

Institution: Imperial College London
Unit of Assessment: 04 Psychology, Psychiatry and Neuroscience
<p>1. Unit context and structure, research and impact strategy</p> <p>Overview</p> <p>The mission of UoA4 is to develop a portfolio of research in neuroscience and mental health focused on clinical translation and to train the next generation of science leaders. We are returning 38 researchers (34.9 FTE), including 7 early career researchers (ECRs, <i>italicized throughout</i>) and 14 clinical academics. Our researchers have won £146m in external grants with a spend in this REF period of £76m, a 17% growth in annualised research income compared to REF 2014. Our vitality is demonstrated by our returned staff, 56% of whom are <50 years old, our own thriving fellows Programme (7 Safra Fellows, 2 Imperial College Research Fellowships awarded), 118 PhDs awards and 252 MRes projects in this period.</p> <p>UoA4 consists of neuroscience researchers from the Department of Brain Sciences (DoBS) and the National Heart and Lung Institute (Lovett) in the Faculty of Medicine as well as 2 researchers from the Medical Research Council (MRC) London Institute of Medical Sciences (LMS) (DiPaolo, Metzis). Staff from the DoBS in UoA4 are managed in one of the three new Divisions within the department, Psychiatry, Neurology or Neuroscience. Other members of the DoBS with more medical or public health interests are returned in the cancer, critical care and endocrinology themes within clinical medicine [UoA1] and Public Health, Health Services and Primary Care [UoA2].</p> <p>The College has invested heavily in new recruitment to UoA4 over the REF period with 16 new staff (four women) returned. Our international recruitments led to hiring of eight independent early or advanced Research Fellows, four Lecturers and four Clinical Senior Lecturers. This recruitment allowed us to launch major new research initiatives over the assessment period, all with highly interdisciplinary and translational aims:</p> <ul style="list-style-type: none"> • Becoming the only UK university to be awarded two Centres within the interdisciplinary flagship UKRI MRC and charity-funded UK Dementia Research Institute (the UK DRI at Imperial [£20m awarded 2017, Director, Matthews] and the UK DRI Care and Technology Centre [CRT] [£20m awarded 2019, Director, Sharp]). • Leading a Brain Sciences theme within the National Institute for Health Research (NIHR) Imperial College Healthcare NHS Trust (ICHT) Biomedical Research Centre (BRC, £8.1m) to strengthen translational neuroscience in the acute care Trust and to enhance clinical research links with our two associated mental health Trusts. • Creating innovative cross-faculty research structures through joint-leadership of the Imperial College Centre for Blast Injury Studies (with Bioengineering), the College-wide Alzheimer's Research UK (ARUK) Network of Excellence for Dementia, extending the British Heart Foundation (BHF) Centre of Research Excellence and the Imperial College Vascular Network, as well as supporting the pan-London Wellcome Trust 7T imaging facility at King's College, which joins physics, neuroscience and clinical researchers across London universities (King's, University College London, Institute of Cancer Research, Imperial College). • Consolidating research, appointing a Director and attracting external investment to create the world's first academic, therapeutically focused Centre for Psychedelic Research within the Division of Psychiatry (£6m, Director, Carhart-Harris). • Expanding our international profile through integrated research programmes with our joint Lee Kong Chian (LKC) School of Medicine, a partnership with Nanyang Technological University (NTU) in Singapore (established 2012, first graduates 2018) while strengthening interactions with other international partners through collaborative programmes (e.g., Broad Institute, McGill University and Chiang Mai and Mahidol Universities of Thailand).

Our outputs are highly cited, **33 of which have already received more than 100 citations**. Overall, our submitted outputs have been cited almost 7400 times. We reach as broad an audience as possible through publishing in general medical and scientific journals (34 submitted publications in e.g., Nature, Science, Lancet, Cell, Neuron, and PNAS), as well as specialist journals (53 submitted publications in e.g., Nature Neuroscience, Nature Genetics, Lancet Neurology, Current Biology, Science Translational Medicine, Brain and Neurology).

Our Strategy

UoA4's strategy emphasises interdisciplinarity and partnership to deliver our mission of innovation in neuroscience and mental health.

Interdisciplinarity: UoA4 reflects Imperial College London's strategy of supporting core disciplines whilst also creating transdisciplinary research partnerships. The College's strong commitment to UoA4's pursuit of this strategy is highlighted by an investment of over £2bn transforming the new White City campus. This has created new laboratories for UoA4 researchers, and new shared space with researchers from Bioengineering, Public Health and the National Heart and Lung Institute. Positioning UoA4 researchers on the White City campus puts them in the heart of a vibrant, growing research ecosystem of scientific researchers drawn from across Faculties, corporate partners, entrepreneurs and the local community.

Sharing this ethos, UoA4 researchers work across boundaries contributing to the foundation and management of the new Engineering and Physical Sciences Research Council (EPSRC) Centre for Doctoral Training (CDT) in AI4Healthcare (11 students), in addition to continued leadership of the EPSRC CDT in Neurotechnology for Life and Health (2014-present) (27 students) and EPSRC Centre for Mathematics in Healthcare (Festenstein, Matthews). We contribute to College Networks, Centres and Institutes promoting convergent, interdisciplinary science including Centres of Excellence for Blast Injury Studies, Integrative Systems Biology and Bioinformatics, Mathematics of Precision Healthcare, Neurotechnology, Translational Nutrition and Food Research and Dementia, and College Networks for Artificial Intelligence, Trauma Bioengineering and Vascular Science and the Data Science Institute.

