UNIVERSITY OF BIRMINGHAM
University of Birmingham Research at Birmingham

Ambition, ‘failure’ and the laboratory

Wynter, Rebecca

DOI:
10.1017/S0007087421000017

License:
Creative Commons: Attribution-NonCommercial-NoDerivs (CC BY-NC-ND)

Document Version
Peer reviewed version

Citation for published version (Harvard):
Wynter, R 2021, 'Ambition, ‘failure’ and the laboratory: Birmingham as a centre of twentieth-century British scientific psychiatry', *The British Journal for the History of Science*, vol. 54, no. 1, pp. 19-40. https://doi.org/10.1017/S0007087421000017

Link to publication on Research at Birmingham portal

General rights
Unless a licence is specified above, all rights (including copyright and moral rights) in this document are retained by the authors and/or the copyright holders. The express permission of the copyright holder must be obtained for any use of this material other than for purposes permitted by law.

•Users may freely distribute the URL that is used to identify this publication.
•Users may download and/or print one copy of the publication from the University of Birmingham research portal for the purpose of private study or non-commercial research.
•User may use extracts from the document in line with the concept of ‘fair dealing’ under the Copyright, Designs and Patents Act 1988 (?)
•Users may not further distribute the material nor use it for the purposes of commercial gain.

Where a licence is displayed above, please note the terms and conditions of the licence govern your use of this document.

When citing, please reference the published version.

Take down policy
While the University of Birmingham exercises care and attention in making items available there are rare occasions when an item has been uploaded in error or has been deemed to be commercially or otherwise sensitive.

If you believe that this is the case for this document, please contact UBIRA@lists.bham.ac.uk providing details and we will remove access to the work immediately and investigate.

Download date: 13. May. 2024

Ambition, 'Failure' and the Laboratory: Birmingham as a Centre of Twentieth-Century British Scientific Psychiatry

Rebecca Wynter*

Abstract

This article will reveal how local scientific determination and ambition, in the face of rejection by funders, navigated a path to success and to influence in national policy and international medicine. It will demonstrate that Birmingham, England's 'second city', was the key centre for cutting-edge biological psychiatry in Britain in the 1920s and 1930s. The ambitions of Frederick Mott – doyen of biochemistry, neuropathology and neuropsychiatry, until now celebrated as a London figure – to revolutionise psychiatric treatment through science, chimed with those of the City and University of Birmingham's Joint Board of Research for Mental Diseases. Under Mott's direction, shaped by place and inter-professional working, the Board's collaborators included psychiatrist Thomas Chivers Graves and world-renowned physiologist J. S. Haldane. However, starved of external money and therefore fresh ideas, as well as oversight, the 'groupthink' that emerged created the classic UK focal sepsis theory which, it was widely believed, would yield a cure for mental illness – a cure that never materialised. By tracing the venture's growth, accomplishments and contemporary potential for biochemical, bacterial and therapeutic discoveries – as well as its links with scientist and key government advisor Solly Zuckerman – this article illustrates how 'failure' and its ahistorical assessment fundamentally obscures past importance, neglects the early promise offered by later unsuccessful science, and can even hide questionable research.

In 1925, at the Royal Commission on Lunacy and Mental Disorder, Sir Frederick Mott – doyen of biochemistry, neuropathology and neuropsychiatry – outlined his vision for the modern British mental hospital. The plan represented renewed international optimism in the potential curability of insanity through scientific research, and was designed to combat what many Western thinkers increasingly felt was the antiquated warehousing of chronicity in lunatic asylums. Mott's ideal facility echoed what had been achieved through the establishment of Maudsley Hospital as a result of his determination, a single generous donation, the forward-thinking of London County Council (LCC), and the provision of 'clinical laboratories' to diagnose and treat 'recent recoverable cases'.[1] However, Mott noted, 'only by psychological, sociological and biological research [can] we […] hope to ascertain the causes and contributory factors of mental disorders, their prevention and their remedial treatment'.[2] Mott recognised the ambition required a grand scheme:

> research would be […] carried out by […] a central laboratory in association with a university for a group of asylums. This laboratory should have a director and an efficient and adequately paid staff, which should collaborate with the asylums […] and, if necessary, undertake skilled routine laboratory investigations which could not be efficiently undertaken in the [asylums'] clinical laboratories […] The director should promote and advise research in [these] asylums [… He] and his staff should undertake systematic researches in collaboration with the medical [… staff, but] retain an independent position. The central laboratory should be equipped […] for physiological, psychological, histological, bacteriological, biochemical and psycho-physical investigations.[3]

Such a scheme existed at London's Maudsley, and was underway in Birmingham, 'England's second city' in the Midlands, under the directorship of Mott himself.[4] Yet Birmingham's venture was distinctive. The enterprise developed from particular local circumstances, most potently the inimitable combination of people involved, including psychiatrist Thomas Chivers Graves, neuropathologist Frank Pickworth, pioneer physiologist J. S. Haldane, and distinguished anatomist, zoologist and scientific advisor, Solly Zuckerman. Through a

uniquely-plotted research trajectory, the scheme developed a scientifically-informed theory of focal sepsis which promised to revolutionise therapeutics and even cure insanity, realising its regional research ambitions along the way.

The Birmingham laboratory was no parochial effort; no tinkering about the edges of scientific research. The venture was operational just as the Maudsley began officially to accept psychiatric patients, the admission of which had been interrupted until 1923 due to the First World War. Between 1922 and 1939, the research laboratory at Hollymoor Mental Hospital – founded by the Joint Board of Research for Mental Diseases, established between the City and University of Birmingham – was eclectic in its work, supported pathology and standard clinical testing, achieved periods of significant output, and found national and international recognition. However, Hollymoor was only ever intended as a stopgap to achieving the ambition of a central laboratory at the University of Birmingham that would co-ordinate cutting-edge research at the twenty-or-more mental hospitals across the Midlands region.

While the enterprise was nationally applauded and internationally recognised in the 1920s, 1930s and 1940s, its ultimate failure to make major discoveries and cure mental illness has meant its work and contemporary importance has been concealed. This is a pattern which echoes Richard Noll's study of Bayard Taylor Holmes, whose work on dementia praecox was similarly 'grounded firmly in medical theories that were popular during World War I: auto-intoxication or focal infections'. Holmes has become 'a lost chapter in the larger story of early twentieth-century […] medicine: the laboratory science approach to discovering the causes of mental illnesses […] and the development of rational treatments based on such laboratory findings'.[5] The cases of Birmingham and Holmes seem to point to a conscious forgetting of the underpinnings of non-German biological psychiatry in countries

that remember Freud as much as psychotherapy, an area in cultural ascendancy during the post-war era, which saw both the moral outrage around human experimentation (at least on white bodies) and the emergence of revisionist history. Histories such as this article and Noll's can be seen to address and problematise Tom Quick's call for 'a fully-fledged neuro-history' through the '[revision of] the historical narrative in the light of the findings of current neurological science' with 'historical epistemology centred on an ideal of experimentation'.[6]

Birmingham's place in the more recently-expressed general history of biological psychiatry has also been left unrecognised.[7] It is missing from the histories of the laboratory in Britain, though these are fragmented, with Cunningham and Williams the most holistic text extant.[8] Indeed, it is virtually absent from the historiography, despite the involvement of Mott and Haldane (in whose biographies the Joint Board is merely named), Zuckerman, and Graves, who later became the Royal Medico-Psychological Association's (MPA) longest-serving president.[9] Graves has loomed large in North American historian Andrew Scull's work on US psychiatrist Henry Cotton and focal sepsis, but even here the Joint Board and its significance are lost entirely.[10] This article aims to place Birmingham firmly on the international map of twentieth-century psychiatric research. In doing so, it will enhance an appreciation of how 'small place' shapes 'big science', and help develop a richer and more contextualised way of considering scientific success and failure.

The spatial turn in scientific history was crystallised by Livingstone's monograph.[11] Since then, microhistories have further clarified the rich geography of local laboratories. Hammerborg's study of Bergen General Hospital, Norway, has suggested that sites away from embedded university tradition counteract the deep academic divisions wrought by scientific institutionalisation, implicit in Lawrence's Edinburgh-based history.[12] Jacyna's

earlier conclusion from Glasgow Western Infirmary – that laboratory science did not overcome clinical scepticism in hospitals – is supported by Davis' study of four diverse Scottish asylums.[13] Nevertheless, her findings suggest pioneer hubs pushed science out into the surrounding asylums. Indeed, while the Hollymoor facility adheres to the accepted pattern first described by Robert E. Kohler – that research laboratories used clinical diagnostic work to fund their explorations – the study of Birmingham suggests the two-way nourishment of science, ambition and research through the umbilical cords between the mother laboratory and its asylum associates.[14]

One of this study's major contributions is in its delineation of the fine, almost ephemeral sense of space and place created by the invisible interactions between the scientists, medical men, their support workers and staff, and thousands of patients. In this way, a research laboratory left in the hands of one or two men with little external influence and even less funding could create and disseminate its own reality, rooted in scientific practice, but fashioning deeply-believed and – as it turned out – deeply-flawed scientific facts. As such, I build on Steven Shapin's ground-breaking ways of thinking about the history of the laboratory via Bruno Latour and Steve Woolgar's pivotal sociological study.[15] Taking 'invisible technicians' and notions of trust, along with the *mise en scene* of the biological laboratory, this article is a case study in how the ties between people and the faith placed in individuals can create success *and* threaten the credibility of an entire organisation. This paper, then, describes one of Shapin's hypothetical 'modern scientific core-sets' of laboratory experts in action.[16] Furthermore, it views the body as both Latourian actor and a co-producer of knowledge: without these bodies in this place with these observers, the British science around focal sepsis would have been completely different.

This paper is also the story left untold by Scull: what happened in Birmingham beyond Graves and the 1922 and 1927 British visits of Cotton. Cotton might, however, be considered a point of introduction for the backdrop to the Joint Board. Like Britain, the US had no tradition of clinical (asylum) psychiatry working with university clinics or researchers. Consequently, in many places asylums were considered to be operating in the same manner as decades before, or even longer. Germany was different, with research and clinical work often closely related at key university centres. Indeed, as Eric Engstrom has shown, German 'academic psychiatrists were able to capture from alienists the professional jurisdiction over laboratory research' in the 1870s and 1880s.[17] Cotton spent 1906 at the University of Munich working under the influential psychiatric researchers, Emil Kraepelin, Alois Alzheimer and Franz Nissl. Returning to New Jersey, America, as Trenton State Hospital's superintendent, Cotton began there to conjure scientifically-informed clinical practice.

