showed a jar containing the brain of a dog that had undergone four such ablative procedures a year before being sacrificed. He stated that, despite these operations, the dog was neither paralyzed nor deprived of hearing or sight, albeit “mentally deficient.” To confirm this report, he offered to exhibit a living dog, brought by him to England, that had undergone similar surgery but without paralysis or loss of vision or smell, as visible evidence that Ferrier’s theory of localization of functions was wrong, and to have the dog sacrificed and its brain examined (Goltz 1881, 218–228).

In response, although not disputing Goltz’s facts, Ferrier reported, “During the last two years I have had opportunities of observing animals operated upon by my colleague, Professor Gerald Yeo, in an investigation into the application of the principles of antiseptic surgery to lesions of the brain and its coverings.” Gerald Francis Yeo (1845–1909), a graduate of Trinity College Dublin, had been appointed Professor of Physiology at King’s College London in succession to Rutherford in 1874 and was a founder member of the Physiological Society (O’Connor, 1988, 189–190; Cunningham 2023). His surgical skills and experience with antiseptic techniques (Yeo 1880, 1881a) thus allowed long-term follow-up of animals following focal brain lesions. Ferrier reported in detail on a monkey with leg paralysis contralateral to a focal lesion of the upper extremity of the fissure of Rolando, along with photographs, a plaster cast, and sequential microscopic sections showing

Wallerian degeneration in the motor pathways of the animal's brain. He offered to demonstrate a living monkey similarly operated (Ferrier 1881, 228–233).

On the afternoon of August 4, the delegates moved to the laboratory of King's College London, separate from the Congress, in order to witness the exhibition of Goltz's dog, which behaved as previously described (Goltz 1881, 234–237). Ferrier then exhibited two monkeys, one with a right hemiparesis resulting from a focal left hemisphere motor area lesion (apparently provoking Charcot's comment, "C'est un malade!") and one with apparent hearing loss following bilateral temporo-sphenoidal hemisphere lesions (Ferrier 1881, 237). Yeo also commented, noting, "the fact of my having done all the operations" and stating that he "commenced this series of experiments with distinct misgivings as to the existence of local cortical centres, in Ferrier's sense, so that I may say I was rather prejudiced against, than in favour of, his views" (Yeo 1881b, 238). Yeo also disputed Goltz's interpretations of his dog's behavior and expressed skepticism as to the extent of its brain lesions, predicting that much of the cortex would be found intact (Yeo 1881b, 238–239). The animals were then killed, and the brains superficially examined, with note made that the dog's left hemisphere was unexpectedly not as extensively damaged as the right, whereas the description of the two monkeys' lesions proved accurate.

Although Foster urged that hurried and superficial examination was of little value and appointed a committee to examine the brains in detail, nevertheless the outcome of the initial findings was a clear victory for Ferrier's views over those of Goltz. Some preliminary pathological findings were included in the published Congress *Transactions*, of the dog's left (Klein 1881) and right (Langley 1881) hemispheres, and of the hemiplegic monkey's brain (Schäfer, 1881). The definitive pathological reports appeared in the *Journal of Physiology* in 1884, including the first publication on which Charles Scott Sherrington was an author (Langley and Sherrington 1884).

As well as the official Congress *Transactions*, the talks and presentations by Goltz and Ferrier on August 4 were also reported in the *Lancet* (Anon 1881b) and in the *BMJ* (Anon 1881c), the latter not appearing until two months later (October 8). It was these two reports that were to contribute decisively to the subsequent legal action directed against Ferrier.

The summons: November 3, 1881

Three months after the discussions at the International Medical Congress and the demonstrations at King's College, unanticipated events were to unfold that catapulted Ferrier into the public limelight.

On November 4, 1881, the *Times* of London, under the heading "Police," reported the granting of a summons against Professor Ferrier under the Vivisection Act, detailing some of the case against him made on behalf of the Victoria Street Society and mentioning both of the monkeys he demonstrated, based on extracts from the report in the *Lancet*. If found guilty, Ferrier was liable to a penalty of £50 (*Times*, 1881a).

The astounding news was also picked up in the medical and scientific press. On November 5, 1881, under the heading "Summons under the Vivisection Act," the *BMJ* reported:

At the Bow Street Police Court, on Thursday [November 3], Mr. Waddy, Q.C., applied, on behalf of the Victoria Street Society for the Protection of Animals from Vivisection, for

a summons under the Vivisection Act against Professor Ferrier of King's College, for performing a "frightful and shocking" experiment without authority from the Home Secretary. The experiment referred to was the removal of the brain from monkeys as described by Dr. Ferrier in the Section of Physiology at the meeting of the International Medical Congress. (Anon 1881d)

A few days later, on November 10, 1881, the summons was noted in the pages of *Nature*:

Most of our readers will have heard with regret, and probably surprise, that Prof. Ferrier has been charged with a breach of the Vivisection Act. On the general question our opinion is well known, but into the merits of this particular case we cannot enter so long as the trial is pending. (Anon 1881e)

The story also ran in the *New York Times* on December 11 (*New York Times* 1881).

In her autobiography, Frances Power Cobbe wrote that "among our undertakings on behalf of the victims of science was the prosecution of Professor Ferrier at Bow Street on the 17th November, 1881, on the strength of certain reports in two leading medical journals" and that "we had ascertained he had no licence for vivisection" (Cobbe 1894, 615). The International Medical Congress reports referred to were those appearing in the *Lancet* and the *BMJ*. The *Lancet* report, although Cobbe dated it incorrectly, noted that Professor Ferrier had "referred in detail to several of his experiments on monkeys" and "was willing to exhibit two monkeys which he had operated upon [*sic*] some months previously" (Anon 1881b, 327). The *BMJ*'s account of the proceedings of the Section on Physiology was even more explicit, reporting:

members were shown two of the monkeys, a portion of whose cortex had been removed by Professor Ferrier [*sic*]. Concerning the first of these, Professor Ferrier said it had been his desire to remove as completely as possible the whole of the psychomotor region. Whether in this he had succeeded perfectly could not be learnt for certainty until after a *post mortem* examination had been made. (Anon 1881c, 589)

It was on the basis of these two reports, both contradicting the unambiguous statements made at the Congress, and appearing in the *Transactions*, by both Ferrier (viz. "I have had opportunities of observing animals operated upon by my colleague, Professor Gerald Yeo"; Ferrier 1881, 230) and Yeo (viz. "the fact of my having done all the operations"; Yeo 1881b, 238), and also Ferrier apparently having no vivisection license that, to the dismay of the scientific community, Frances Cobbe and the Victoria Street Society felt they had found the ideal target for summons to criminal trial.