Working in partnership: Neuroscience and mental health research are core elements of our Imperial College Academic Health Sciences Centre (AHSC), re-designated in 2019 by the Department of Health and Social Care (DHSC). The AHSC is central to the creation of the Whole Systems Integrated Care (WSIC) database of 2.2m patients in NW London and the Imperial BRC Clinical Analytics, Research and Evaluation (iCARE) hub. These both provide de-identified clinical data for research and are being developed further to enable large scale studies linking, for example, quantitative neuroradiological measures and clinical and social care data to investigate the impact of diagnoses and treatments on health outcomes. Support for our NIHR Imperial BRC Brain Sciences theme (£8.1m) underpins much of our translational research. UoA4 staff work in two local psychiatric Trusts, Central and North West London NHS Foundation Trust and West London Mental Health Trust supporting care delivery, as well as leading in research (Crawford, Lingford Hughes, *Erritzoe*). More recently, through the UK DRI Care and Technology Centre (Sharp), we have established new partnerships through shared interests in remote monitoring for social care with the Hammersmith and Fulham County Council (Linda Jackson, Council Lead) and the Hammersmith and Fulham Primary Care Network (David Winfield, Research Lead).

There is a close and growing academic partnership with the MRC LMS, two members of which are returned with UoA4 (*Metzis*, de Paola). Facilities (e.g., animal and human clinical imaging, flow cytometry, genomics) are shared, research collaborations have developed and students are co-supervised. This has led to greater combined critical mass and new synergies, particularly for neuro-epigenomics, development of which was a core strategic research objective driving many of the recent recruitments to UoA4.

Our response to COVID-19

Our agility to respond rapidly to need was highlighted through our response to the COVID-19 pandemic. For example, the UK DRI CRT validated and implemented high-throughput robotic assays to scale up COVID-19 testing in local care homes early in the pandemic (in collaboration with Hammersmith and Fulham Council). The new technology of GripAble™ (impact case study) which allows electronically controlled, home self-administration of individually-tailored upper limb exercises was adopted by ICHT to support remote rehabilitation when face-to-face visits became impossible. Clinically qualified staff voluntarily redeployed to support ITU, acute medicine and additional specialty and vaccination clinics.

For staff, the COVID-19 pandemic hit whilst the full restructuring to create DoBS was still in early stages, and the vast majority of staff were working from home. To ensure an inclusive, cohesive department with an accessible management committee, we developed regular Q&A sessions, chaired by the People, Culture and Engagement (PCE) Committee Chair and involving senior management including the Head of Department. Divisions have been meeting virtually regularly. Remote working was encouraged for all staff where this could be conducted effectively off campus and support for necessary resources were provided by the Department. As government guidelines made campus-based work safer, managers met with staff individually to ensure that workplans were appropriate and safe, often including flexible working times to allow travel outside of peak times and always allowing social distancing, with provision of masks, disinfectant and hand washing stations within the Department, and, where necessary, staggering work hours.

During the COVID-19 lockdown, The College and DoBS, as the administrative centres for all staff, made particular efforts to provide support for ECRs, guided by a COVID-19 impact survey for ECRs (April 2020). ECRs near the end of fellowships or with other deadlines were prioritised for getting back into laboratories and supported by extensions to their research periods using funding from UKRI COVID-19 allocations to the College, the NIHR BRC Brain Sciences Theme and DoBS funds.

All staff and students without symptoms have access to “on demand on campus” COVID-19 antigen and antibody testing throughout the College (linked to NHS Test and Trace).

Our Divisions***Division of Psychiatry***

The Psychiatry Division conducts pioneering, innovative research that results in more effective prevention, assessment and treatment of psychiatric disorders. Research is conducted using a breadth of approaches including neuroimaging (PET, MR), experimental medicine with behavioural and pharmacological challenges, epidemiology, genetics and clinical trials. Advanced analytical methods based on multimodal imaging, genetic and clinical data are being exploited for patient stratification with the goal of improving treatment outcomes.

The Division hosts Europe’s first **Centre for Psychedelic Research**, where novel therapeutic applications of psychedelic drugs are being pioneered alongside basic research to understand the underlying neurobiology (Carhart-Harris, *Erritzoe*, Nutt). The Division also has considerable expertise in clinical trials of newly developed and established psychological and pharmacological interventions using mixed methodologies, particularly involving individuals with personality disorders or addiction (Crawford, *Erritzoe*, Lingford-Hughes, Nutt).

Space has been renovated on the Hammersmith Hospital campus to bring all of the Psychiatry Division together in close proximity to the dedicated laboratory space for the Neuroscience Division. This will enable greater interactions between the Divisions and a greater potential for transdiagnostic science.

New recruits as independent investigators include Carhart-Harris and *Erritzoe*.

Some major **achievements** include:

- The development of new PET tracers or methods and their application in neuropsychiatry (J Cereb Blood Flow Metab, 2014) and their use to understand mechanisms of addiction (Mol Psych, 2018).
- The first major randomised controlled trial of a mood stabilizer for people with personality disorder (Am J Psychiatry, 2018)
- Demonstration of the safety and efficacy of psilocybin for treatment-resistant depression (Lancet Psych, 2016)
- Five major research grant awards from the MRC to investigate the neurobiology of addiction and obesity and novel pharmacotherapeutics to improve treatment (Lingford-Hughes, Nutt)
- Establishment of the UK's only MRC Addiction Research Clinical (MARC) programme to develop the future UK clinical research leaders in addiction and address the gap in clinical research capacity in this area (Lingford-Hughes)
- Staff have been recognised individually for their high achievements as an NIHR Senior Investigators (Crawford), Web of Science Highly Cited Researcher (Nutt) or recipient of the Maudsley Hospital Denis Hill Prize (2017) and an Academy of Medical Sciences Starter Fellowships for Clinical Lecturers (*Erritzoe*). Carhart-Harris received the Junior Clinical Award of the British Association of Psychopharmacology (2015) and was named as the Association for Behaviour Analysis International BF Skinner Award Winner in 2018.