There had been some isolated instances of laboratory research in England, such as at West Riding Asylum from 1866.[18] Echoing the period of development in Germany, if not the trajectory, the 1870s and 1880s saw 'alienism [move] in a self-consciously scientific direction'.[19] Soon after, pockets of progress inspired by the German model emerged in Britain. In 1895, under Mott, the LCC established a central laboratory for London at Claybury Asylum (later moving to Maudsley Hospital).[20] In Scotland, 1897, a national scheme for pathological research forged a laboratory hub at Edinburgh Royal Asylum; an adjunct group clustered around its Glasgow counterpart from 1909.[21] In 1908, a clinic and laboratory opened in association with the University at the mental hospital in Cardiff, the Welsh capital.[22]

This proactive approach is evident in another area with which Cotton was connected: somatic therapy. With the growth of germ theory from the 1880s and rapid advances in

bacteriology, confidence grew that insanity was a physical disease with identifiable biological causation.[23] Between 1905 and 1910, the spirochaete which caused General Paralysis of the Insane (GPI, a form of tertiary syphilis) was identified; its role was confirmed by Mott's work on paretic patients' brains; and the disease had been successfully treated by the new drug Salvarsan. From 1917 malaria therapy, one of the first forms of effective somatic treatment, was introduced for acute, later-stage patients that Salvarsan did not help. Confidence in radical somatic therapy blossomed.

By the time Cotton first visited Britain in 1922, he was a self-proclaimed eradicator of chronic mental illness. As Scull describes, Cotton went about serially removing the potential wells of leaking sepsis thought by him to be the root cause – tonsils, teeth, reproductive organs; pieces of stomach, bowel, colon – and Graves was not far behind.[24] While Graves initially concentrated on teeth, his approach shifted in response to the work carried out under the Joint Board's remit, which came to focus on the sinuses. Scull does not investigate the science behind Cotton's version of focal sepsis, which honed in on '"an unrecognized, but nevertheless extensive, disease in a congenitally misshapen and deformed bowel"'.[25] The distinctive research and ideas at Birmingham present the 'legitimate rationale' behind focal sepsis and its clinical treatment where Scull saw none, though, as we shall also see, this legitimacy was later complicated by the quiet shutting-away of questionable research methodologies. Scull also described the growing omnipotence of the 'notoriously intimidating' Graves – from superintendent of Rubery and Hollymoor mental hospitals, to the Chief Medical Officer of Birmingham's Asylums Committee in 1925/6.[26] Graves was indeed proactive behind the scenes, but his voice is rarely audible through the Joint Board's official documents, which record only those of senior laboratory workers and the University

– at least, curiously, until the renaming as the Department of Mental Disease and relocation to Edgbaston in 1939, when Graves spoke out to significant effect.

One final absence that the article will address is that of funding. There is a rich literature concerning its impact on medicine and science through the British Medical Research Council (MRC) and especially the American Rockefeller Foundation, with Rockefeller breaking national frontiers and investing in the UK.[27] The ramifications of the lack of substantial external funding have yet to be explored fully and historically; a beginning may here be found. Indeed, this article offers an anatomy of how the construction of scientific fact is place-specific, strengthened by adversity and can be dismantled as oversight strengthens, networks weaken, and greater space for individual thinking emerges, adding to the body of work which draws on the seminal texts of Thomas Kuhn, and Latour and Woolgar.[28]

Using minutes, often-internal annual reports, and the central outlets of research dissemination – the *Journal of Mental Science*, *British Medical Journal* and *Journal of Laryngology and Otology* – this article is a study of macro- and microscopic ambition. Separated into six thematic sections, the paper moves sequentially through the Joint Board's establishment and planned regional initiative, before interlacing the progress made in this scheme with the layered chronological development of laboratory work and medical-scientific theories, from standard clinical testing to investigations in endocrinology, basal metabolism and focal sepsis. In essence, it is the story of how scientific ideas and praxis directed the rise and fall of the classic British focal sepsis theory in psychiatry, and with it one of the most important psychiatric research laboratories in the UK.

Establishing the Joint Board

Birmingham enjoyed a deep heritage of technology and invention, science and Nonconformity. The Industrial Revolution and the Lunar Society had primed its enviable nineteenth-century position as the 'city of a thousand trades'. Energised by the civic gospel, by the turn of the twentieth century the Liberal city was a 'municipal powerhouse […] with powerful links to central government and Empire, especially through the Chamberlain family'.[29] Indeed, the substantial reforms to public health and education ushered in by Mayor Joseph Chamberlain were crowned by the 1900 establishment of 'the first civic university'.[30] The University of Birmingham grew from Mason College of Science. The College was founded in 1875 by a local philanthropic industrialist, opened in 1880 with a speech by 'Darwin's Bulldog', Thomas Henry Huxley, and merged fully with Birmingham Medical School in 1892. By the time the University had moved into its purpose-built campus at Edgbaston, it had already gained a reputation for innovation through its staff, including surgeon Lawson Tait and physicist Oliver Lodge. Even so, for experimentation at least, the application for a vivisection license in 1903 'appears to mark the beginnings of research at the university'.[31] Moving through each stage of development – Medical School, Mason College, University – was Gilbert Barling, pathologist and surgeon. Barling went on to become Medical School Dean in 1905 and Vice-Chancellor (1912—1932).

During the First World War, much of Edgbaston campus was requisitioned for a military hospital. Staff encounters with mustard gas injuries and shell shock would only have underscored the importance of science to somatic ills and to the University. The conflict reignited links between Birmingham and J. S. Haldane, who was working for Doncaster Coal Owners' Association laboratory (DCOAL), and for the British Government. His war work on the effects of poison gas prompted theories that shell shock was another symptom of the

same underlying physical cause, cementing a connection between Haldane's gas investigations and Mott's research into shell shock.[32] Both DCOAL and Haldane moved to the University in 1921, the year before the Joint Board was founded.

The early twentieth century had also witnessed profound shifts in mental health care in Birmingham. The City had been the first authority to create a borough asylum under the 1845 legislation mandating public lunacy provision. Winson Green Asylum opened in 1850, followed by Rubery in 1882 and Hollymoor in 1905. Rubery and Hollymoor, built less than a mile apart to the largely undeveloped south-west of the settlement, were only around five miles from the University. During these years the City spearheaded new approaches to learning disability. Birmingham-born Francis Galton's theories of eugenics, coupled with national educational reform, were stitched into pioneering special schooling in Birmingham. Through innovations in after-care, medico-sociological explorations of mental deficiency, and the 'colony' form of institution, the city shaped the 1913 Mental Deficiency Act.[33]

With the University in receipt of Government payment for wartime requisitioning and the City at the vanguard of mental health policy, the two tied together their ambitious post-war research ideals in a pioneering plan to literally change the world. The initiative was made manifest in the new state-of-the-art research laboratory at Hollymoor, and through the co-operation of Barling and Councillor Henrietta Bartleet.[34] Within two years of her 1918 election, Bartleet 'became the first woman to hold a committee chairmanship' at the city council when she was elected chair of the Asylums Committee. A tour de force in public health and hospitals of all forms, Bartleet 'strove hard to improve conditions in the city's mental hospitals', and her ambition and verve swiftly began to gain traction.[35] Together Barling and Bartleet persuaded Mott to come to Birmingham in 1922, a year before his official retirement from the Maudsley, to 'help in the research work' and 'advise in the

improvements being made in the mental hospitals'.[36] These plans were at the forefront of Birmingham's interwar move to marry clinic and laboratory. Jonathan Reinarz has placed the proliferation of laboratories at the medical school and voluntary hospitals in the city merely as beginning by 1925, but the development of the University, as well as the local authority's push for research, can be seen to have boosted scientific modernity across Birmingham.[37]

Ahead of Mott's 1922 arrival, Graves had begun to propagate his theories that 'mental disorder was the product of auto-toxicity' by way of hidden 'reservoirs of infection'.[38] Recognising a kindred spirit in Cotton, Graves was instrumental in securing his appointment as plenary speaker at the MPA's annual meeting in London in 1922.[39] In the audience listening to Cotton's identification of focal sepsis and alleged 87% recovery rate was Mott, who heard echoes of his own work that '[identified] a similar mechanism for' GPI in which 'some psychotic presentations had an organic basis'.[40]

With Mott appointed Lecturer in Morbid Psychology at the University and Honorary Director of the Joint Board, the first full meeting took place in December 1922. The Board was comprised of five representatives from each the University and City, mainly drawn from Medical Faculty and the management committees of the various Birmingham asylums. Members included Barling (as Chair), Bartleet, Mott, Graves, and Assistant Pathologist Frank Pickworth. A conjoint Chemistry and Medicine graduate, Pickworth had known Mott during his time at Claybury and Charing Cross Hospital, London.

The seeds for what would become the UK's classic focal sepsis theory were, then, present at the Joint Board from the first, but so too was the perennial concern of funding research. Barling had approached the Ministry of Health, pressing for legislation enabling local authorities to join together for research initiatives.[41] There was 'an urgent necessity for co-ordinated research and investigation into the basal causes of mental disorder [… The]

financial cost of modern scientific enquiry prevents the majority of individual local authorities from attempting such investigations'.[42] The MRC – instigated in 1913 by the British Government to support research of national importance – were urged to assist plans to move the central laboratory from Hollymoor to the University, once legislation facilitated asylums outside Birmingham to join the enterprise.[43] In what must have seemed a hopeful sign, the Hollymoor laboratory was officially opened in 1923 with Neville Chamberlain, Minister of Health, in attendance.