The trial: November 17, 1881

The fullest contemporary account of the trial appeared in the *BMJ* (Anon 1881f), but other journals published abbreviated reports, including the *Lancet* (Anon 1881g) and the *Boston Medical and Surgical Journal* (Anon 1881h), as did the *Times* (*Times*, 1881b). The London Metropolitan Archive's Bow Street collection does not extend back beyond the 1890s and has no record. Some previous accounts of the trial have appeared (e.g., French 1975, 200–204; Finn and Stark 2015, 15).

The case was heard before the chief magistrate of London, Sir James Ingham (1805–1890), sitting at Bow Street Court on November 17, 1881. The cost of Ferrier's defense, there being no professional insurance at the time, was met by the British Medical Association.

Mr. Waddy, Queen's Council, Mr. Besley, and Mr. Coleridge appeared for the Crown, with Mr. Gully and Mr. Houghton, instructed on behalf of the British Medical Association by Mr. Upton, for the defendant. Ferrier was offered the opportunity of trial by jury but favored the Chief Magistrate as arbiter (Anon 1881f, 836).

Mr Waddy opened by referring to pretrial discussions with the Judge and Mr. Gully that had clarified "what it is we propose to prove." He continued that the Act "was passed in favour of the medical profession and in the interests of science," agreeing that no experiment should be performed except by a licensed person who, having obtained the necessary certificate, could lift certain restrictions on how experiments should be conducted in the interests of science. He stated:

I am not going to allege that Dr Ferrier performed the operation in question; I do not know that he did; but that is not the question we are upon. The question we are upon now is whether or not the operation was the beginning of the experiment performed six months before the time of which I speak, and whether the victims—or as that may be an offensive term, I will say the subjects—of the initial part of the experiment were kept alive by Dr. Ferrier for the purpose of experiments being performed upon them in contravention of the 4th subsection of section 3: "The animal must, if pain is likely to continue after the effect of the anaesthetic has ceased, or if any serious injury have been inflicted on the animal, be killed before it has recovered from the influence of the anaesthetic which has been administered."

He concluded his opening statement by saying, "there shall be no real restriction upon the performance of all experiments that are necessary in the interests of science and humanity" (Anon 1881f, 836).

Mr. Gully for the defense responded: "Do I understand that the charge made here to-day is, not that Dr. Ferrier performed an operation upon animals calculated to give pain, but that, having performed such operation, he did not destroy the animals?"

The Judge asked the counsel to consider what was meant by the term "experiment." Did this begin and end with the operation, or did it continue over a reasonable period of time to attain the objective of the vivisection? If the alleged offense was committed at the time of surgery alone, and if the surgery were before May 3, then the case was barred, because of the passage of time, under statute of limitation. If the surgical operation was only part of an experiment that continued up until its eventual conclusion, then it could be adjudicated. On the basis that evidence would show the experiment, as defined by the Act of Parliament, was continuing within a period of six months from the date of the summons, Sir James Ingham allowed the trial to proceed. Mr. Waddy for the prosecution acknowledged that if he could not establish "that there has been an experiment performed within six months of the date of the summons, I must fail" (Anon 1881f, 837).

Waddy defined two kinds of experiment: one in which the purpose was to establish an immediate fact, in which case the animal was killed before the effect of an anaesthetic ceased, and the other in which the aim was not immediate but, rather, to study the result of a certain operation. He agreed that the Act said that it was reasonable for an experiment to last weeks or months to serve its scientific purpose but that it would require a certificate "to continue your experiments as long as, in the interest of science, it may be considered necessary." He outlined the process for acquiring this certificate from the Government and the manner in which approval for a vivisection experiment was obtained, monitored, and, if indicated, disallowed. Having addressed the Act with respect to pain suffered by animals, and the requirement to minimize this by ensuring that the animal was killed before the

effect of an anaesthetic had worn off, he went on to discuss Dr. Ferrier's experiments. He described the purpose as being "the removal of the brains [*sic*] of monkeys, one or more, then the careful observation from day to day of the subsequent lives of those monkeys" (Anon 1881f, 837). He added that there was no advantage in the animals continuing under anaesthetic thereafter, as the purpose was to observe them awake.

Waddy outlined to the Judge the concept of cerebral localization, the role of vivisection in its understanding, and Ferrier's preeminence as a researcher. He challenged Ferrier that "You have been performing this experiment over a considerable length of time; and you ought, therefore, to have had a certificate." He added that, "Men of eminence, men of science, men of benevolence, are precisely those who must bring themselves within the operations of the law." Waddy noted that at the Medical Congress, after the live demonstration of the dog and the monkeys, Ferrier, Goltz, and the committee adjourned to the laboratory to examine the now slaughtered animals. The experiment was therefore, in his view, continuous up until the moment of the committee's adjudication. Waddy speculated that someone else with a license, "Professor Yeo, for instance," might perform the operations, and pass the animal on to an unlicensed person such as Dr. Ferrier, who would then observe the consequences of the operation and protect themselves by saying, "I did not do the cutting and wounding; I did not perform the first operation—I am merely keeping the animal alive now that it is seriously injured." The prosecution's case lay with the experiment being continuous up until its adjudication and that Dr. Ferrier was experimenting right up to that moment without a license to do so. Waddy concluded, "I am not stating that Dr. Ferrier is a cruel or a brutal man. I am simply bringing forward the short and narrow point that Dr. Ferrier had not got a certificate" (Anon 1881f, 838).

Charles Smart Roy (1854–1897), then working in Michael Foster's physiological laboratory in Cambridge (O'Connor 1988, 183–185), and one of the secretaries for the Physiological Section of the Congress, was next examined by Mr. Coleridge for the prosecution. Dr. Roy had dictated, to a shorthand writer, a portion of the Congress report eventually published in the *BMJ* in October 1881, although he had not read the proofs before publication and subsequently felt the account, describing Dr. Ferrier performing the operations, was inaccurate. Dr. Roy started by saying that Ferrier had referred to experiments he had made or assisted in where parts of brain cortex were removed from monkeys. Dr. Roy could recollect little more than that the two monkeys exhibited were operated on by Professor Yeo. He commented that he could remember Dr. Ferrier alluding to two monkeys that would be exhibited to show the results of certain operations but, "I do not remember that he said that he had performed the operations." He recalled a large number of the members of the Congress, between 70 and 100, adjourning to the King's College laboratory, where Ferrier spoke about the monkeys' paralysis and deafness. He observed that Dr. Ferrier did not touch the hemiplegic monkey, as the paralysis was evident to all. Dr. Roy concluded by saying that the laboratory at which the monkeys were examined was under Professor Yeo's charge and that he was "well known in the scientific world with reference to experiments of this nature" (Anon 1881f, 839).