Division of Neurology

The Division of Neurology supports researchers investigating mechanisms of neurological diseases and pioneers early assessments of novel treatments. The breadth of the research includes epilepsy (Johnson), advanced treatments and monitoring of multiple sclerosis (MS) (Reynolds, Matthews, Muraro), traumatic brain injury (TBI) (Sharp), dementias (Alegre Abarrategui, Matthews, Malhotra, Sharp), essential tremor and Parkinson's disease (Piccini). Stroke has also been the focus of large clinical studies within the Division funded by Horizon 2020 (Veltkamp). We pursue genomic medicine approaches, supported by the MRC and industry (Roche, UCB, Biogen) for single-cell transcriptomics and epigenomics to identify causal disease pathways and novel drug targets (Johnson, Reynolds, Matthews).

Our collaborative approach is exemplified by our neurodegeneration research across MS, TBI and other dementias, which moves from discovery to clinical trials and cutting-edge imaging techniques that already are improving clinical outcomes (e.g., HSCT treatment for MS, patient stratification for management of TBI). We have also developed imaging protocols and as part of a major international clinical trial to test therapeutic benefits of dopaminergic cell transplants Parkinson's (Piccini).

New recruits: Alegre Abarrategui, *Lally*.

Some major **achievements** include:

- Pioneering application of magnetic resonance spectroscopy for neonatal brain injury and demonstration of the efficacy of moderate hypothermia for neuroprotection (Lancet Neurol, 2019); long-term outcomes after autologous hematopoietic stem cell transplantation for multiple sclerosis, establishing safety after lower dose immunosuppression and efficacy (JAMA Neurol, 2017)
- Development and progression of the EU Horizon2020 supported trial 'PREvention of STroke in Intracerebral haemorrhaGE survivors with Atrial Fibrillation' (PRESTIGE-AF; Veltkamp)
- Leading development of the UK Biobank Imaging Enhancement, providing a research resource of imaging of almost 50,000 participants (towards a goal of almost 100,000, with re-imaging of up to 70,000 underway) to improve understanding of dementias and other late-life diseases (Nature Neurosci, 2016)
- Discovery and validation of advanced clinical imaging markers for stratification of patients at highest risk of cognitive impairments after TBI (Brain, 2019)
- Advancing systems biology of neurological diseases discovery of novel druggable pathways for disease modification in epilepsy (Nat Neurosci, 2016) and creation of a spinout, CoSyne

Therapeutics, as well as generation of a first, comprehensive single-cell atlas of the human substantia nigra (Nat Comm, 2020)

- Staff have been recognised individually for their high achievements with a Sir Henry Wellcome Fellowship (*Lally*), a UK Stroke Association Patient Carers & Public Involvement Silver Prize (2015) and an NHS England Rehabilitation Innovation Prize (2016) (*Bentley*), election to the Academia Europaea and as an NIHR Senior Investigator (Matthews, 2016 and renewed 2020) or selection as a Clarivate Highly Cited Researcher (Sharp, Matthews).

Division of Neuroscience

Since the last REF, we have substantially expanded and consolidated our basic discovery research within a new Division of Neuroscience, recruiting 8 new staff, and developing greater synergies and collaborations with colleagues in the MRC LMS (*De Paola, Metzis*). Research addresses fundamental mechanisms that underpin nervous system diseases and their mechanistic underpinnings. Our cutting-edge basic research includes studies of neuronal circuitry and plasticity (*Barnes, Grossman, Knopfel*), the cellular clocks in the brain (*Brancaccio*), signalling pathways (*Sastre, Ye*) and epigenetic mechanisms (*Marzi, Nativio, Nott, Skene, Festenstein*). Cellular and molecular research also focuses on animal models and human pathology of multiple sclerosis (*Reynolds*) and uses state of the art gene approaches to prevent neurodegeneration and brain cancer (*Mazarakis*). The Division's research interests also include the pre-clinical investigation of the development, repair and regeneration of the spinal cord and of the central and peripheral sensory nervous system (*Di Giovanni, Metzis, Lovett*).

New recruits: *Barnes, Brancaccio, Marzi, Nott, Skene, Ye, Jackson, Nativio, Metzis*

Some **major achievements** include:

- Development and demonstration of the safety and efficacy of a novel gene therapy for Parkinson's disease (*Lancet*, 2014)
- Discoveries of critical epigenetic and signalling signatures associated with neuronal regenerative ability (*Nat Neurosci*, 2019)
- Genetic identification of cells responsible for initiation of pathology in Parkinson's disease (*Nat Genet*, 2020)
- Discovery of astrocyte timekeepers within the suprachiasmatic nucleus (SCN), the brain's master timekeeper, and demonstration that they both modulate natural circadian cycles and control them independently of the SCN neurons (*Science*, 2019)
- Discovery of principles and development of transformative, steerable, non-invasive interference Transcranial Alternating Current brain stimulation technology, recognised by the 2018 Science PINS Award (*JAMA Neurology*, 2018).
- Individual recognition of high achievements of submitted staff includes a Fellowship of the Royal Society of Biology (*Mazarakis*), the PNAS Cozzarelli Prize (2015, *Gentleman*), award of the Spinal Cord Injury Gold Medal (2016) and the Lolou Foundation Prize for New Discovery in CDKL5 Biology (2020) (*di Giovanni*), a Royal Society Wellcome Trust Sir Henry Dale Fellow (*Metzis*), a UKRI Future Leaders Fellowship (2020-) (*Skene*) and four Safra Fellowships (*Marzi, Nott, Barnes, Skene*)