Standard clinical tests

In order to finance and secure long-term scientific research work, the Joint Board needed sustained and dependable revenue. Making clinical testing available to all Midlands mental hospitals was the commercial means to support research; it also encouraged scientific working among medical officers, and generated masses of human material, which could be retained and used for research.[44] Nevertheless, Mott's London microbiology work, as well as general efforts to identify typhoid carriers, meant the checks were introduced as standard in all Birmingham asylums. Hollymoor offered vaccine preparation and a range of tests at 'about half' the price of commercial laboratories.[45] These included: blood, serum, complement fixation; calculy and concretion examination; gastric content and integrity; and the examination of cerebrospinal fluid, faeces, urine, throat swabs, sputum and pus for signs of infection or damage.[46] This in itself marks the laboratory at the asylum in Birmingham out from its predecessor at West Riding, where '[m]uch of the work … depended upon the dead body'; and as we shall see it was the living bodies of medical and care staff, and patients which dominated efforts at Hollymoor, even if the contemporary and long-term relevance of the initiative depended on preserving tissue from the diseased and deceased.[47]

In 1924 a laboratory assistant was appointed from the Lister Institute of Preventative Medicine, London; a centre for cutting-edge research science. With an annual £250 donation from Sir Charles Hyde (proprietor of the *Birmingham Post* newspaper group), the Joint Board established a Research Fellowship in early 1924, quickly appointing D. L. Woodhouse, a Birmingham Chemistry student. Coinciding with Mott's 1924 instigation of a sociological investigation of the origin of mental deficiency – work on pedigrees carried out by asylum after-care workers, which left little trace in the archives or the Board or Laboratory minutes – an animal house was built.[48] Animal experiments went on to act as the bellwether for more sustained lines of inquiry into endocrinology, basal metabolism and focal sepsis.

Endocrinology research

In 1925, a reflective Mott explained to Barling that

> After many years work on […] the relation of the Reproductive-Endocrine System to general metabolism and mental disease based upon the complete histological survey of the ovaries, testes, suprarenals, pituitary, thyroid, I was led to form definite conclusions that this subject was worthy of further investigation by an intensive study of individual cases during life and post mortem.[49]

Mott's theories were rooted in recent developments. Defects in ductless gland secretion had been linked to anencephaly, and Mott had himself expressed associations between testicular inhibition in dementia praecox and congenital 'mental defect'.[50] Indeed, as Evans and Jones have demonstrated, Mott's wider ground-breaking endocrine work helped establish a pattern at the Maudsley which meant that laboratory research into organ extracts translated to clinical interventions. While, like the Birmingham venture, inefficacy has meant this 'has largely been forgotten', the outcome for 'sporadic cretinism' (congenital hypothyroidism) or myxoedema had recently been dramatically altered by thyroid treatment and the causal link

with iodine– hence the contemporary potential that endocrinology held for treating psychiatric disorders.[51]

Mott, however, aware of the investment of faith and money received and required, humbly lamented that no great breakthrough had yet emerged from thyroid research at Birmingham. He was sorry that he had not been 'wiser than to hope to see in the Midlands during my life-time a similar hospital' to the Maudsley, 'connected to the University', with a central laboratory around which the region's 'subordinate pathological laboratories' could orbit.[52] The lack of funding had stymied plans. The thyroid research was, though, steadily yielding results; 1925 saw the first substantial paper published under Pickworth's name and the aegis of the Joint Board, and the appointment of two new 'laboratory boys'.[53] The methodological article considered iodine content in thyroid tissue. The laboratory had processed sixty thyroids with wildly varying results. This helped develop suspicion as to the 'association between chronic sepsis and disturbed endocrine function […] bacteriological work [had therefore] become part of the research', dominating laboratory time; a pattern which continued through to 1939 and beyond.[54]

Basal metabolism research

The Joint Board experienced mixed fortunes throughout the 1920s. The MRC agreed to fund a laboratory assistant, but nothing more: 'the indefinite nature of the work [… did not] appeal directly […] more definite lines of research which are more or less certain to produce quick results [… will] obtain their interest and help'.[55] Nevertheless, Charles Hyde agreed to continue funding a researcher, and Herbert Strecker, graduate of Psychiatrischen Universitätsklinik Würzburg, conducted unpaid research until the 1930s.[56] In fact, 1925 had added to the kudos of working at Hollymoor: not only was the MPA's annual meeting in

Birmingham, but Mott had been appointed its President, and Hollymoor's laboratory received plaudits from the national gathering.[57] The next year, however, Mott was dead. Pickworth was appointed Director. Nevertheless, work 'carried on as has been and is planned for some time to continue on the lines initiated by' Mott.[58]

Key to Mott's strategy had been research into basal metabolism. He hypothesised that malfunctioning thyroids were intimately linked with mental disorder; something that was seemingly confirmed by Hollymoor's metabolic studies comparing psychiatric patients to published 'normal' readings.[59] Mott had brought with him to Birmingham a £400 MRC grant for 'apparatus and respiration chambers' to study 'basal metabolism, blood pressure etc.'[60] The 'usual Douglas bag or spirometer methods, involving mouth and nose pieces or a mask, were quite unsuitable […] the disturbing factors of fear, anxiety and excitement should be eliminated'.[61] A respiratory chamber, similar to Haldane's at the University Mining Department, was constructed. Indeed, Haldane suggested 'improvements for the gas analysis apparatus used for the determination of minute changes in the atmosphere of the chamber'. Apparatus 'perfection' had taken months, but finally Haldane 'pronounced [it] satisfactory'.[62] The chamber measured around 6 x 6 x 9 feet with an air capacity of 10,000 litres, and was built into a temperature-controlled, lead-lined room close to the wards inside the main hospital at Hollymoor.[63] Haldane's advice continued until the experiments ended in 1930.

Hollymoor's new method of assessing basal metabolism paid more heed to the role of emotion and activity in physiological assessments than did similarly-concerned experiments on 'indigent epileptics' at Northwestern Medical School, Illinois, in 1935/6.[64] Even so, the ethics of both UK and US work were reflective of the time. In Birmingham, aside from the observation window and some bulbs and switches, the chamber was 'a good substitute for a

light airy cheerful ['decorated and furnished'] bedroom'.[65] Experiment methodology changed significantly over the six-or-so years. At first, patients were taken to the chamber at 8am, after fasting for twelve hours. Air readings and blood were taken at the start and end of the patient's two hours in the chamber, in order to ascertain blood sugar and 'carbon dioxide output and the oxygen intake'.[66] The results were at such variance with recognised findings that Mott and Pickworth made substantial efforts to establish readings from control subjects: nurses.

The historiography is comparatively silent about the use of medical and care staff in experiments, whilst more recent scientific research – notably predominantly in neurological and bio-psychiatric studies – mentions the issue, and also recognises how problematic quietly-established patterns are, including the preponderance of men as subjects and that 'hospital staff as control subjects limits interpretation'.[67] Moreover, these experiments at Birmingham took place 15-20 years before the randomised control trial had been formally and robustly outlined in the literature, pointing to how and why such problematic patterns came into being.[68] These metabolic trials, then, fall into the period during which historian Martin Edwards has argued that the 'use of comparison controls increased.'[69]

The results from Birmingham's initial experiments on patients diverged from the literature, because, they reasoned, their rigorous method was so precise.[70] Careful and comparable determinations were then taken with patients and controls, laboratory staff and nurses, from 1924. During the most careful control experiments in 1925-1926, employees were tested: sitting and lying; reading, including in one instance '[memorising] "Faust"'; after a hot or cold bath; playing the violin (from imagining doing so to '[p]laying difficult music' such as 'Andante from Concert, Elgar'); when 'somewhat irritable'; and in a range of other attitudes in order to eradicate variability, so that any reading differential could only be due

to basal metabolism.[71] Moreover, at around the time Haldane was presenting the results to the internationally-esteemed Royal Society in 1926, test subjects began to sleep in the chamber overnight, as this was 'the only satisfactory method of investigation with patients whose co-operation is doubtful'.[72]

'Many were the sleepless nights', Pickworth later reminisced, 'my assistant and I had in order to make observations and collect specimens for analysis'.[73] Not only does this indicate the range of tasks carried out by laboratory boys, or assistants, who were responsible for the commercial and routine testing, but also their importance to the shaping and conduct of experimentation.[74] The statement also demonstrates the murkier side of science and staff complicity (in relation to consent and sedation) when it is remembered that these specimens from sleeping patients included blood. For Pickworth, hypoglycaemia and other abnormalities in sugar metabolism (which could alter blood pH) were associated with endocrine function.[75] The rationale behind blood testing, as well as simultaneous research on blood corpuscle and brain permeability, also appears to have been informed by Haldane's internationally-recognised work on blood oxygenation. Haldane found that the absorption of waste carbon dioxide affected blood pH, dictating how effective the brain stem was at controlling respiration. Moreover, he articulated how tissue with high lipid content (such as nerve cells) and poor blood flow resulted in the pooling of nitrogen.[76] When this happened, the bends (caisson disease) could present as unpredictable neurological or mental disorder (for example, paralysis, confusion, hallucinations). The full gravity of the thinking that emerged from Pickworth's work with blood and oxygen will become clear in the next section of this article.