The prosecution next called Dr. Michael Foster (1836–1907), Lecturer in Physiology at Trinity College Cambridge (O'Connor 1988, 167–171), President of the Physiological Section of the Congress and Chair during the debate. He recalled that Goltz and Ferrier discussed the methodology of their respective vivisections in detail, with Ferrier advocating an antiseptic surgical approach modeled on that of Professor

Joseph Lister. He added that in former years Ferrier “had removed from the surface of the brains of monkeys certain parts, and certain parts only” in consequence of which removal the animal was unable to move an arm or leg, or was left blind or deaf, according to the specific part removed. Foster noted Ferrier’s claim that his former experiments on monkeys had been corroborated by later observations that he had been able to make on monkeys Professor Yeo had operated on using Lister’s antiseptic techniques. Foster concluded that “there are two sets of monkeys, the old and the new. The old monkeys were operated on by Professor Ferrier himself, and the new monkeys by Dr Yeo” (Anon 1881f, 840).

The counsel asked Foster why there was no public announcement made at the Congress that the animals would be exhibited and thereafter slaughtered with their brains examined. Foster replied that he and the Executive Committee thought it undesirable to become “entangled with what is popularly called the vivisection question.” He added it was thought by the physiologists present that it would be desirable to “examine these animals together—on the one hand, the dog brought by Professor Goltz, and on the other hand the monkeys which had been operated upon by Professor Yeo.” When asked when the killing of the animals took place, he replied that he had no part in the process, although the proposal to do so came through himself as an expression of “the desire of, I may say, all the physiologists present,” along with the appointment of four eminent members to receive and examine the brains. He stated that the paralyzed monkey was selected for postmortem and that, “We all knew that this monkey had been operated upon by Professor Yeo in a definite way, and had received a definite superficial injury” (Anon 1881f, 840).

Here the Judge intervened to ask the prosecution counsel, if it was proved that the monkeys had been operated on by Professor Yeo, then what was the offense Professor Ferrier was being accused of? Waddy replied, “Continuing the experiment upon this animal upon which serious injury had been inflicted, it not having been killed before it recovered from the influence of the anaesthetic.”

The Judge, referring to Ferrier’s postsurgical assessments, summarized, “Then you say that his pinching the monkey which had been operated upon by Professor Yeo made him a participator in that cruel experiment?”

The prosecution, now accepting Yeo as the operator, was now pressing the case against Ferrier on the grounds that the monkeys had not been killed before the anaesthetic had worn off, that the experiment had lasted for months after they had been awoken, and therefore any person continuing an experiment that had commenced with inflicting pain and suffering remained liable. If the offense—not sacrificing the monkeys before the anaesthetic had worn off—was accepted, then Ferrier would be aiding and abetting through keeping those animals alive and continuing to observe them. The Judge asked if, by that argument, “the hundred scientific gentlemen who attended the laboratory were partakers in the cruelty?” and therefore also liable. At this stage, given that there was no proof that Ferrier had anything to do with the original vivisection, Sir James felt, if the prosecution had nothing else to adduce, it was his duty to dismiss the summons (Anon 1881f, 840–841).

The examination of Michael Foster, who had remained in the witness box throughout, resumed. He said that he understood the monkeys were the property of Professor Yeo and were being observed by Professor Ferrier for the effects of their brain surgery. Regarding the eventual slaying, he stated that he had not asked Ferrier’s permission for this, although the latter had acquiesced beforehand. He said that he was uncertain if he

had known about the monkeys prior to the Congress demonstration but that their existence had been known to other physiologists, including Professor Burdon Sanderson (Anon 1881f, 841).

The founding editor of the *Lancet*, Thomas Wakley, was next called to answer to the accuracy of his journal's Congress report, which had been authored by Professor Arthur Gamgee (1841–1909) of Owens College, Manchester (O'Connor 1988, 232–234). With the accuracy of the report disputed by the defense, the prosecution asked for an adjournment in order to call Gamgee, Waddy expressing frustration that “we do not get much assistance in the course of a prosecution of this kind from gentlemen of the medical profession.” Mr. Gully for the defense said that he had communicated with Professor Gamgee, who would only say what Dr. Roy had already said, that “the article does contain false impressions.” Request for adjournment was withdrawn (Anon 1881f, 841).

The Judge, Sir James Ingham, then opined that it had been proved that the operation that had caused pain was performed by Yeo and that thereafter the monkeys were kept in Yeo's possession with facilities afforded to Ferrier so that he might inspect them from time to time to ascertain the outcomes of Yeo's surgery. He concluded, “Further, I think the case cannot be carried,” as Ferrier had done no more than take “great interest in the results of a cruel operation performed for the purposes of science no doubt by another person.” Gully responded to the word “cruel” by clarifying that Professor Yeo had conducted the surgery “in strict accordance with the law, using anaesthetics, having a licence for the operation, and having a certificate for the keeping the animal alive.” The summons was dismissed (Anon 1881f, 841–842). Ferrier had not been required to utter a single word in court.

The aftermath: Reaction to the dismissal

As the trial ended, the *BMJ* published an anonymous justification of Ferrier's work entitled, “Dr Ferrier's Localisations: For Whose Advantage?” (Anon 1881i). In citing cases in which cerebral localization had led to successful treatment, the author(s) asserted that Ferrier's researches through mapping of the brain were “as invaluable as a chart of an unknown region would be to an explorer” and concluded by regretting “that these benefactors of the human race have been interrupted, and dragged to the police-court as criminals, happily in vain, but at the very moment when science and humanity are hailing their work as of the most beneficent character and of the largest promise.”