UoA4 delivery against REF2014 aims

- Enhancing our capabilities for dementia research by attracting over £32M in external funding to establish two UK DRI Centres, consolidating cross-College dementia research with creation of an Alzheimer's Research UK (ARUK) Network of Excellence for Dementia Research, recruiting seven new non-clinical dementia researchers as lecturers and, in addition, recruiting a new clinical senior lecturer in the neuropathology of dementia.
- Creation of a dedicated Division of Psychiatry, recruiting two new staff returned with UoA4 (a research fellow and a clinical senior lecturer), expanding areas of core expertise in addiction research and neuropsychopharmacology, attracting over £6M in external funding to found Europe's first Psychedelics Research Centre
- Expanding support for clinical research training through Academic Clinical Lectureships (three) and building on cross-faculty programmes for neurotechnology and translational data

science with creation of the UK DRI CRT (Sharp) and appointment of Matthews as a Deputy Director of Imperial College Data Science Institute

Our Future Research

Major investments and strategic restructuring have contributed to an expanding portfolio of translational research in neuroscience and mental health. Our strategy has emphasised development of interdisciplinary interactions, which has created a new vitality particularly in areas of mental health and dementia. Moving forward, our strategy will involve an emphasis on development of larger-scale collaborative translational science to exploit “big data” analytics and platforms for advanced therapies through College Networks and Centres, the BRC and the UK DRI, we will:

- Build on the first quinquennium of our UK DRI at Imperial, elucidating therapeutically targetable mechanisms linking genetic and environmental risks for neurological and psychiatric diseases, with a particular focus on neurodegeneration and repair.
- Pioneer advanced biological (e.g., viral vector), bioelectronic or remotely deployed behavioural therapeutic interventions
- Pursue innovative applications of data science and bioinformatics to neuroscience and mental health
- Optimise patient care pathways through AI-supported remote sensing and high-volume patient or subject-level data capture and monitoring.
- Rapidly share data and tools for reproducible science

Our impact

Thirty-seven percent of staff returned in UoA4 are clinical academics. Through them we have developed an extensive portfolio of clinical trials and studies underpinned by a range of infrastructures both within the UoA and more broadly within FoM. For example, since 2017 alone, UoA4 researchers have pursued more than 24 basic science research projects using BRC platforms. This has led to novel discoveries, for example, of a novel computational framework for drug discovery used to identify a therapeutic target for epilepsy (Nat Commun, 2018), provided new insights into the biological processes which determine nerve cells’ ability to regenerate after injury (Nat Neurosci, 2019) and, using Artificial Intelligence (AI), ways of improving stroke and dementia diagnosis in brain scans (Radiology, 2018).

Clinical translation of these discoveries into first-in-human as well as later phase clinical research is enabled by the **Imperial Clinical Research Facility (CRF)** (NIHR, £21m 2012-2022; Director, Wilkins). For example, the CRF was central to:

- Extension of our psilocybin trial as a treatment for major depression in 50 patients, providing specialist facilities, as well as leading for obtaining schedule I Home Office Licenses.
- Completing several studies of TBI, e.g., establishing a proof-of-principle for cognitive enhancement using non-invasive brain stimulation (Brain, 2019).
- Completing a first-in-human study of the efficacy and safety of high dose nicotinamide in patients with Friedreich’s ataxia (Lancet, 2014)

UoA4 staff have led more than 30 clinical research studies in the CRF over the census period.

Interdisciplinary translational research pilots can be funded internally by the **Imperial Translational Research Fund (ITRF)**, which has been created from both BRC funding and devolved funding streams: MRC Confidence in Concept Scheme, EPSRC and Biotechnology and Biological Sciences Research Council (BBSRC) Impact Accelerators, the Wellcome Institutional Strategic Support Fund (ISSF) and the Higher Education Innovation Fund. The Fund also is supported by the Rosetrees Trust. Examples of projects supported by ITRF include development of GripAble™ (Bentley), a novel proof-of-concept for Parkinson’s disease treatment (Piccini, Sharp), repurposing Low-Cost Consumer Technology for Motion Correction in Dementia Neuroimaging (Gunn) and a proof-of-concept study of non-invasive phase-lock stimulation treatment for essential tremor (Grossman). To support UoA 4 researchers develop the College’s entrepreneurial strategy, all have access to the FoM’s Translator in Residence who provides

support for planning spin-outs, business plans and fund raising as well as complex IP and its licensing.

Technology transfer and commercialisation is supported through the College's newly reorganised Industry and Partnerships teams. Over the assessment period, 15 patents were filed and four start-ups were developed and co-founded by UoA4 staff (Cosyne Therapeutics, Elemind Technologies Inc, GripAble™, and TI Solutions AG). Several new industry-academic partnerships were also created, for example, within the Pfizer Rare Disease consortium, the Biogen OPTIMISE real world pharmacovigilance study for MS (Biogen, Merck, BMS/Celgene) and computational drug target discovery in PD (Roche) and epilepsy (UCB).

As well as translating our research into new treatments, diagnostics and devices, UoA4 researchers guide policy through their research. Some examples include advisory input on alcohol policy (Crawford, Nutt), guidelines for treatment of personality disorders (Crawford), expert advice to the *Dept of Transport* for disability blue badge guidelines (Malhotra), and stroke with mechanical thrombectomy (Lobotesis, see impact case study), as well as health (Johnson, advisory to the *UK Parliamentary Health Ombudsman*), research strategy (Matthews, *UKRI MRC Strategy Board*), clinical genetics (Festenstien, advisory to *Genomics England*) and clinical management in sub-specialty services (Piccini through the *Association of British Neurologists Movement Disorders Panel* and Malhotra through the *Association of British Neurologists Cognitive Impairment Advisory Group*).