In the 1929 Festschrift to mark Mott's death, Pickworth argued it was 'probable that the most important factor responsible for the abnormal reactions in cases of mental disease

[could] be traced to some variety of defective oxygen metabolism'; the age at which this defect first occurred determined the form of mental disorder.[77] The hypothesis was that

> toxic substances [were] absorbed from the intestinal canal (and evidence of blood infection with intestinal organisms [was] found almost invariably in association with acute mental disorder) might effect a chemical change in […] haemoglobin […] rendering it useless for respiratory purposes.[78]

Blood and other metabolic testing had been carried out on at least 100 patients. Twenty-eight were found to have 'deficient oxygen capacity'.[79] The presence of 'inactive pigment' was 'correlated with evidence of blood infection by intestinal organisms'.[80] Indeed, the capacity of blood to carry substances was also being researched.[81] The 'permeability of blood corpuscles' was assessed, especially with regard to various chlorides, the most penetrative being bromide, a substance known for its effect on epilepsy.[82]

Permeability was also addressed by Herbert Strecker's Hollymoor research. Strecker studied the choroid plexus and the brain membrane to establish the permeability of the blood-brain barrier. He assessed the blood and cerebrospinal fluid of GPI and dementia patients to see if the ratio of ingested bromide altered from that found in 'normal' subjects.[83] Permeability was confirmed as increased in GPI and decreased in dementia patients, developing the idea that substances crossed from blood to cerebrospinal fluid and the brain.[84]

Research and focal sepsis theory

The year 1930 brought with it cause for optimism with regards to the regional research initiative. The new Mental Treatment Act (prompted by the 1925 Royal Commission) heralded a clear shift in mental health care, rejecting what Kathleen Jones called the nineteenth century 'triumph of legalism', and emphasising the primacy of medical

imperatives by enabling early voluntary admission.[85] Largely overlooked by the historiography has been the national coordination of British psychiatric research under the Government's mental hospitals inspectorate, the Board of Control (BoC), and their powers to approve local authorities 'undertaking research […] and making agreements with' similar bodies elsewhere.[86]

Barling readied the Joint Board 'to take steps […] to secure the advantages which this ['awaited'] Act offered', having already written to the BoC seeking 'advice and guidance […] to secure the co-operation of' Midlands mental hospitals. He then announced his vision for the future, hoping that the Rockefeller Foundation would contribute to 'a Central Laboratory at the University'.[87] A laboratory there 'would be more likely to secure the co-operation of other Mental Hospital Authorities rather than one situated at a Mental Hospital', and enabled cross-disciplinary working.[88] A meeting was held at the University for Midland hospital representatives, from which emerged public plans for a regional research board.[89]

Nevertheless, money worries were never far away. Against the backdrop of the international financial turmoil unleashed by the Wall Street Crash, in Britain the 1929 Local Government Act meant extensive upheaval in administration and health care, ensuring the Joint Board lost money.[90] Local philanthropic funding also evaporated, including Charles Hyde's yearly donation.[91] Rockefeller refused to give financial support.[92] Plans for a promotional meeting at Hollymoor laboratory for Midland hospitals were quashed; hardly surprising, especially as responses to the 1930 University meeting were distinctly mixed.[93] Finally, the MRC pulled the little financial support it was giving. Barling issued a bleak letter to the Joint Board: 'We must […] wait […] in the hope [of] better times […] and with the confident feeling that the work of our Director and his staff is of high value in unravelling the causes of Mental Disease'.[94]

The Joint Board was certainly growing in stature, especially from 1928, with increased attention from the BoC, and staff publications and conference appearances. Hollymoor's research promised to revolutionise the treatment and outcome of insanity everywhere and garnered international interest. Key British figures visited, including bacteriologist William Topley, Cambridge pathologist H. R. Dean, and Juda Quastel, head of Cardiff Mental Hospital research laboratory. Cardiff was itself deeply involved in similar areas of biological psychiatric research to Birmingham, in particular its focus on brain biochemistry and metabolism. However, whilst Quastel was a gifted researcher, his background was removed from psychiatry, and he therefore found it difficult to marry laboratory science and 'psychiatric thought'. At the same time, he found 'that the work of the Cardiff laboratory seemed isolated from that of the hospital and the immediate needs of patients'.[95] His visit to Hollymoor and Birmingham's specific ingredients of people and place must have contrasted sharply with his experience at Cardiff. Hollymoor had received 'letters of appreciation from eminent men in foreign countries especially America and Germany'.[96] It welcomed visitors from Australia, Sweden and the Netherlands and other international figures such as Professor William Burridge from Lucknow University, India, and Francis Benedict, world-leading American chemist, physiologist and nutritionist.

Birmingham had worked long and hard for such recognition. In 1924, the MRC had approached Mott to assess 'the value of tryparasamide, a new drug [… for] syphilis of the nervous system including general paralysis'.[97] Tryparasamide, an arsenical compound manufactured by Rockefeller was concurrently trialled elsewhere, including the Maudsley and Cardiff.[98] Initial findings at Birmingham were clinically 'disappointing'.[99] However, it was later trialled alongside bosmoxyl – supplied by the eminent Romanian and pioneer in virology and immunology, Constantin Levaditi from the leading global centre for biomedical

research, the Pasteur Institute, Paris – as was a combination of phlegotan and novarsenobillon. The cohort of 21 similarly-presenting patients was somehow 'divided into two equal groups'. One group received treatment 'for the correction of gross focal sepsis, especially of the mouth' and reportedly showed 'greater […] improvement', suggesting that focal sepsis removal improved 'general resistance'.[100]

The GPI drug trials were the first assumed scientific proof that focal sepsis was a tangible reality and not just a hunch of, not only Graves, but Mott and Pickworth too. Other clinical and pathological exploratory work as to the 'existence of chronic septic foci' had been ongoing since 1923/4, assisted by Hollymoor's new, 'special radiographic, dental, gynaecological and [ear, nose and throat] departments'. The laboratory had been studying infection types 'and their correlation with morbid processes in other tissues'.[101] The research had already resulted in case studies – published alongside Cotton's keynote from the 1922 MPA meeting – of x-rays revealing 'deep infection' of jaw bones and nasal passages.[102] However, Birmingham's research moved on swiftly, informed by standard clinical testing, metabolic experiments and the thyroid work, especially as Mott reasoned that chronic sepsis might drain the endocrine system.[103]

Bacteriological testing and the increased use of vaccine therapy in Birmingham developed ideas about the type of toxin which caused focal sepsis and the means of its deployment. Initial explorations were wide, into 'clinically condemned teeth', sinuses and endocervices.[104] While a host of potentially-harmful bacteria were identified through agglutination, the common factor honed in on was organisms affecting the gastro-intestinal tract, especially streptococci. In other lines of research, there was evidence to link gastric issues with infection. The overwhelming majority of clinically-selected patients with sepsis of the mouth and nasal pharynx, were found in the laboratory to have 'no free hydrochloric

acid', implying an inability to stem infection.[105] Tests from patients who were not typhoid carriers, or injected with typhoid-paratyphoid A and B (TAB) vaccine, demonstrated evidence of past intestinal infection from the bacteria; a finding that suggested infection hindered recovery, hinted at cumulative effect, and suggested a longer-term 'etiology [*sic*] of mental disease'.[106] That the laboratory had occasionally discovered brain samples containing streptococci, fed into the brain permeability research. Coincidentally, cases of bacteriaemia were identified, which reinforced the wider suspicion that blood carried infection to the brain.[107]

The accumulated weight of circumstantial scientific evidence – including the number of cases identified post-mortem – finally led to the focus and mechanism of infection: 'nasal sinus disease'. Findings from a single dead patient in 1927 were considered decisive: here was 'a long standing perforation of the Spehnoid sinus into the Pituitary fossa. The pituitary was surrounded by a mucinous septic fluid, [… with] evidence of considerable extension subdurally of this septic process'.[108] The apparent breakthrough made by Hollymoor laboratory under Pickworth was informed by the clinical work of Graves, whose own judgements were shaped by close collaborations with Ear Nose and Throat (ENT) specialists. These included William Stirk Adams (founder of the Midland Institute of Otology) and Patrick Watson-Williams, a founding father of ENT in Britain, based at Bristol Infirmary, and a former colleague of Graves at Birmingham's asylums.

The flurry of activity resulted in the publication of at least eight papers between 1928 and 1929 under the auspices of the Joint Board, six of which were authored by Pickworth (one co-written with Graves) and centred on sphenoidal sinuses and focal sepsis.[109] From these it becomes clear that Pickworth (and Graves) believed that there was a specific, unconfirmed type of psychosis, which was caused by a toxic cycle of focal sepsis. Graves may

have hypothesised, but it was Pickworth who published widely and articulated the scientific pieces of the focal sepsis jigsaw through each successive publication. Essentially, typhoid, paratyphoid or food poisoning bacteria caused low-level systemic infection, inhibited gastric function, and stimulated a localised toxic reaction which serially broke through the integrity of physiological spaces and spread through blood, finally corrupting endocrine action, both leaking toxins into the brain and impacting on neuron functionality, causing confusional insanity. By 1930, the theory had been bolstered:

> The relation of these [the sinuses and intestinal tract] to local damage of the nervous system and endocrine imbalance via a disturbed pituitary have been investigated, histologically by the careful examining and sectioning of post-mortem Sinus material, bacteriologically by the agglutination reaction, chemically by Basal Metabolism determinations during sleep and the Chloride content of the Cerebro-Spinal Fluid as indicative of a low-grade meningitis.[110]

For the next decade, Pickworth and Graves worked on the theory away from the University site and assisted by a second bacteriologist and a third laboratory boy. Much of the July 1932 *Journal of Mental Science* was given over to the collaborations formed by the Joint Board's efforts. But it was Pickworth and the science taking place in his laboratory which continued to drive evidentially the theory of focal sepsis. Whilst he published a monograph, for Pickworth most post-1930 work was predicated on improving scientific testing: definitive proof for focal sepsis was there, but existing methods were unable to observe it.[111] Coinciding with the research on blood corpuscles, Pickworth developed a new means of suspending brain arteries in thick sections.[112] The histology revealed 'vascular lesions not only in general paralysis, but also, to a lesser extent, in more chronic forms of mental disease such as dementia praecox and manic depressive insanity'.[113] Blood supply was therefore foregrounded in research and by 1938, new staining methods demonstrated 'capillaries in histological brain section' and localised neurological ischaemia.[114]

Meanwhile, the spread of Birmingham's focal sepsis theory, optimism and therapy was being advanced by the BoC. While in 1936 the inspectorate had been consternated that more hospitals had not seemed 'to direct special attention to the subject', the classic British theory of focal sepsis had taken off at others, especially Worcester City and County Mental Hospital and the BoC's 'own [State] hospital at Rampton', established for criminals considered 'mentally defective'. Graves also noted that Birmingham's theory was associated with cases in Paris and South Africa, confirmed by Cotton's US experience at Trenton, and advanced by pioneering research work at Harvard University's Medical School and at Hollymoor.[115]

In the midst of Hollymoor's investigations – perhaps because of the profile achieved through laboratory research – the Joint Board had finally managed in 1934 to gather together representatives at Hollymoor from many of the Midlands mental hospitals. The summit also boasted an exhibition of diverse scientific and pathologic exhibits from fourteen of these hospitals, demonstrating the extent to which Birmingham had stimulated scientific endeavour. Pickworth's address conveyed his ambition for the Joint Board's work 'in the localization of the mind within the brain'.[116] Barling also 'voiced the hope' that the region's hospitals could see the merits of 'a scheme of co-ordinated research', orchestrated from a University hub, ending the isolation of Hollymoor and enabling work with general pathology, physics and biology.[117]