There was ample comment on the outcome of the trial both in the *BMJ* and elsewhere (e.g., Anon 1881j), the *Lancet*, for example, opining of the prosecution that “the case stated by them was nothing less than absurd” (Anon 1881k). The *Times* published an account of Ferrier's work abridged from the *BMJ* article (*Times*, 1881c). Both sympathy for and congratulations to Ferrier were forthcoming from various medical bodies (e.g., the Medical Society of London, Middlesex Hospital Medical Society, the Harveian Society) and from individuals proposing a testimonial for Ferrier (Sewill 1881; Wilks 1881). But in addition to personal support for Ferrier, a more general concern about the future of experimental science was generated by the trial, prompting calls, emanating initially from Samuel Wilks, for the setting up of a science defense fund or association. Such calls were to lead to further action from the corporate body of experimental physiologists.

The aftermath: Frances Power Cobbe

Frances Cobbe remained convinced of Ferrier's guilt and felt that the dismissal was down to collusion with his fellow vivisectionists. Writing in the *Fortnightly Review* (Cobbe 1882, 98) she reproduced the *Lancet* and *BMJ* reports upon which the summons was based, although she muddled the respective publication dates, alongside what she saw as the contradictory evidence of Drs. Roy and Wakley. Cobbe concluded "We find it practically impossible to separate torturing from non-torturing Vivisection, or to obtain for an animal bound on a vivisection table any security against the extremity of torture. We, therefore, ask of Parliament the total prohibition of Vivisection" (Cobbe 1882, 104). (Coincidentally in the same volume of the *Fortnightly Review*, Gerald Yeo wrote on the practice of vivisection in England.)

In 1881 the Victoria Street Society drafted its own abolition bill and introduced it to Parliament through its powerful contacts, but after several attempts and little enthusiasm, it was withdrawn in 1884 and no further attempt was made thereafter (French 1975, 165). Frustrated, Cobbe stayed on as the Society's honorary secretary until she left London for Wales later in 1884 (Cobbe 1894, 610) with her partner, the Welsh sculptor Mary Lloyd (1819–1896), and their dog, Hajjin (Mitchell 2004, 139–147).

Some years later, in *The Modern Rack* (Cobbe 1889, 72–75), reflecting on the 1883 House of Commons debate on a bill for the total prohibition of vivisection, Cobbe made her views on Ferrier's trial clear. She hypothesized that there were only two possible explanations for Dr. Roy and Professor Gamgee making precisely the same error in their independent Congress reports—namely, attributing the operations to Ferrier rather than to Yeo. First, that in both draft reports the experiments had been correctly attributed to Yeo but "the editor, for some occult reason, substituted throughout the name 'Ferrier' for 'Yeo'"; or second, that Roy wrote "Ferrier" by mistake when he meant "Yeo" and that Gamgee "in reporting for the *Lancet*, underwent precisely the same very remarkable hallucination!" (even though Gamgee's report appeared first!). Cobbe also referred to the publication by Ferrier and Yeo in the *Philosophical Transactions of the Royal Society* in 1884 describing their experiments on the effects of lesions to regions of the monkey cerebral hemispheres, noting that both authors received a grant from the British Medical Association but only Ferrier from the Royal Society, and that the Congress monkeys were included in the report (Ferrier and Yeo 1884). This, along with the fact that Ferrier's name appeared as first author, led her to deduce that Ferrier had the leading share in the experiments and carried the responsibility for them. Questioning the veracity of Ferrier and others, Cobbe concluded "If these things were done *under oath*, what might we expect to find in their books and reports?" (italics in the original).

The Victoria Street Society changed its name in 1897 to the National Anti-Vivisection Society (NAVS). With the change in policy and leadership Cobbe threatened to resign and withdraw financial support. The new leadership under Stephen Coleridge no longer considered total abolition of vivisection a practical aim, adding that Miss Cobbe was admired for her stainless life "but at this point her judgment is astray" (Mitchell 2004, 353). Furious at this, Cobbe resigned and, in 1898, formed her new society, the British Union for the Abolition of Vivisection (BUAV) (French 1975, 163). The journal *The Abolitionist* was founded, replacing the Victoria Street Society's *Zoophilist* (Obenchain 2012, 229), and here Cobbe set out her manifesto in an article entitled, "Why We Have founded the British

Union for the Abolition of Vivisection.” In this she stated, “There is the greatest of all objections to Lesser Measures, namely that Vivisection being a *great Sin* – . . . it ought to be opposed absolutely and unreservedly” (Cobbe 1898, 5, capitals and italics in original) while bemoaning that the Prime Minister “loads the most notorious Vivisectors with baronetcies and knighthoods” (Cobbe 1898, 8).

To ensure that the BUAV would outlive her, Cobbe appointed Walter Hadwen (1854–1932), a Gloucester general practitioner, as her successor. (Mitchell 2004, 360). On her eightieth birthday in 1902, Cobbe received a congratulatory card signed by 346 prominent people, including Mark Twain and Florence Nightingale (Williamson 2005, 209). While her reputation remained untarnished, her desire to seek total abolition of vivisection had been diminished by lack of progress. Cobbe died in April 1904 and was buried, alongside her partner, Mary Lloyd, in Llanelltyd Cemetery.

The aftermath: David Ferrier

Ferrier’s trial was reported not only in the medical press but also in the popular press, both in the United Kingdom and the United States. This brought him before the public eye, and it was probably as a consequence of this that subsequent literary works addressed his activities, at least in passing. These fictions either mentioned him by name—as in Wilkie Collins’s *Heart and Science: A Story of the Present Time* (1883) and Bram Stoker’s *Dracula* (1897)—or responded to his experimental work, as in H. G. Wells’s *The Island of Doctor Moreau* (1896; see Larner 2023b; Otis 2007; Pedlar 2003). Despite, or possibly even because of this, Ferrier’s reputation was preserved, both scientifically and clinically.

Ferrier and Yeo’s paper describing their experimental studies was read to the Royal Society in January 1884 and published in full with plates in the Society’s *Philosophical Transactions* later that year (Ferrier and Yeo 1884). In the prefatory note, the research funding is as described by Cobbe and it is made clear that the results presented are “partly the results of research made conjointly.” Moreover, “The conjoint experiments are marked with an asterisk. Of these alone joint authorship is to be understood.” The animals, exclusively monkeys and mostly of the macaque species, were chloroformed throughout and lesions were made by galvanic cautery using aseptic techniques. Thirty-three experiments were described, of which Cases 13 and 18 were those animals presented by Ferrier at King’s College; both of these are marked with an asterisk indicating joint authorship, although there is no indication whether Ferrier or Yeo performed the surgery (Ferrier and Yeo 1884, 505–507 and 517–520, respectively). Despite Cobbe’s interpretation, there is no “smoking gun” in the *Philosophical Transactions* paper, only ambiguity.