Demonstrating our impact

Our engagement with a range of key stakeholders, governments and industry locally, nationally and internationally, ensures that research in UoA4 is relevant to society more broadly. Our REF impact cases reflect the success of our strategy for interdisciplinary translational and discovery science, e.g., discovery of a first genetic treatment for choroideremia and to reverse disease in some patients and formation of the spinout of Nightstar Therapeutics (subsequently purchased by Biogen for \$800M), commercial spin out of GripAble™, a remote physical rehabilitation tool, and an influential cost effectiveness analysis of mechanical thrombectomy that supported NHS adoption of the treatment and rapid service development in ICHT.

Beyond our case studies, UoA4 researchers have delivered additional impact from their research with development of a novel non-invasive transcranial stimulation method (alternating current interference) and the demonstration that it can relieve pathological tremor (Grossman), discovery of common mechanisms by which psychedelic drugs promote recovery of mental health to develop low-dose psychedelic medicines as novel therapeutics (Carhart-Harris, Nutt), demonstration of the clinical benefits of the novel anticoagulant rivaroxaban for stroke of unknown origin (Veltkamp), development of improved designs for head protection for TBI using computational modelling (with Bioengineering) (Sharp), supporting early phase drug development with novel quantitative molecular imaging approaches (Gunn) and changing healthcare policies with long-term assessment of the value of cognitive-behavioural therapies on health anxiety (Crawford).

Research integrity

Researchers across the Faculty and the broader AHSC are supported by teams in the Joint Research Office (JRO) and the Research Governance and Integrity Team (RGIT). A Research Officer and three Divisional administrative managers support UOA4 staff in their liaison with these offices. Researcher interactions with Imperial College Research Ethics Committee (ICREC) are additionally supported by early protocol reviews in the Imperial NIHR CRF for studies to be performed there. All protocols for non-health related research involving human participants and/or their data are reviewed with the Head of the DoBS before submission to the national Research Ethics Committees or the College Science, Engineering and Technology Research Ethics Committee (SETREC). Awareness of responsibilities and changes in policies for clinical research is managed by regular updates or training offered through ICHT or the CRF, for human tissue researchers through a Departmental Human Tissue Authority lead and for management of all data through a departmental Programme Manager for Data.

Open Research

Rapidly and openly sharing tools, data and results is central to the Unit's research. The College has implemented an open access mandate for all research publications, subject to publishers' copyright policy, to be deposited in Spiral. Our institutional repository. Submissions in UoA4 are 100% OA compliant. UoA4 researchers are also supported by the Imperial Open Access Fund which supports researchers to publish their research in open access journals. Our researchers also share code through GitHub and share their data on a range of open access platforms, e.g., the National Centre for Biotechnology Information Gene Expression Omnibus (GEO) Database (e.g., <https://github.com/NathanSkene>, <https://github.com/nf-core/scflow>).

2. People**Recruitment strategy**

To maintain a thriving research environment and vitality, our highest priority is our staff. Since REF2014, DoBS has recruited eight professors, three readers, six senior lecturers, seven lecturers and five research fellows or advanced research fellows in international searches managed by panels with a diverse representation. Investments in salary and start-up packages from the College (supported by additional funding from affiliated hospital Trusts) thus far has represented new investment in excess of £18m over the assessment period. Recognising evolving responsibilities, we have annual Job Level Reviews to ensure equity of salaries for staff. We have had a special focus on recruitment and career development of ECRs to build long-term capacity; Imperial College and the Faculty have developed the Imperial College Research Fellowships (ICRFs; formerly the Imperial Junior Research Fellowship) and the department has used two generous endowments from the Edmond Safra Foundation and Lily Safra to fund nine Safra Fellowships (4-year awards intended to provide first independent research roles), five recipients of which already have progressed to independent academic positions at Imperial or elsewhere. We have appointed two departmentally-supported ICRFs during the assessment period. The Unit also supports **joint appointments** of more senior staff to promote partnerships with external public or private organisations, for example, Reynolds as a 0.4 FTE Professor in LKC Medical School, Singapore, Veltkamp as 0.8 FTE Professor in the University Hospital in Essen, Germany and Gunn as a 0.8 FTE Senior Vice President of Invicro Ltd.

Recognition and reward

We run annual promotions rounds in DoBS. Candidates can apply directly, as well as be proposed by managers. Promotion guidelines, which take administration, pastoral, outreach, mentoring and diversity activities, as well as caring responsibilities or parental leave into account, are made available to all eligible staff with reminders sent out on a regular basis. Quality of research is emphasised over quantity. Interview panel members have all undertaken unconscious bias training and include academic representation, PCE committee representative and a College Consul who serves to ensure fair process across all Faculties. Within this REF period, 30% of staff within UoA4 have been promoted, including promotions of two new professors, four readers and a new senior lecturer.

We also recognise the importance of **job stability** for our staff. All lecturers are appointed on the tenure-track with confirmation of their appointments by the end of the third year of their employment. With our commitment to career development for young, independent researchers holding career development awards (e.g., the 9 UK DRI Group Leaders, 6 Safra fellows (2 now with new academic appointments elsewhere), 2 Imperial College Research Fellows (now in other positions), a Sir Henry Dale Fellow, a Sir Henry Wellcome Fellow and a Future Leaders Fellow), we have expanded numbers of academic staff on the tenure track over the assessment period. All non-clinical staff recruited previously into tenure track posts who have been reviewed for tenure over the assessment period have had their appointments confirmed. Two out of four clinical staff reviewed for tenure returned to NHS contracts within ICHT, but both have continued their clinical research activities with the UoA with support from the College. Our current return includes 18% on fixed-term contracts compared to 21% in REF 2014.