In October 1937 it was unanimously agreed that Staffordshire, Leicestershire, Worcestershire and Shropshire would co-operate in the establishment of a Midland Research Centre housed at the University with Pickworth as director.[118] Six months later, after sixteen years of lobbying, and facilitated by the 1930 Mental Treatment Act, the transfer of the 'Department for Research into Mental Diseases' to the new Medical School at

the University was detailed. The three-room central laboratories were located close to the main entrance. The facility would continue to receive major funding from the City and it was anticipated that once all Midland hospitals joined it would net £5000 annually. A donor had already contributed £2000 for new equipment, but Rockefeller funding remained the goal.[119]

It seems that Pickworth could increasingly feel the bonds of Hollymoor and of Graves' oversight loosening. By 1938 it was apparent to him that the reported results simply did not support the established Birmingham theory of focal sepsis and he spoke out clearly. 'The prevailing opinion of my teachers and colleagues, as to the aetiological causes of mental disorder, was that of biogenetically deteriorated or toxin-impaired cerebral neurones [*sic*]'. However, Pickworth reasoned, people with disordered minds underwent remission, even after years; were neurons structurally compromised, this could not occur. 'The biogenetic theories […] which we have cherished so long [… have] become untenable'. Mental disorders were so varied that 'any simple infectious agent as a cause' was 'unlikely'.[120] Toxins existed, but it was inhibited cerebral circulation – producing intermittent interruptions of blood supply to capillaries anywhere in the brain – which explained the varied, sporadic and unpredictable mental and emotional states displayed by patients in mental hospitals.[121] The vascular system was the key to prevention and treatment.[122]

The Death of a Theory

Final plans were made for the 1939 opening of the Research Department in Mental Diseases.[123] The first 'Advisory Board for Research in Mental Diseases', the replacement for the Joint Board, on which many of the same figures sat, including Barling and Bartleet, took place on 9 February 1939 at the University. As well as this steering committee, a Scientific Committee was established, which had more direct and expert oversight of the laboratory.

Its Honorary Director was Dr Stanley Barnes, former Dean of the Medical School and specialist in neurology, who was joined by Pickworth, the 'Scientific members of the University, and The Medical Officers appointed by the contributing Authorities', including Graves.[124]

This should have been the point at which the reputation of the laboratory and the research around 'mental diseases' was enhanced by its relocation to one of the largest centres for research in Britain, and through the achievement of close working with a network of new colleagues and ideas. Yet the Second World War soon ensured that attention was often elsewhere. Meetings of the Advisory Board continued, but with the death of Barling in 1940, and then Bartleet in 1944, stability was lost. Pickworth became a veritable island. With no close oversight (scientific or otherwise) to speak of, either from the University or from Graves, in 1945 it became painfully clear that Pickworth had not followed protocol and had set the scientific method to one side. Whilst the full and precise story is absent from the records, seems to have been one of, at best poor practice, and at worst sham science.

This fall from grace is all the more tragic, because Birmingham and the Department of Mental Diseases continued to be a draw for scientific stars. Indeed, the Department had pushed for the University to appoint Solly Zuckerman in 1939. Zuckerman, a lauded figure in twentieth-century biological science, was in some ways at the height of his powers. He had been recently elected a Fellow of the Royal Society and in 1939 appointed Scientific Advisor to the Allies' Combined Operations HQ. One strand of his government research was to assess the effects of civilian bombing on brains, bodies and buildings. Whilst this seems to have been one of the reasons why his appointment at Birmingham was delayed until 1943, confirmation of his professorship ensured ongoing consultation with the Scientific Board. In

particular, from 1940 he began to direct the work which took place under Pickworth, outlining 'a special line' of study in the 'field of hormone research'; something perfectly suited to the laboratory at Birmingham.[125] Alongside this, the Department's extant research continued and subjects proliferated. These included brain-blast studies from air-raid casualties and from Zuckerman's bomb experiments on monkeys.[126]

Pioneering psychopharmacologist Joel Elkes recalled 'Mental Diseases Research' as a 'small subdepartment of two rooms' located on the floor below the Department of Pharmacology, when he co-founded it in 1941. Pickworth was 'a gifted neuropathologist' surrounded by 'innumerable slices and slides of the brain in all manner of pathological states, stained by his methods'.[127] He continued to work on focal sepsis, nasal sinuses and vascular mechanics, but something new was growing from Zuckerman's suggestion. In 1940, Austrian Dr Franz Schütz had been appointed from the Pharmaceutical Society Laboratories (London), where he had been working on the 'biological standardisation of hormones'.[128] Working with Pickworth's brain samples, he soon thought he had identified a possible 'mechanism of drug addiction and drug tolerance'. From his experiments concerning the production of chemicals involved in sleep, he believed 'that the choline esterase should have a therapeutic effect on the number of fits in epilepsy' and was developing a new drug, which received significant interest from practitioners, the pharmaceutical company Glaxo and appeared as a short item in *Nature*.[129] Schütz's work on the role of cynates in sleep developed, with the Advisory Board commenting in 1945 that it 'continued to arouse wide interest in the world of medical science and appeared to be of fundamental value'.[130]

As the War drew to a close, normal business began slowly to resume. The Scientific Committee met on 11 October 1945 for the first time in four years, chaired by Professor A. C. Frazer, a biochemist with expertise on digestion, and included Graves. Pickworth '[gave]

the results of his investigations […] at some length' and was 'thanked for the manner in which he had dealt with the numerous questions put to him'.[131] Frazer wrote a letter to the Scientific Committee. This was read at their January 1946 meeting and discussed with Graves, but without Pickworth and Schütz in the room. They resolved '[t]hat, in the majority opinion of this Committee, the research work that Dr. Pickworth has conducted has suffered severely from the absence of adequate and reasonable control observations'. This is surprising, given the careful earlier work with both the metabolic and the psychopharmaceutic experiments. Pickworth was given a right to reply before the next meeting.[132] The fallout was dramatic. The Scientific Committee expressed their 'lack of confidence in the work of Dr. Pickworth' and proposed that 'the Secretary of the Medical Research Council should be invited to appoint two or three Assessors to report to the Board on the scientific validity of Dr. Pickworth's work'. Pickworth tendered his resignation as the 'Chief Research Officer to the Board of Mental Disease', though seemingly not for the hospital-associated work or research he had been carrying out since 1922. The resignation was quickly accepted and then refused, Pickworth being temporarily 'reinstated in his original position'.[133] In the discussions which followed, he submitted to an independent assessment. 'Graves, however, stated that, as Dr. Pickworth would be under his jurisdiction after April, he was not prepared for [… the] work to be examined by any assessors'.[134]

The impact of the Scientific Committee's stance was soon clear, as the City of Birmingham pulled out of the 'scheme for Research in Mental Diseases' that it had co-established in 1922.[135] A letter of explanation made it clear that the City believed 'that Dr. Pickworth had not been receiving [the agreed] measure of co-operation from the other Departments of the University'.[136] Worcestershire also pulled out.[137] The Department,

already in a precarious position, found themselves with significantly less funding, and felt the introduction of the National Health Service would arrest future income.[138]

The MRC-assessment proposal was dropped. Focus shifted to shoring up effective working with the remaining local authorities. One member of the meeting suggested that 'a sub-committee be formed […] to review the activities of the Department. The Chairman pointed out, however, that this was one of the very purposes for which the existing Scientific Sub-Committee was instituted'.[139] The matter was referred up to the Medical Faculty and the Council of the University.[140] Whilst no dramatic moment emerged from this, quietly the Advisory Board decided that, as the University was planning to establish a Department of Neurology, Neurosurgery and Psychiatry, any public moves should cease. Until then, Schütz, whose work had easily passed the Committee's investigations, would continue conducting research under the guidance of Zuckerman.[141] Elkes, whether unknowingly, consciously or forgetfully shielding the truth, recalled Pickworth as having retired, when the Mental Diseases Research 'laboratory reverted to the Department of Pharmacology'.[142] Back at Hollymoor, under Graves, Pickworth continued to work. Just before his 1955 retirement as Consultant Pathologist, Group 6 Hospitals, Birmingham, he published his second monograph. The book, an overview of his life's work at the Joint Board, was savaged by W. Ross Ashby, a new-generation psychiatrist and innovator in cybernetics.[143]

Conclusion

Since 1955 (and seemingly beforehand) the national importance and international influence of the Joint Board of Research for Mental Diseases, City and University of Birmingham, has been forgotten. Yet it involved Mott and Haldane, two chief pioneers in the modern scientific understanding of the body, drew in Zuckerman, a leading British scientist of the

twentieth century, and cut across international boundaries and professional silos through collaborations between psychiatrists, neuropathologists, ENT specialists, and physiologists. The Joint Board also investigated major issues, including endocrinology, neurotoxicity, psychopharmacology and basal metabolism. The tenacity of the Board eventually achieved the objective of a University-based central laboratory and stimulated scientific work across a large region now regarded as provincial; today's funders would do well to take note. The Joint Board existed in various forms for around 25 years, mostly under the direction of Pickworth. It suffered from and was felled by, not only the insularity fostered by the general lack of outside investment and oversight, but also by failings in the University's oversight, and Pickworth's own apparent lack of rigour.

With hindsight it is easy to consider the initiative a failure, resulting in its erasure from global and British histories of psychiatric research, and the theory of focal sepsis as misguided, as Scull has argued. Although Graves may have informed the theory deeply, it was scientific research that undergirded focal sepsis. Pickworth provided the rationale for therapeutics and was to a large degree responsible for publicising focal sepsis and lending it credibility; something overlooked in previous studies. That said, the theory – or at least the research – could not have been produced anywhere else: it was the result of Birmingham's civic ambition and the unique recipe of the Joint Board's space, members and hidden or nameless figures: laboratory workers, psychiatric nurses, and patients. Indeed, one of the core aspects this study has refined is the notion that 'place' is about more than location, though location can make all the difference with regard to failure as well as success. 'Place' in the history of science is also not strictly about a geographical location – its economy or cultural and political influences – or close-knit core sets. There is something more ephemeral and rather less quantifiable: a sense of place that is temporary, a will o' the wisp dependent

on brushes with invisible or unknowable people and bodies, and on absences – funding, individuals (Mott, Bartling and Bartleet), external influence, fresh ideas, and monitoring.