In his earlier publications detailing his studies on the brains of monkeys, Ferrier made no mention of collaboration and thus can be assumed to have conducted the experiments single-handedly (Ferrier 1874b). Similarly, in the first edition of *The Functions of the Brain* (Ferrier 1876), there is no acknowledgment of collaboration with Yeo, or any others. In the rewritten and enlarged second edition of this monograph, published in 1886, Gerald Yeo is mentioned on several occasions (11) in relation to “the monkeys operated upon by Dr Yeo and myself” (Ferrier 1886, 275). Both the animals presented at King’s College in 1881 are described (Ferrier 1886, 310, 356) but no mention is made here of Yeo. However, there is evidence that Ferrier and Yeo worked conjointly before the International Medical Congress and the subsequent trial: At the 1880 Annual Meeting of the British Medical Association held in Cambridge Ferrier spoke on

affections of vision from cerebral disease “in connection with recent investigations made by himself and his colleague Professor Gerald Yeo” (Ferrier 1880, 333). Contrary to his previous view that the angular gyrus was the visual center (a view later shown to be erroneous: Fishman 1995; Glickstein 1985), Ferrier here reported that “the visual centre in the monkey included not only the angular gyrus but the occipital lobe” (Ferrier 1880, 333). Similarly, in Yeo’s presentation, given at the same meeting, on the antiseptic method of dressing in cranio-cerebral surgery he acknowledged having “had the great advantage of the advice and assistance of Dr. Ferrier” (Yeo 1880, 339; also, 1881a, 763).

In his Marshall Hall Prize Oration delivered on October 23, 1883, Ferrier described the encounter with Goltz by saying that the “fundamental question ‘localisation or no localisation?’ was brought to a crisis at the meeting of the International Medical Congress” (Ferrier 1884, 36). He quoted Virchow to the effect that the goal of modern medicine must be the localization of disease (Ferrier 1884, 47). Ferrier added that when the sacrificed monkey’s brain was independently examined, “Suffice it to say that the lesions were confined to the cortical and subjacent medullary fibres, in the regions I have indicated” (Ferrier 1884, 38). He briefly acknowledged Gerald Yeo’s contribution to the debate but did not credit him with involvement in the experimental work (Ferrier 1884, 37). He concluded by commenting that “the unfailing safety” of experiments on animals made him “believe that similar results are capable of being achieved on man himself” (Ferrier 1884, 48).

Although he had to endure further attacks from the antivivisectionists during the 1880s, in the form both of flyers (*Professor Ferrier’s Experiments on Monkeys’ Brains*, 1885; *Ferriestic Brain Surgery. A Candid Condemnation*, 1887; French 1975, 281–282) and publications (Clarke 1888), Ferrier was able to witness first-hand the ultimate clinical and humanitarian justification for his vivisection work. This occurred when Rickman Godlee, in November 1884, undertook the surgical removal of a brain tumor (Bennett and Godlee 1884), its location correctly predicted by the correlation of clinical signs and Ferrier’s brain maps.

Ferrier delivered the Croonian Lectures at the RCP London on cerebral localization in 1890, and further work on experimental brain lesions in animals was to follow in studies undertaken with Aldren Turner (Ferrier and Turner 1894, 1898, 1901). Ferrier was a founder member of the Neurological Society of London in 1886 and its president in 1894. His standing in the profession was further reinforced by his appointment as RCP Harveian Orator in 1902 and Lumleian Lecturer in 1906. He was knighted in 1911 and later became president of the Medical Society of London (1913–1914). His death in 1928 was much lamented, one obituary characterizing him (alongside Hughlings Jackson) as one of “the Saints of Neurology” and “among the greatest benefactors of the human race” for having “made straight the way for us, their humble surgical followers” (Balance 1928, 574). The neurologist Aldren Turner described Ferrier as “the foremost of scientific physicians of his day” (Turner 1928, 575). Many years later (in 1941), Sherrington, in his reminiscences of his early association with the Physiological Society, stated of Ferrier: “He was much hampered by anti-vivisectionists. They prosecuted him for the experiments he had done on the monkey’s brain. He won the action hands down, so perhaps they were not so much in his way after all” (Bynum 1976, 27).

Some questions remain. Why did Ferrier, a skilled animal experimentalist with an enduring interest in the questions of cortical localization, not apply for a Home Office license which, if granted, would have entirely avoided his summons and trial? Perhaps he thought others more able to perform the ablative surgery, as opposed to his skills of

localized brain stimulation. Perhaps it was evident that Yeo had these skills and, moreover, was a designated physiologist, whereas Ferrier was no longer officially affiliated to physiology but to forensic medicine, although the history of the Physiological Society indicates that he was still regularly attending meetings in the early 1880s, his attendance waning notably only after 1884 (Sharpey-Schafer 1927). The antiseptic techniques that Yeo pioneered in the experimental situation may have offered obvious potential benefits to Ferrier's research interests and hence to collaborative study.

However, another possibility is raised by a note in the *BMJ* on "Refusal of licences for experiment on animals" published shortly after the trial, which stated, "It is known . . . that Professor Ferrier was warned not to apply to the Home Office for a licence for experiments, seeing that there are there enthroned prejudices and influences which made it unlikely that it would be granted" (Anon., 1881).

The source of these "prejudices and influences" was unstated, but one might speculate that Ferrier's reputation as a vivisector was so toxic (perhaps due to the lobbying of Cobbe and the VSS) as to negate political support for such an application. A subsequent analysis of "Applicants refused licences, 1876–1882" does not include Ferrier's name, but Yeo is there, in November 1881 (French 1975, 186–187). However, O'Connor (1988, 189) stated that "Ferrier had not been allowed a vivisection licence under the 1877 [*sic*] Act."