Integration into the research culture

On appointment, all new staff are given 1:1 inductions to the buildings and major facilities and meet with their academic manager. Each new academic staff member is assigned an administrator to support them with monitoring budgets and in applying for research funding. Academic staff additionally are invited to meet with the Head of the Department and the Head of Division regularly over the first year. All new staff are offered mentors. New early career faculty investigators are released fully or largely from teaching and administrative responsibilities during their first year of appointment. Divisions have quarterly meetings with all staff and the department has biannual mixers. Centres within UoA4 additionally have regular research and support meetings on at least a monthly basis. Five separate seminar weekly/fortnightly series run concurrently through the academic year bringing researchers together, with weekly short 'Works in Progress' presentation opportunities for junior research group members.

Supporting staff careers

We strive to help our staff develop their capabilities and careers in the College and foster an intellectually challenging and invigorating environment. For example, researchers in the UoA4 join or lead annual meetings of specialist interest groups in the College (e.g., the ARUK Network of Excellence in Alzheimer's Disease) and are encouraged to become involved in College multidisciplinary Networks and Centres of Excellence to stimulate collaborative science, approximately 50% of UoA4 are involved with one or more of these initiatives. We also offer opportunities for new staff to assume management roles that help both in their personal development and in succession planning. All staff have annual, supportive Personal Review and Development Plans (PRDPs) meetings with their manager, helping to ensure that both College and their own expectations are being met. DoBS (along with the rest of the College) also undertakes an open annual review of salaries to ensure equity in pay. We support part-time working and currently 17% of UoA4 staff are on part-time contracts.

Helping staff to develop their academic excellence while maintaining a healthy and sustainable work-life balance has become an additional area of focus, particularly with home or mixed patterns of working during the COVID-19 pandemic. We plan management meetings, departmentally sponsored activities and seminars within the usual core working hours (10-4 pm), encourage all staff to take their full annual leave, offer flexible working hours and support home working for all staff when necessary. The College also offers subsidised housing on the White City campus for staff within the qualifying income range.

Clinical academic staff

Clinical translation is key to our mission. We are returning 14 clinical academic staff in this submission (37%). They are allowed time in their job plans for contributions to clinical care and administration, the balance of which is adapted to the career ambitions of the staff (ranging between 2-5 programmed activities/week). The Head of the Department and Heads of all the Divisions are clinical academics, reflecting our strong clinical focus. NHS-employed clinicians in the ICHT and mental health Trusts (Central North West London NHS Foundation Trust, West London NHS Trust) contributing to research or teaching are given honorary contracts with the Department of Brain Sciences. 86 NHS staff currently hold honorary appointments (14 Visiting Professors/Readers or Professors of Practice, 37 Clinical Lecturers or Clinical Senior Lecturers and 35 Clinical Research Fellows). Their seamless integration is facilitated by joint academic-clinical appraisals. NHS employed clinicians who have made substantial contributions to their fields can be promoted to Professors of Practice in the Department and two clinical academics in UoA4 were awarded this prestigious title over the census period (Lobotesis, Nicholas).

To support development of aspirant or new clinical academics, Imperial set up the **Clinical Academic Training Office** (CATO) in 2015 (Director, Levy, Professor of Practice) in partnership with Imperial College Healthcare Trust. Reporting directly to the Imperial FoM Dean and AHSC NHS Chief Executives, CATO provides a centralised academic training hub for doctors and other healthcare professionals. Some outputs and success (both across FoM and for this UoA) include:

- AHSC support for the full range of neuroscience health professionals (Nurses, Midwives, Allied Health Professions, Healthcare Scientists, Pharmacists, Psychologists), e.g., through AHSC research skills course 'Starting out in Research', 1:1 support/mentoring, supporting with fellowship applications.
- Academic Clinical Fellows (ACF)/Clinical Lecturers (CL) next post destinations – 91% of our ACFs have been registered for a higher degree within 2 years of completion of the ACF, of whom ~70% have been awarded a prestigious MRC, Wellcome Trust or NIHR CRTF
- CL academic retention: 70% of our CLs have been appointed to a subsequent academic post with primary research activity, either as Clinician Scientists, NIHR/Wellcome/BHF or other post-doctoral fellowships or University Senior Lecturers. For example, in neurology our 5 previous CLs have gone on to obtain two MRC Clinician Scientist awards, one followed by an NIHR Professorship, one Wellcome Trust Intermediate Fellowship, and one NIHR Senior Lectureship.

Research students

15 of the staff returned for UoA4 supported management or training for doctoral training accounts (DTAs) from the MRC (DTP, iCASE, MARC), BBSRC and EPSRC (including EPSRC Centre for Doctoral Training in AI 4 Healthcare) managed by Imperial College. The College also offers The President's PhD Scholarships with 10 of these scholarships awarded within Uo4 during this REF period. Internationally, within our jointly founded medical school in Singapore (LKC School of Medicine), we have developed a PhD exchange programme to attract the brightest graduates. Funded by Research England, this was due to start in academic year 20/21 but has been delayed due to COVID.