With the crisis of the Second World War and eyes and attention diverted elsewhere, a new sense of place opened up for Pickworth in Birmingham. Free of oversight and perhaps struggling to make sense of an apparently failing theory with so little input, the grand ambitions of 1922 faltered. Pickworth's practise was quietly moved, back to Hollymoor. The intervention of Graves in avoiding an independent investigation not only spared the public undermining of the focal sepsis theory, but also Pickworth and the University public embarrassment. The fortunes and reputation of the institution and Graves were tied together with those of world-renowned scientists at the University in a complex human-organisational core-set.

Shapin articulated the trust and truth on which scientific fact-making was built from the seventeenth century. Drawing on sociologist Howard Becker, he argued that 'spokesmen make assertions on behalf of subordinates "and are held responsible for the truth of those assertions." The institution constitutes a "hierarchy of credibility."'[144] Shapin saw modern expertise and 'genuine knowledge' as based on 'internal "rigorous policing" […] Who would not misrepresent the truth for advantage', he asked, 'if they could get away with it?'[145] The rise and fall of the Mental Diseases laboratory and the theory of focal sepsis presents us with a twentieth-century case-study through which we are able to see both core-sets and this hierarchy of credibility in action and the threat of what were in 1945 considered scientific fictions.

While the Birmingham research – even that produced before its post-1939 altered state of place – has not achieved any long-lasting major, accepted clinical or theoretical breakthroughs to date, in the 1920s, 1930s and 1940s it looked to UK and international

observers to be a source for major discoveries and even the cure for mental disorders. The fifteen articles published under the aegis of the Joint Board that are mentioned in this paper (not an exhaustive list) have until now received at least 194 citations. Pickworth's 1967 obituary stated that his capillary staining techniques were still widely used.[146] His paper detailing the method was cited as recently as 2017; 'impact', even for scientific research and methodology, can be belated.[147] The number of citations of the at least 135 articles which used his paper is 3,927, ad infinitum, their authors working across the globe, from Japan to Israel, America to China.[148] Despite all the absences described in this article, much modern international medical science thus rests on the presence of the research and practical techniques instituted by the Joint Board. What is more, after being in the shadows for decades, investigations connecting the gut and mind are again part of the mainstream.[149] There is, therefore, no better time to consider the place of Britain's past focal sepsis theories in the building blocks of contemporary science.

* Social Studies in Medicine, Institute for Applied Health Research, Murray Learning Centre, University of Edgbaston, Edgbaston, Birmingham, B15 2TT, UK

Email: R.I.Wynter@bham.ac.uk.

Acknowledgements

I'd like to thank Len Smith, Vanessa Heggie, Mike Finn and Tom Harrison for their reading and helpful suggestions on earlier drafts. I also want to say thank you to both anonymous reviewers for their careful comments, which have produced a refined and enhanced manuscript. Thanks too to the Editors of *BJHS*, and to Trish Hatton, who is an excellent and effective first point of contact with the *Journal*.

New primary sources for this article emerged, and writing was completed, during the AHRC-funded project, 'Forged by Fire: Burns Injury and Identity in Britain, *c*.1800-2000' (grant number AH/N00664X/1).

---

[1] Anon., 'Memorandum of the evidence given on May 4 and 5 1925, on behalf of the Royal Commission on Lunacy and Mental Disorder (passed by the Association at the Quarterly Meeting, November 20, 1924). With appendices', *Journal of Mental Science* (1925a) 71, pp. 493-558, p. 513.

[2] Anon., 1925a, op. cit. (1), p. 515.

[3] Anon., 1925a, op. cit. (1), p. 517.

[4] See R. Hayward, 'Germany and the making of "English" psychiatry: the Maudsley Hospital, 1908-1939', V. Roelcke, P.J. Weindling and L. Westwood, *International Relations in Psychiatry: Britain, Germany, and the United States to World War II*, London, Boydell & Brewer, 2010, pp. 67-90.

[5] R. Noll, 'Infectious insanities, surgical solutions: Bayard Taylor Holmes, dementia praecox and laboratory science in early 20th-century America. Part 1', *History of Psychiatry*, 17 (2),

2006a, pp. 183-204, pp. 183-4. See also R. Noll, 'Infectious insanities, surgical solutions: Bayard Taylor Holmes, dementia praecox and laboratory science in early 20th-century America. Part 2', *History of Psychiatry*, 17 (3), 2006b, pp. 299-311.

[6] T. Quick, 'From phrenology to the laboratory: physiological psychology and the institution of science in Britain (*c*.1830-1880)', *History of the Human Sciences*, 27 (5), 2014, pp. 54-73.

[7] See, for example: J.T. Braslow, *Mental Ills and Bodily Cures: Psychiatric Treatment in the First Half of the Twentieth Century*, London: University of California Press, 1997; J. Gach, 'Biological psychiatry in the nineteenth and twentieth centuries', in E.R. Wallace IV and J. Gach, *History of Psychiatry and Medical Psychology. With an Epilogue on Psychiatry and the Mind-Body Relation*, New York: Springer, 2008, pp. 381-418; E.S. Valenstein, *Great and Desperate Cures: The Rise and Decline of Psychosurgery & Other Radical Treatments for Mental Illness*, New York: Basic Books, 1986.

[8] A. Cunningham and P. Williams (eds), *The Laboratory Revolution in Medicine*, Cambridge: Cambridge University Press, 1992.

[9] C.G. Douglas, 'John Scott Haldane, 1860-1936', in *Obituary Notices of Fellows of the Royal Society* (1936) 2, pp. 11439; M. Goodman, *Suffer and Survive. Gas Attacks, Canaries, Spacesuits and the Bends: the Extreme Life of J. S. Haldane*, New York: Pocket Books, 2008; S.E. Mathews, 'Matter Over Mind: The Contribution of the Neuropathologist Sir Frederick Walker Mott to British Psychiatry, c.1895-1926', University of Manchester: Unpublished Ph. D. Thesis, 2006; A. Meyer, 'Frederick Mott, founder of the Maudsley Laboratories', *British Journal of Psychiatry* (1973) 122, pp. 497-516; W.J. O'Connor, *British Physiologists 1885-1914: A Biographical Dictionary*, Manchester: Manchester University Press, 1991; E.A. Sharpey-Schafer, 'Mott, Sir Frederick Walker (1853–1926)', rev. Rachel E. Davies, *Oxford*

Dictionary of National Biography, Oxford University Press, 2004/1926, accessed 9 January 2019 at: http://www.oxforddnb.com/view/article/35127; S.W. ; Sturdy, 'A Co-ordinated Whole: The Life and Work of John Scott Haldane', University of Edinburgh: Unpublished Ph.D. Thesis, 1987; S.W. Sturdy, 'From the trenches to the hospitals at home: physiologists, clinicians and oxygen therapy', in J.V. Pickstone (ed.) *Medical Innovations in Historical Perspective*, London: MacMillan, 1992, pp. 104-23; S.W. Sturdy, 'Haldane, John Scott (1860–1936)', *Oxford Dictionary of National Biography*, Oxford University Press, 2004, accessed 9 January 2019 at: http://www.oxforddnb.com/view/article/33642.

[10] A. Scull, 'Focal sepsis and psychosis: the career of Thomas Chivers Graves, BSc, MD, FRCS, MRCVS (1883-1964)', in H. Freeman and G.E. Berrios (eds) *150 Years of British Psychiatry. Volume II: The Aftermath*, London: Athlone Press, 1996, pp. 517-36; A. Scull, 'Somatic therapies and twentieth century psychiatry – problems and prospects', in T. Hamanaka and G. Berrios (eds), *Two Millennia of Psychiatry in West and East – Selected Papers from the International Symposium "History on the Threshold to the 21st Century," 20-21 March 1999, Nagoya, Japan*, Tokyo: Gakuju Shoin, 2003, pp. 193-206; A. Scull, *Madhouse. A Tragic Tale of Megalomania and Modern Medicine*, New Haven and London: Yale University Press, 2005/2007.

[11] D. Livingstone, *Putting Science in Its Place: Geographies of Scientific Knowledge*, London: University of Chicago Press, 2003.

[12] M. Hammerborg, 'The laboratory and the clinic revisited: the introduction of laboratory medicine into the Bergen General Hospital, Norway', *Social History of Medicine* (2011) 24, pp.758-75. C. Lawrence, *Rockefeller Money, the Laboratory and Medicine in Edinburgh 1919-1930: New Science in an Old Country*, New York: University of Rochester Press, 2005.

[13] L.S. Jacyna, 'The laboratory and the clinic: the impact of pathology on surgical diagnosis in the Glasgow Western Infirmary, 1875-1910', *Bulletin of the History of Medicine* (1988), 3, pp. 384-406; G. Davis, *'The cruel madness of love': Sex, Syphilis and Psychiatry in Scotland, 1880-1930*, Amsterdam: Rodopi, 2008, p. 241.

[14] R.E. Kohler, *From Medical Chemistry to Biochemistry: The Making of a Biomedical Discipline*, Cambridge: University of Cambridge Press, 1982.

[15] S. Shapin, *A Social History of Truth: Civility and Science in Seventeenth-Century England*, London: University of Chicago Press, 1994; B. Latour and S. Woolgar, *Laboratory Life: The Construction of Scientific Facts*, New York: Sage Publications, 1979.

[16] Shapin, 1994, op. cit. (15), pp. 409-17, quote from p. 416.

[17] E.J. Engstrom, *Clinical Psychiatry in Imperial Germany: A History of Psychiatric Practice* (Ithaca and London: Cornell University Press, 2003), p. 107.

[18] For more see: M. Finn, 'The West Riding Lunatic Asylum and the Making of the Modern Brain Sciences in the Nineteenth Century', University of Leeds: unpublished PhD thesis, 2012; J. Wallis, *Investigating the Body in the Victorian Asylum*, London: Palgrave Macmillan, 2017.

[19] Wallis, 2017, op. cit. (18), p. 80.

[20] T. Buklijas, 'The laboratory and the asylum: Francis [*sic*] Walker Mott and the pathological laboratory at London County Council Lunatic Asylum, Essex (1895-1916)', *History of Psychiatry*, 28 (3), 2017, pp. 311-25.

[21] Davis, op. cit. (13), pp. 129-30.