The aftermath: The response of experimental physiologists

The founding of the Association for the Advancement of Medicine by Research (AAMR) followed closely on the heels of Ferrier's trial (French 1975, 200–215). As shown by Boddice (2021, 20–49), this occurred not simply as a consequence of the trial, although this was obviously the trigger for renewed activity, but in the context of previous publications in the *Lancet* (Anon 1881m) and the *Journal of Science*, the latter suggesting the need for a Biological Defence League (M.D. 1880). The Physiological Society was also involved in these efforts: Instructed by the Society's committee, Lauder Brunton approached Darwin to become President of the mooted AAMR, which he declined but pledged money (£100) in support. The organization did garner a large number of illustrious scientific supporters and financial resources. Yeo was on the council, but Ferrier does not seem to have been involved in any way.

By April 1882, the AAMR was founded. Shortly thereafter, in May 1882, an offer was made to the Home Secretary that AAMR members would be willing to advise and assist in administering the Cruelty to Animals Act, an offer that was quickly taken up. Thus, by the end of 1882, only applications vetted and recommended by the AAMR were to be submitted to the Home Secretary for licensing. Henceforward AAMR effectively administered the Act, to the outrage of the antivivisectionists.

Conclusion

Despite its brevity, the trial of David Ferrier may be seen as pivotal in the history of experimental neuroscience in that it galvanized experimentalists to take robust, albeit discreet, steps to protect themselves from any future legal jeopardy. Perhaps operating on the principle that if a researcher as lionized as Ferrier could be targeted, so could they all, collective action was undertaken to establish the AAMR. The members of the AAMR effectively defanged the Cruelty to Animals Act by collaborating with government to allow experimentalists to vet research applications before

consideration by the Home Secretary, ensuring professional rather than political influence took precedence in decision making. The enormous increase in animal experimentation after Ferrier's trial is testimony to the effectiveness of this response, which so facilitated the further development of neuroscientific research in the later part of the nineteenth century.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The authors reported there is no funding associated with the work featured in this article.

ORCID

Ian Bone  <http://orcid.org/0009-0000-5418-1167>

Andrew J. Larner  <http://orcid.org/0000-0003-0128-8010>

References

- Abrath, G. A. 1876. First conviction under the Vivisection Act. *BMJ* 2:545.
- Anon. 1835–1836. Experiments on living animals. *Lancet* 2:390–91.
- Anon. 1837. On experiments on living animals. *London Medical Gazette* 20:804–08.
- Anon. 1874a. Forty-second Annual Meeting of the British Medical Association. *BMJ* 2:247.
- Anon. 1874b. The dinner. *BMJ* 2:250.
- Anon. 1874c. Forty-second Annual Meeting of the British Medical Association. *BMJ* 2:287.
- Anon. 1874d. The vivisection of dogs at the British Medical Association Meeting: Prosecution for alleged cruelty. *The Norwich Chronicle*. December 12.
- Anon. 1874e. Vivisection. *Medical Times and Gazette* 2:666.
- Anon. 1874f. Vivisection at Norwich. *Medical Times and Gazette* 2:691.
- Anon. 1874g. Prosecution at Norwich. Experiments on animals. *BMJ* 2:751–54.
- Anon. 1874h. M. Mangan's experiments. *BMJ* 2:828–29.
- Anon. 1875. The recent vivisection trial at Norwich. *BMJ* 1:25–26.
- Anon. 1876a. First conviction under the Vivisection Act. *Medical Press and Circular* 23:285.
- Anon. 1876b. [Untitled]. *BMJ* 2:475.
- Anon. 1876c. Dr. Abrath, of Sunderland. *Medical Times and Gazette* 2:442.
- Anon. 1881a. [Untitled]. *BMJ* 2:238.
- Anon. 1881b. The International Medical Congress. Section II. – Physiology. *Lancet* 2:326–28.
- Anon. 1881c. Discussion on the localisation of the functions in the cerebral cortex. *BMJ* 2:588–89.
- Anon. 1881d. Summons under the Vivisection Act. *BMJ* 2:752.
- Anon. 1881e. [Untitled]. *Nature* 25(628):42.
- Anon. 1881f. The Charge against Professor Ferrier under the Vivisection Act: Dismissal of the summons. *British Medical Journal* 2(1090):836–42.
- Anon. 1881g. The vivisection prosecution. The Queen v. Ferrier. *Lancet* 2:892–93.
- Anon. 1881h. Letter from London. The prosecution or persecution of Professor David Ferrier F.R.S., M.D., by the anti-vivisectionists. *Boston Medical and Surgical Journal* 105:552–54.
- Anon. 1881i. Dr Ferrier's localisations: for whose advantage? *BMJ* 2:822–24.
- Anon. 1881j. The Ferrier prosecution. Comments of the Press. *BMJ* 2:886.
- Anon. 1881k. The Vivisection prosecution. *Lancet* 2:881.
- Anon. 1881l. Refusal of licences for experiment on animals. *BMJ* 2:948.