Students in UoA4 are enrolled into the new Department of Brain Sciences. Established in 2019, over the first year (2019-20), 75 (64.9% women, 35.1% men) PGR students were enrolled. While home students (56.8%) were the predominant group represented, substantial numbers of students came from overseas (24.3%) or the EU (18.9%). Previous to this, students were enrolled in the larger Department of Medicine, in which Brain Sciences was a Division.

We have a thriving MRes in Experimental Neuroscience course and over the assessment period, 252 research projects have been completed by MRes students, of which 135 (54%) received a Distinction. Excellence of these Master's students also has been recognised by regular awards of a Dean's Prize for each of the last 4 years.

PhD students are supported by departmental peer groups and all have at least one co-supervisor, as well as an independent mentor. Progress is monitored by an independent pair of assessors, who approve the PhD research plan, meet with the student at 9 months after the start of the PhD to determine the appropriateness of progression or Early Stage Assessment, and at the beginning of the third year to help ensure planning and research towards completion of the thesis or Late Stage Review. During the course of their PhD, the students also receive support and pastoral care from their personal tutors and their divisional cohort leads, as well as supervisors. Development of presentation, leadership and management skills in students is supported by the College's Graduate School. Students also are encouraged to undertake online courses (e.g., R programming) or join in neuroscience or other courses being offered across the department and College to support additional training where it may help them.

Over the period 2014-20, none of our PhD students withdrew. 118 PhDs were awarded to doctoral candidates over the census period, with annual numbers awarded of between 9 (2019-20, affected by the COVID pandemic) and 23 (2013-14). Within the census period (prior to the final year impacted by COVID), an average of 18 research doctoral degrees were awarded each year. On time submission rates were comparable to those across the former Department of Medicine, which averaged 90.4% (with Brain Sciences contributing 40.5% of students represented in the total number).

Equality and diversity

As mentioned, UoA4 is nested within the new DoBS. The Department initially maintained the Athena Swan Silver Award status of its precursor Department of Medicine. Silver status (until 2024) subsequently was awarded to DoBS as an independent department. We are committed to fostering a supportive culture for all staff. We arrange regular meetings for feedback at multiple levels (Department, Divisional, Centre-based and individually through annual PRDPs), run biennial, alternating culture and staff quality of workplace surveys to identify areas for development and an DoBS level Reward and Recognition scheme through which we aim to recognise achievements and contributions to the UoA (e.g., for technical/administrative support, sustainability, public engagement or teaching) particularly from ECRs. There have been regular Q and A Sessions with the Executive Management Group and Head of DoBS, a popular photography competition, regular communications not just about academic matters, but also home schooling resources, activities for children and articles addressing issues specific to underrepresented groups and a fortnightly newsletter.

For senior positions in UoA4 we have a roughly 80/20% male/female ratio. We are actively addressing this gender imbalance by reviewing all staff annually in job level and pay relativity reviews, promotions and academic leadership positions, while inviting manager and self-nominations, as well. This already has led to appointment of 2 women amongst our 3 Division heads. Within DoBS, we have a 53%/47% female/male ratio, 14% black and minority ethnic, more than 43% of the Departmental Executive Group and 50% of the Management Group are women and 63% of the NIHR ICHT BRC Brain Sciences Theme Management Group are women. Recognising that at the time of formation of the Department (2019), only a minority of staff had engaged with equality, diversity and inclusiveness (EDI) training, we have made this mandatory for all staff (including regularly updated unconscious bias training for senior staff) and integrated monitoring of this into our annual PRDP process. In the most recent round of 9 recruitments to Advanced or Safra Research Fellowships, Lectureships and more senior roles (2017-2020), we offered positions to 7 women for the 15 posts, successfully recruiting 5 (33%).

One of the main objectives for the DoBS at its creation was to set clear leadership roles across the Department in relation to EDI. The Department has made the PCE Committee, the Chair (*Jackson*) is a permanent member of the Departmental Management Committee and importantly, works closely with a Faculty-level Culture Initiatives Management Group (CIMG) chaired by the Vice Dean Institutional Affairs. The PCE includes representatives from all job families with members from diverse ethnicities and gender identifications (63% women, 34% men and one person identifies as non-binary). This committee actively monitors recruitment, selection and promotion processes.

The PCE Committee aims to improve recognition and support for a diverse environment within the Department, some examples of its activity include: working to maintain PRDP completion rates of >80% with the goal of 100% compliance by 2023; ensuring compliance to training; personalising support to staff with disabilities or other chronic health limitations, e.g., change in management meeting structures for one senior academic staff with anxiety disorder, provision of emergency evacuation chair and alerts of fire officers to accommodate mobility-limited staff member or special flexibility in work hours for a staff person with a sleep disorder. Evidence for success includes the recognition of three staff members from the UoA (amongst only 10 from across the entire College) for their inspiring stories as part of a 2020 Celebration of Cultural Diversity at Imperial, "Shifting the Lens".

3. Income, infrastructure and facilities**Income**

With the strategic flexibility that creation of the new DoBS has allowed, we have focused on a limited number of research areas to fully embrace interdisciplinary research and to better ensure our long-term sustainability. UoA4 researchers have won £146m in external grants with a spend to date in this REF period of £76m, equating to £310k per FTE per year – a 17% growth in annualised research income compared to REF 2014. This includes £20M from the MRC, £40M from the DRI, and £12M from NIHR. £107M of the increased funding was accrued since 2017.