[22] For more see: P. Michael, 'Welsh psychiatry during the interwar years, and the impact of American and German inspirations and resources', in Roelcke, Weindling, and Westwood,

op. cit. (4), pp. 197-217; P. Michael, 'Prolonger narcosis therapy in the interwar years', in H-W Schmuhl and V. Roelcke, *Heroische Therapien: Die deutsch Psychiatrie im internationalen Vergleich, 1918-1945*, Goëttingen: Wallstein Verlag, 2013, pp. 114-30.

[23] For more see, for example: R. Noll, 'The blood of the insane', *History of Psychiatry* (2006c) 17, pp. 395-418; Scull, 1996, op. cit. (10); Scull, 2007, op. cit. (10).

[24] Scull, 2007, op. cit. (10).

[25] Scull, 2007, op. cit. (10), p. 52.

[26] Noll, 2006c, op. cit. (23), p. 411. Scull, 1996, op. cit. (10), p. 172; Scull, 2007, op. cit. (10), p. 228.

[27] See, for instance: E.R. Brown, *Rockefeller Medicine: Medicine & Capitalism in America*. Berkley and Los Angeles, California: University of California Press, 1979; L.E. Kay, *The Molecular Vision of Life: Caltech, The Rockefeller Foundation, and the Rise of the New Biology*, Oxford: Oxford University Press, 1993; A. Landsborough Thomson, *Half a Century of Medical Research. Volume One: Origins and Policy of the Medical Research Council (UK)*, London: HMSO, 1973; Lawrence, op. cit. (15).

[28] T.S. Kuhn, *The Structure of Scientific Revolutions,* Chicago: University of Chicago Press, 1962; Latour and Woolgar, op. cit. (15).

[29] R. Wynter, 'Pictures of Peter Pan: filtering mentally deficient children in early twentieth century Birmingham', *Family and Community History* (2015) 18, pp. 122-38, p. 127.

[30] E. Ives, D. Drummond and L. Schwarz, *The First Civic University: Birmingham, 1880-1980. An Introductory History*, Birmingham: University of Birmingham, 2000.

[31] J. Reinarz, *Health Care in Birmingham, The Birmingham Teaching Hospitals, 1779-1939*, London: Boydell & Brewer, 2009, p. 165.

[32] Sturdy, 1992, op. cit. (4), p. 108. E. Jones, "An atmosphere of cure: Frederick Mott, shell shock and the Maudsley', *History of Psychiatry*, 25 (4), 2014, pp. 412-21.

[33] Wynter, 2015, op. cit. (29).

[34] Library of Birmingham, *Asylums Committee, etc., and Mental Hospitals Committee: Annual Reports 1916-17 to 1937-38* (hereafter ACAR), L47.13, 1922-3, p. 34.

[35] 'Alderman Miss Bartleet Dead', *Evening Dispatch*, 26 May 1944, p. 3. See also S. Roberts, '"My whole time is given to the service of my fellow citizens" – the first women elected to Birmingham City Council', *The Iron Room: Archives and Collections @ the Library of Birmingham*, 4 March 2015, https://theironroom.wordpress.com/2015/03/04/my-whole-time-is-given-to-the-service-of-my-fellow-citizens-the-first-women-elected-to-birmingham-city-council/ (accessed: 13 March 2020).

[36] Anon., 'Notes and news: the Medico-Psychological Association of Great Britain and Ireland. The Eighty-Fourth Annual General Meeting', *Journal of Mental Science* (1925b), 71, pp. 797-855, p. 829 and p. 839.

[37] Reinarz, op. cit. (31), p. 230.

[38] Scull, 2007, op. cit. (10), p. 112.

[39] Scull, 2007, op. cit. (10). P. 109.

[40] E. Jones and S. Rahman, 'Framing mental illness, 1923-1939: the Maudsley Hospital and its patients', *Social History of Medicine* (2008), 21, pp. 107-25, p. 111.

[41] Library of Birmingham, 'City of Birmingham: Joint Board of Research for Mental Disease Minute Book, No. 1' (hereafter JBM), 7 December 1922-30, May 1933, BCC1/FE/1/1/1, 7 December 1922.

[42] JBM, op. cit. (41), 13 February 1923.

[43] JBM, op. cit. (41), 7 December 1922.

[44] JBM, op. cit. (41), 7 June 1923.

[45] JBM, op. cit. (41), 'Annual Report, June 1924', p. 2.

[46] JBM, op. cit. (41), 'Circular to Midlands Hospitals'.

[47] Wallis, 2017, op. cit. (18), p. 81.

[48] JBM, op. cit. (41), 5 Jun. 1924.

[49] JBM, op. cit. (41), 'Letter to Barling, 23 June 1925'.

[50] Meyer, 1973, op. cit. (9), p. 506; G. Shuttleworth and W.A. Potts, *Mentally Defective Children: Their Treatment and Training*, Fifth edition, London: H. K. Lewis & Co, 1922, p. 78.

[51] B. Evans and E. Jones 'Organ extracts and the development of psychiatry: hormonal treatments at the Maudsley Hospital, 1923-1938', *Journal of the History of Behavioural Sciences* (2012), 48, pp. 251-76, p. 251. For overview of iodine, see: J. Lindholm and P. Laurberg, 'Hypothyroidism and thyroid substitution: historical aspects', *Journal of Thyroid Research*, 2011, pp. 1-10.

[52] JBM, op. cit. (41), 'Letter to Barling, June 1925'.

[53] F.A. Pickworth, 'A method for the estimation of iodine in thyroid gland', *Biochemical Journal* (1925), 19, pp. 768-72. JBM, op. cit. (41), 30 June 1935.

[54] JBM, op. cit. (41), 'Annual Report, 1925', p. 1.

[55] JBM, op. cit. (41), 19 June 1926. JBM, op. cit. (41), 'Director's Report, 16 June 1928', p. 2.

[56] JBM, op. cit. (41), 29 June 1927.

[57] Anon. 1925b, op. cit. (36), p. 828 and p. 846.

[58] JBM, op. cit. (41), 'Annual Report, 1927', p. 2.

[59] JBM, op. cit. (41), 'Annual Report, 1929', p. 3.

[60] JBM, op. cit. (41), June 1924.

[61] F.A. Pickworth, 'Basal metabolism as determined by the respiratory exchange', communicated by J.S. Haldane, *Proceedings of the Royal Society B* (1927a), 101/708, pp. 163-85, p. 163.

[62] JBM, op. cit. (41), 'Annual Report, 1924', p. 1.

[63] Pickworth, 1927a, op. cit. (61), pp. 163-4.

[64] E. Dwyer, 'Neurological patients as experimental subjects: epilepsy studies in the United States', in L.S. Jacyna and S.T. Casper (eds), *The Neurological Patient in History*, New York: University of Rochester, 2012, pp. 44-62.

[65] Pickworth, 1927a, op. cit. (61), p. 164.

[66] JBM, op. cit. (41), 'Annual Report, 1925', p. 2.

[67] P. Tanskanen, M. Happea, J. Veijola, J. Miettunen, M-R. Jarvelin, J. Pytinen, P.B. Jones, M. Isohanni, 'Volumes of brain, grey and white matter and cerebrospinal fluid in schizophrenia in Northern Finland 1966 Birth Cohort: an epidemiological approach to analysis', *Psychiatry Research: Neuroimaging*, 174 (2009), pp. 116-20, p. 118.

[68] M.L. Meldrum, 'A brief history of the randomized controlled trial: from oranges and lemons to the gold standard', *Hematology/Oncology Clinics of North America*, 14 (4), 2000, pp. 745-60.

[69] M. Edwards, *Control and the Therapeutic Trial: Rhetoric and Experimentation in Britain, 1918-48*. Clio Medica, Amsterdam and New York: Rodopi, 2007, p. 11.

[70] JBM, op. cit. (41), 'Annual Report, 1927', p. 3.

[71] JBM, op. cit. (41), 'Annual Report, 1926', pp. 8-10.

[72] JBM, op. cit. (41), 'Annual Report, 1928', p. 2.

[73] Anon. 'Notes and News: City and University of Birmingham Joint Board of Research for Mental Disease', *Journal of Mental Science*, 80 (320), 1934a, pp. 173-7, p. 174.

[74] For more see, for example: Shapin, 1994, *op. cit.* (15); P.L. Twohig, '"Local Girls" and "Lab Boys": Gender, Skill and Medical Laboratories in Nova Scotia in the 1920s and 1930s', *Acadiensis*, XXXI (1), 2001, pp. 55-75.

[75] F.A. Pickworth, 'Perforation of the pituitary fossa by a septic lesion of the sphenoidal sinus associated with recent epilepsy and insanity', *Journal of Laryngology and Otology* (1928b) 43, pp. 186-90, p. 188.

[76] J.L. Phillips, *The Bends: Compressed Air in the History of Science, Diving, and Engineering*, New York: Yale University Press, 1998, pp. 121-8.

[77] Quote from, D.L. Woodhouse and F.A. Pickworth, 'The oxygen capacity of the blood in one hundred cases of mental disorder', *Biochemical Journal* (1930), 24, pp. 834-49, p. 834; JBM, op. cit. (41), 'Annual Report, 1930', p. 3.

[78] Woodhouse and Pickworth, 1930, op. cit. (77), p. 834.

[79] Woodhouse and Pickworth, 1930, op. cit. (77), p. 849.

[80] JBM, op. cit. (41), 'Annual Report, 1930', p. 3.

[81] Woodhouse and Pickworth, 1930, op. cit. (77).

[82] JBM, op. cit. (41), 'Annual Report, 1930', p. 3. D.L. Woodhouse and F.A. Pickworth, 'Permeability of vital membranes. The red blood corpuscle', *Biochemical Journal* (1932), 26, pp. 309-16.

[83] H.A. Strecker, 'Investigation of the permeability of the brain membranes in cases of mental disorder', *Journal of Mental Science* (1928), 74/304, pp. 73-80.

[84] Anon. 1934a, op. cit. (73), p. 176.

[85] K. Jones, *A History of the Mental Health Services*, London: Routledge and Kegan Paul, 1972, p. 153.

[86] Anon., 'The Board of Control and the Mental Treatment Act, 1930', *The Lancet* (1930) 216/5591, pp. 921-3, p. 922.

[87] JBM, op. cit. (41), 31 July 1930.

[88] JBM, op. cit. (41), 31 July 1930.