- Anon. 1881m. [Untitled]. *Lancet* 2:343–44.
- Balance, C. 1928. Obituary. The late David Ferrier. *BMJ* 1:574.
- Bates, A. W. H. 2017. *Anti-vivisection and the profession of medicine in Britain: A social history*. London: Palgrave Macmillan.
- Bennett, A. H., and R. J. Godlee. 1884. Excision of a tumour from the brain. *Lancet* 2 (3199):1090–91. doi:10.1016/S0140-6736(02)29062-5.
- Bernard, C. 1865. *An introduction to the study of experimental medicine*. Paris: J.B. Bailliere et Fils.
- Boddice, R. 2021. *Humane professions: The defence of experimental medicine, 1876-1914*. Cambridge: Cambridge University Press.
- Burdon Sanderson, J. S., ed. 1873. *Handbook for the physiological laboratory*. 2 volumes. London: J. & A. Churchill.
- Bynum, W. F. 1976. A short history of the Physiological Society 1926–1976. *The Journal of Physiology* 263 (1):23–72. doi:10.1113/jphysiol.1976.sp011621.
- Clarke, J. H. 1888. *Monkeys' brains once more: Schaefer v. Ferrier*. London: Victoria Street Society.
- Cobbe, F. P. 1875. *The moral aspects of vivisection*. London and Edinburgh: Williams and Norgate.
- Cobbe, F. P. 1882. Vivisection: Four replies. *Fortnightly Review* 31:88–104.
- Cobbe, F. P. 1889. *The Modern Rack: Papers on vivisection*. London: Swan Sonnenschein & Co.
- Cobbe, F. P. 1894. *The life of Frances Power Cobbe: By herself*. Boston and New York: Houghton Mifflin & Co.
- Cobbe, F. P. 1898. *Why we have founded the British Union for the Abolition of Vivisection*. Gloucester: P J Brooke.
- Cunningham, M. 2023. Gerald Francis Yeo: Mapping the brain. *Physiology News* 129:44–46.
- Eadie, M. 2009. Absinthe, epileptic seizures and Valentin Magnan. *The Journal of the Royal College of Physicians of Edinburgh* 39 (1):73–78.
- Ferrier, D. 1873a. Experimental researches in cerebral physiology and pathology. *BMJ* 1 (643):457. doi:10.1136/bmj.1.643.457.
- Ferrier, D. 1873b. Experimental researches in cerebral physiology and pathology. *West Riding Lunatic Asylum Medical Reports* 3:30–96.
- Ferrier, D. 1874a. Pathological illustrations of brain function. *West Riding Lunatic Asylum Medical Reports* 4:30–62.
- Ferrier, D. 1874b. Experiments on the brain of monkeys – No. 1. *Proceedings of the Royal Society of London* 23:409–30.
- Ferrier, D. 1876. *The functions of the brain*. London: Smith, Elder & Co.
- Ferrier, D. 1878. *The localisation of cerebral disease being the Gulstonian Lectures of the Royal College of Physicians for 1878*. London: Smith, Elder & Co.
- Ferrier, D. 1880. Affections of vision from cerebral disease. *BMJ* 2:333–34.
- Ferrier, D. 1881. *Discussion on the Localization of Function in the Cortex Cerebri. Transactions of the International Medical Congress. Seventh session. Held in London, August 2d [sic] to 9th, 1881. Prepared for publication under the direction of the executive committee by Sir William Mac Cormac Honorary Secretary-General assisted by George Henry Makins, F.R.C.S. Under-Secretary and the Secretaries of the Sections*. Vol. 1, 228–33, 237, 240, London: J.W. Kolckmann.
- Ferrier, D. 1884. Cerebral localisation. A review and forecast. Being the Marshall Hall Prize Oration. *Medico-chirurgical Review* 67 (1):33–49. doi:10.1177/095952878406700103.
- Ferrier, D. 1886. *The functions of the brain*. 2nd ed. London: Smith, Elder & Co.
- Ferrier, D., and W. A. Turner. 1894. Record of experiments illustrative of the symptomatology and degenerations following lesions of the cerebellum and its peduncles and related structures in monkeys. *Philosophical Transactions of the Royal Society of London* 185:719–78.
- Ferrier, D., and W. A. Turner. 1898. An experimental research upon cerebro-cortical afferent and efferent tracts. *Philosophical Transactions of the Royal Society* 190:1–44.
- Ferrier, D., and W. A. Turner. 1901. Experimental lesion of the corpora quadrigemina in monkeys. *Brain* 24 (1):27–46. doi:10.1093/brain/24.1.27.
- Ferrier, D., and G. F. Yeo. 1884. A record of experiments on the effects of lesion of different regions of the cerebral hemispheres. *Philosophical Transactions of the Royal Society of London* 175:479–564.

- Finger, S. 2000. David Ferrier and Eduard Hitzig: The experimentalists map the cerebral cortex. In *Minds behind the brain. A history of the pioneers and their discoveries*, ed. S. Finger, 155–75. Oxford: Oxford University Press.
- Finn, M. A., and J. F. Stark. 2015. Medical science and the Cruelty to Animals Act 1876: A re-examination of anti-vivisectionism in provincial Britain. *Studies in History and Philosophy of Biological and Biomedical Sciences* 49:12–23. doi:10.1016/j.shpsc.2014.10.007.
- Fishman, R. S. 1995. Ferrier's mistake revisited, or when it comes to the brain, nothing is simple. *Archives of Neurology* 52 (7):725–30. doi:10.1001/archneur.1995.00540310099022.
- Fraser, T. R., T. L. Brunton, and D. Ferrier. 1871. Report on the progress of physiology: From 1st January to 1st April, 1871. *Journal of Anatomy and Physiology* 5 (Pt 2):389–411.
- French, R. D. 1975. *Antivivisection and medical science in Victorian society*. Princeton and London: Princeton University Press.
- Fritsch, G., and E. Hitzig. 1870. Über die elektrische Erregbarkeit des Grosshirns [On the electrical excitability of the cerebrum]. *Archiv für Anatomie, Physiologie und wissenschaftliche Medizin* 37:300–32. Reprinted in *Epilepsy Behav* 2009; 15:123–30.
- Glickstein, M. 1985. Ferrier's mistake. *Trends in Neurosciences* 8:341–44. doi:10.1016/0166-2236(85)90119-5.
- Goltz, F. 1881. *Discussion on the Localization [sic] of Function in the Cortex Cerebri [in German]*. *Transactions of the International Medical Congress. Seventh session. Held in London, August 2d [sic] to 9th, 1881. Prepared for publication under the direction of the executive committee by Sir William Mac Cormac Honorary Secretary-General assisted by George Henry Makins, F.R.C.S. Under-Secretary and the Secretaries of the Sections*, Vol. 1, 218–28, 234–7, 240. London: J.W. Kolckmann.
- Hall, M. 1847. On experiments in physiology, as a question of medical ethics. *Lancet* 1 (1220):58–60, 161. doi:10.1016/S0140-6736(00)59261-7.
- Hamilton, S. 2006. *Frances Power Cobbe and Victorian feminism*. London: Palgrave Macmillan.
- Hornsby, A. 2019. Unfeeling brutes? The 1875 Royal Commission on Vivisection and the Science of Suffering. *Victorian Review* 45 (1):97–115. doi:10.1353/vcr.2019.0033.
- Huxley, T. 1876. Letter to Michael Foster. 25th May. Huxley papers 4.120.
- Jackson, J. H. 1870. A study of convulsions. *St Andrews Medical Graduates' Association Transactions* 3:162–204.
- Klein, E. 1881. *Brain of dog. Left side of brain of dog*. *Transactions of the International Medical Congress. Seventh session. Held in London, August 2d [sic] to 9th, 1881. Prepared for publication under the direction of the executive committee by Sir William Mac Cormac Honorary Secretary-General assisted by George Henry Makins, F.R.C.S. Under-Secretary and the Secretaries of the Sections*, Vol. 1, 242a–b. London: J.W. Kolckmann.
- Langley, J. N. 1881. *Brain of dog. Right side of brain of dog*. *Transactions of the International Medical Congress. Seventh session. Held in London, August 2d [sic] to 9th, 1881. Prepared for publication under the direction of the executive committee by Sir William Mac Cormac Honorary Secretary-General assisted by George Henry Makins, F.R.C.S. Under-Secretary and the Secretaries of the Sections*, Vol. 1, 242b–c. London: J.W. Kolckmann.
- Langley, J. N., and C. S. Sherrington. 1884. Secondary degeneration of nerve tracts following removal of the cortex of the cerebrum in the dog. *The Journal of Physiology* 5 (2):49–65. doi:10.1113/jphysiol.1884.sp000151.
- Larner, A. J. 2023a. The *West Riding Lunatic Asylum Medical Reports*: The precursor of *Brain ? Brain* 146 (11):4437–45. doi:10.1093/brain/awad219.
- Larner, A. J. 2023b. Neuroliterature: David Ferrier (1843–1928). *Advances in Clinical Neuroscience and Rehabilitation* 22 (2):20–22.
- Leyland J. (ed.). 1888. *Contemporary medical men and their professional work: Biographies of leading physicians and surgeons, with portraits, from the "Provincial Medical Journal."* Volume II. Leicester: Office of the Provincial Medical Journal.
- M.D. 1880. The protection of research. *Journal of Science* 17(78):408.
- Midgley, M. 1998. *Animals and why they matter*. Athens: University of Georgia Press.