[89] JBM, op. cit. (41), 8 December 1930.

[90] JBM op. cit. (41), 10 July 1931 and 30 July 1832.

[91] JBM, op. cit. (41), 28 June 1931.

[92] JBM, op. cit. (41), 18 July 1932.

[93] JBM, op. cit. (41), 18 July 1932. JBM, op. cit. (41), 10 July 1931.

[94] JBM, op. cit. (41), 'Annual Report, 1933', p. 4.

[95] Michael, 2013, op. cit. (22), p. 121.

[96] JBM, op. cit. (41), 'Director's Report, May 1933', p. 1.

[97] JBM, op. cit. (41), 8 January 1924.

[98] Michael, 2010, op. cit. (22), p. 210.

[99] JBM, op. cit. (41), 'Annual Report, 1925', p. 4.

[100] JBM, op. cit. (41), 'Annual Report, 1925', p. 4.

[101] JBM, op. cit. (41), 'Annual Report, 1924', p. 3.

[102] T.C. Graves, 'The relation of chronic sepsis to so-called functional mental disorder', *Journal of Mental Science* (1923), 69/287, pp. 465-71, p. 470.

[103] Anon., 1925b, op. cit. (36), p. 839.

[104] JBM, op. cit. (41), 'Annual Report, 1925', p. 3.

[105] JBM, op. cit. (41), 'Annual Report, 1925', p. 4.

[106] JBM, op. cit. (41), 'Annual Report, 1926', p. 1; F.A. Pickworth, 'Agglutination of typhoid and dysentery organisms by the sera of mental hospital patients', *Journal of Pathology and Bacteriology* (1927b), 30, pp. 627-40.

[107] JBM, op. cit. (41), 'Annual Report, 1926', pp. 1-2. JBM, op. cit. (41), 'Annual Report, 1927', p. 1.

[108] JBM, op. cit. (41), 'Annual Report, 1927', p. 2.

[109] T.C. Graves and F.A. Pickworth, 'Sinusitis in the etiology of mental disorder', *Proceedings of the Royal Society of Medicine* (1928), 21/7, pp. 1267-84; F.A. Pickworth, 'A case of diplococcal infection of the sphenoid sinus with associated haemorrhages in the stomach', *Proceedings of the Royal Society of Medicine* (1928a), 21/5, pp.972-84; Pickworth, 1928b,op. cit. (75); F.A. Pickworth, 'Variation in agglutinin formation in mental hospital patients and its probable relation to focal sepsis', *Journal of Mental Science* (1928c), 74/307, pp. 709-19; F.A. Pickworth, 'Confusional insanity with empyema of the sphenoidal sinus', *British Medical Journal* (1929a), 1/3563, pp. 721-3; F.A. Pickworth, 'A case of mania melancholia with caries of the sphenoid', *Journal of Laryngology and Otology* (1929b) 44/11, pp. 250-2; Strecker, 1928, op. cit. (83); D.L. Woodhouse, 'The fat, lipid and cholesterol constituents of adrenals and gonads in cases of mental disease', *Biochemical Journal* (1928), 22, pp. 1087-96.

[110] JBM, op. cit. (41), 'Annual Report, 1929', p. 1.

[111] F.A. Pickworth, *Chronic Nasal Sinusitis and Mental Disorder*, London: H. K. Lewis & Co, 1935.

[112] Woodhouse and Pickworth, 1932, op. cit. (82).

[113] F.A. Pickworth, 'The Influence of Septic Infection of the Sphenoidal Sinus upon the Cerebral Blood Supply', The Journal of Laryngology and Otology, XLVII (XII), 1932, pp. 797-807, p. 798.

[114] F.A. Pickworth, 'A new method of study of the brain capillaries and its application to the regional localisation of mental disorder', *Journal of Anatomy* (1934), 69, pp. 62-71; F.A. Pickworth, 'Cerebral ischaemia and mental disorder', *Journal of Mental Science* (1937), 83/346, pp. 512-33.

[115] ACAR, op. cit. (34), 1937-1938, pp. 15-16.

[116] Anon., 1934a, op. cit. (73), p. 176.

[117] Anon., 'Mental diseases research centre in the Midlands', *British Medical Journal* (1934b), 1/3089, p. 32.

[118] ACAR, op. cit. (34), 'Annual Report, 1938', p. 34.

[119] Cadbury Research Library, University of Birmingham, 'Medical Faculty Minute Book, 1936-8', 12 April 1938, uncatalogued.

[120] Pickworth, 1937, op. cit. (114), pp. 512-13.

[121] Pickworth, 1937, op. cit. (114); F.A. Pickworth, 'A new outlook on the physiology and pathology of mental and emotional states', *British Medical Journal* (1938), 1/4022, pp. 265-73.

[122] Pickworth, 1938, op. cit. (121), p. 271.

[123] ACAR, op. cit. (34), 'Annual Report, 1938', p. 34.

[124] Cadbury Library, 'Minutes of the First Meeting of the Advisory Board for Research in Mental Diseases', 9 February 1939, Advisory Board for Research in Mental Disease Minutes, 1938-1945 (hereafter ABM1), UB/COM/41/1, p. 2.

[125] 'Mental Disease Research: Minutes of a Meeting of the Scientific Members of the Advisory Board', 25 January 1940, ABM1, op. cit. (124).

[126] 'Department of Mental Disease Research: Report of Research for the Year 1941. For consideration of the Meeting of the Board, March 1942', ABM1, op. cit. (124). For more on Zuckerman's blast experiments see: I. Burney, 'War on fear: Solly Zuckerman and civilian nerve in the Second World War', *History of Human Sciences*, 25 (5), 2012, pp. 49-72.

[127] J. Elkes, 'Psychopharmacology: finding one's way', in I.G. Farreras, C. Hannaway and V.A. Harden (eds), *Mind, Brain, Body, and Behavior: Foundations of Neuroscience and Behavioral Research at the National Institutes of Health*, Amsterdam: IOS Press, 2004, pp. 201-20, p. 204.

[128] 'Minutes of a Meeting of the Scientific Members of the Mental Disease Advisory Board', 29 February 1940, ABM1, op. cit. (124).

[129] 'F. Schutz, Report on Research Work for the year 1941', ABM1, op. cit. (124). 'Report of F. Schutz', 1942, ABM1, op. cit. (124).

[130] 'University of Birmingham Meeting of the Advisory Board for Research in Mental Diseases', 24 May 1945, ABM1, op. cit. (124), p. 3.

[131] 'Meeting of the Scientific Committee of the Advisory Board in Mental Disease Research', 11 October 1945, ABM1, op. cit. (124).

[132] 'Meeting of the Scientific Committee of the Board of Research into Mental Diseases', 17 January 1946, Advisory Board for Research in Mental Disease Minutes, 1946-7 (hereafter ABM2), UB/COM/41/2.

[133] 'Meeting of the Advisory Board of Research in Mental Diseases', 21 March 1946, AMB2, op. cit. (132).

[134] 'Minutes of the Scientific Committee of the Board of Research in Mental Diseases', 7 February 1946, ABM2, op. cit. (132).

[135] 'Meeting of the Advisory Board on Research in Mental Diseases', 28 February 1946, ABM2, op. cit. (132).

[136] 'Meeting of the Advisory Board of Research in Mental Diseases', 21 March 1946, AMB2, op. cit. (132).

[137] 'Meeting of the Scientific Committee of the Board of Research in Mental Disease', 11 April 1946, ABM2, op. cit. (132).

[138] 'Report from the Director of Research in Mental Disease', September 1946, ABM2, op. cit. (132).

[139] 'Meeting of the Advisory Board on Research in Mental Diseases', 28 February 1946, ABM2, op. cit. (132).

[140] 'Meeting of the Advisory Board on Research in Mental Diseases', 28 February 1946, ABM2, op. cit. (132).

[141] 'Meeting of the Sub-Committee of the Scientific Committee of the Board of Research in Mental Disease', 16 May 1946, ABM2, op. cit. (132).

[142] Elkes, op. cit. (127), p. 204.

[143] W. Ross Ashby 'Review: *New Outlook on Mental Diseases*. By F.A. Pickworth. Bristol: John Wright & Sons, 1952', *Journal of Mental Science* (1952), 98/411, pp. 344-5.

[144] Shapin, 1994, op. cit. (15), p. 406.

[145] Shapin, 1994, op. cit. (15), p. 413.

[146] R.C.B., 'Obituary Notices: F. A. Pickworth, B.Sc, M.B., B.S.', *British Medical Journal*, 11 November 1967, p. 363.

[147] J. Chedly, S. Soares, A. Montembault, Y. von Boxberg, M. Veron-Ravaille, C. Mouffle, N. M-Benassy, J. Taxi, L. David and F. Nothias, 'Physical chitosan microhydrogels as scaffolds for spinal cord injury restoration and axon regeneration', *Biomaterials* (2017), 138, pp. 91-107.

[148] All figures here are those given on Google Scholar: http://scholar.google.co.uk/. Date accessed: 28 October 2018.

[149] See, for example: M. Costani, 'Gut bacteria regulate nerve fibre insulation', *The Guardian*, 5 April 2016, https://www.theguardian.com/science/neurophilosophy/2016/apr/05/gut-bacteria-brain-myelin?CMP=share_btn_tw (accessed: 1 June 2020); J.R. Kelly, C. Minuto, J.F. Cryan, G. Clarke, and T.G. Dinan, 'Cross talk: the microbiota and neurodevelopmental disorders', *Frontiers in Neuroscience*, 11, article 490, 2017, pp. 1-31; T. Kuntz and J. Gilbert, 'Microbiome: does the brain listen to the gut?, *eLife*, 25 May 2016, e17052, DOI: 10.7554/eLife.17052 (accessed: 1 January 2020); T. Lewis, 'Stroke alters gut microbiome, impacting recovery', *The Scientist*, 15 July 2016, https://www.the-scientist.com/daily-news/stroke-alters-gut-microbiome-impacting-recovery-33182 (accessed: 10 February); A. Sakar, S.M. Lehto, S. Harty. T.G. Dinan, J.F. Cryan and P.W.J. Burnet, 'Psychobiotics and the manipulation of bacteria-gut-brain signals', *Trends in Neuroscience*, 29 (11), 2016, pp. 763-81.