- Millett, D. 1998. Illustrating a revolution: An unrecognized contribution to the “golden era” of cerebral localization. *Notes and Records of the Royal Society of London* 52 (2):283–305. doi:10.1098/rsnr.1998.0051.
- Mitchell, S. 2004. *Frances Power Cobbe: Victorian feminist, journalist, reformer*. Charlottesville and London: University of Virginia Press.
- Moss, A. W. 1961. *Valiant crusade: The history of the R.S.P.C.A.* London: Cassell.
- New York Times*. 1881. Dr Ferrier accused. December 11, p. 5.
- Niven, C. D. 1967. *History of the humane movement*. London: Johnson Publications.
- Obenchain, T. G. 2012. *The Victorian vivisection debate. Frances Power Cobbe, experimental science, and the “Claims of Brutes.”* Jefferson, North Carolina: McFarland and Company.
- O’Connor, W. J. 1988. *Founders of British physiology. A biographical dictionary, 1820-1885*. Manchester and New York: Manchester University Press.
- Olmsted, J. M. D. 1944. *François Magendie. Pioneer in experimental physiology and scientific medicine in the nineteenth century*. New York, NY: Schuman.
- Otis, L. 2007. Howled out of the country: Wilkie Collins and H.G. Wells retry David Ferrier. In *Neurology and literature, 1860-1920*, ed. A. Stiles, 27–51. Basingstoke: Palgrave Macmillan.
- Ozer, M. N. 1966. The British vivisection controversy. *Bulletin of the History of Medicine* 40:158–67.
- Pedlar, V. 2003. Experimentation or exploitation? The investigations of David Ferrier, Dr Benjulia, and Dr Seward. *Interdisciplinary Science Reviews* 28 (3):169–74. doi:10.1179/030801803225005201.
- Schäfer, E. A. 1881. *Examination of the monkey’s brain. Transactions of the International Medical Congress. Seventh session. Held in London, August 2d [sic] to 9th, 1881. Prepared for publication under the direction of the executive committee by Sir William Mac Cormac Honorary Secretary-General assisted by George Henry Makins, F.R.C.S. Under-Secretary and the Secretaries of the Sections*, Vol. 1, 242d–3. London: J.W. Kolckmann.
- Sewill, H. 1881. Subscription to Dr. Ferrier. *BMJ* 2 (1091):878–79. doi:10.1136/bmj.2.1091.878-b.
- Sharpey-Schafer, E. 1927. History of the Physiological Society, 1876-1926. *The Journal of Physiology* 64 (1):1–181. doi:10.1113/jphysiol.1927.sp002414.
- Snow, S. J. 2008. *Blessed days of anaesthesia. How anaesthetics changed the world*. Oxford: Oxford University Press.
- Stahnisch, F. W. 2010. The use of animal experimentation in the history of neurology. In *Handbook of clinical neurology*, ed. S. Finger, F. Boller, and K. L. Tyler, Vol. 95, 3rd series ed., 129–48. History of neurology. Amsterdam: Elsevier B.V.
- Taylor, C. B. 1892. *Vivisection: Is it justifiable?* London: Society for the Protection of Animals from Vivisection.
- Times* (London). 1881a. Police. November 4, p. 12
- Times* (London). 1881b. The charge against Professor Ferrier. November 18, p. 10
- Times* (London). 1881c. Dr Ferrier’s researches. November 19 p. 12
- Turner, A. 1928. Obituary. The late David Ferrier. *BMJ* 1:574–75.
- Tyler, K. L., and R. Malessa. 2000. The Goltz-Ferrier debates and the triumph of cerebral localizationist theory. *Neurology* 55 (7):1015–24. doi:10.1212/WNL.55.7.1015.
- Wilks, S. 1881. A science defence association. *BMJ* 2 (1091):878. doi:10.1136/bmj.2.1091.878-a.
- Williamson, L. 2005. *Power and protest: Frances Power Cobbe and Victorian society*. London: Rivers Oram Press.
- Yeo, G. 1881b. *Discussion on the Localization of Function in the Cortex Cerebri. Transactions of the International Medical Congress. Seventh session. Held in London, August 2d [sic] to 9th, 1881. Prepared for publication under the direction of the executive committee by Sir William Mac Cormac Honorary Secretary-General assisted by George Henry Makins, F.R.C.S. Under-Secretary and the Secretaries of the Sections*, Vol. 1, 237–40. London: J.W. Kolckmann.
- Yeo, G. F. 1880. Note on the application of the antiseptic method of dressing in cranio-cerebral surgery. *BMJ* 2:339–40.
- Yeo, G. F. 1881a. Note on the application of the antiseptic method of dressing to cranio-cerebral surgery. *BMJ* 1 (1063):763–64. doi:10.1136/bmj.1.1063.763.
- Young, R. M. 1970. *Mind, brain and adaptation in the nineteenth century: Cerebral localization and its biological context from Gall to Ferrier*. Oxford: Clarendon Press.