As noted previously, we are the only institution in the UK to hold two UK DRI Centre awards. The breakdown of our research spend is as follows (annualised):

- Research Councils £3.7m
- UK charities £2.0m
- Health research funding bodies £1.3m
- UK government, industry and other £1.6m
- EU £1.0m
- Non-EU/other (e.g. overseas charities) £1.0m

To support our investigators, we pro-actively help them improve the competitiveness of their research funding bids. For example, to improve our UKRI MRC success rates, we have undertaken rigorous supportive internal peer review from 2017-18. This has been associated with reduced numbers of unsuccessful grants submitted and an increase in success rates from 18% over 2014-16 (114 grants submitted to open MRC schemes) to 26% over 2018-date (58 grants submitted) and an increase in the average value of successful grants from ~£400,000 to ~£700,000.

We also work with the Imperial College Development Office to raise funds for specific projects, e.g., > £17m in philanthropic donations (over 130 gifts) supporting the foundation of a Safra Chair and Fellowship Programme, a £1.2m endowment for Gloria Borley studentships, philanthropic donations of \$6m to the Centre for Psychedelic Research (Carhart-Harris) and for supporting a range of other specific projects, including development of temporal interference stimulation (Grossman) and the brain banks maintained by researchers in the Unit (Gentleman, Reynolds).

Infrastructure

Since the last REF, we have transformed our estate with investment of ~£2bn in our White City Campus as described in detail in REF 5a. The Sir Michael Uren Hub (£40m) on this campus became operational in 2019 bringing together over 500 engineers, clinicians and scientists to become our main hub for technology development in healthcare. The Hub will house ~80 staff and students from UoA4, alongside those from UoAs 1, 2 & 12. We have also ensured our existing infrastructure remains fit-for-purpose with additional £6m spend across this REF period for refurbishment of lab space within the Commonwealth Building on the Hammersmith Hospital campus to provide space for growth of UoA4 mental health research. We also have developed specialised circadian and behavioural testing facilities and a new imaging mass cytometry and FACS facility as part of Central Biomedical Services (CBS) provision on the Hammersmith Hospital campus as part of our UK DRI at Imperial research programme.

Facilities and Research Data Management

The College maintains many large shared facilities that support UoA4 researchers, complementing the sharing of resources on more local levels within our open-plan laboratories. For example, the Department of Bioengineering houses micro-manufacturing facilities for bioelectronics in the White City Uren Building that are shared with UoA4 researchers. Other specialised research support facilities include the National Phenome Centre (for lipidomics, metabolomics and mass spectrometry), the BRC Genomics Core (£9.1m, which provides rapid, lower cost genomic sequencing). Facility for Imaging by Light Microscopy FILM (a well-equipped shared advanced microscopy facility), the Multiple Sclerosis and Parkinson's Tissue Bank managed by the Department and the Imperial NIHR/Wellcome Trust CRF.

Imaging is a key aspect of research across UoA4 and our researchers have access to state-of-the-art X-ray, ultrasound, Positron Emission Tomography (PET) and Magnetic Resonance Imaging (MRI) through a range of partnerships. Our Clinical Imaging Facility and ICHT Imaging Department, core funded by the BRC (£9.8m), provide access to MRI (Siemens 3T Verio MRI scanner), PET (Siemens Biograph 6 PET/CT scanner), electroencephalography and Transcranial Electric Stimulation, all delivered in partnership with ICHT. We have also built our PET/MRI capability through our partnership with InVicro, Ltd (formerly Imanova), with a £5.6m

machine housed within InVicro on our Burlington Danes site. InVicro provide the staffing to run the machine as well as advanced GMP radiochemical and analytical expertise.

The College is strongly supporting the rapidly growing application of biomedical data science by UoA4 researchers. For example, the Imperial Data Science Institute and The Imperial Secure Enclave and Research Computing Service (RCS) environment have a ISO27001:2013 certified data management environment that supports curation and use of large sensitive (de-identified and identifiable) data sets for imaging, neuroepidemiological and genomic studies (e.g., UK Biobank). The College's high-performance computing (HPC) facility supports a wide range of genomic and other intensive computations for both students and faculty and is actively used by the UK DRI at Imperial teams. External cloud services have been set up for larger computational challenges, e.g., bespoke Azure platform for collection and management of sensor data collected from people with dementia in their homes, its processing and associated GP alerts for developing an AI-driven dementia home care pilot (Sharp) and a Google cloud hosted pipeline for snRNA sequencing meta-analyses (*Marzi, Skene*).

Prior to publication, we encourage researchers to store all non-sensitive data on Imperial's computing cluster. This low-cost College service to users offers dual copy off-site data redundancy for datasets: all raw data will be stored in this manner, prior to archiving post-publication. Data are maintained for at least 10 years. Imperial also provides a longer-term data archiving facility. These general research data management solutions are approaching full conformity to ISO9001.

UoA4 is supported by a local DoBS information governance support and oversight structure to help researchers conduct their work in ways that remain fully compliant with College guidelines, ethical expectations and current law. A Data Programme Manager links UoA4 researchers directly to main College support structures and an academic lead for Information Governance is responsible for ensuring all of our researchers are aware of current expectations. Specific staff supporting researchers in areas of clinical data access, dataset management for imaging and in computational bioinformatics are provided through Imperial BRC-supported staff working within the Unit. New electronic health record datastores are available to UoA4 researchers through Imperial's Clinical Analytics, Research and Evaluation (iCARE) and the West London Whole Systems Integrated Care (WSIC) integrated healthcare databases.

4. Collaboration and contribution to the research base, economy and society

Collaboration

A large proportion of staff perform major components of their work as part of national or international academic networks, such as the UK DRI (across 6 UK universities), supporting UK Biobank, international charities or disease interest groups, such as the International Network for Research, Management and Education on Prader-Willi Syndrome, the international ENIGMA Brain Imaging Consortium, the Alzheimer's Disease Neuroimaging Initiative (ADNI), the International Stroke Genetics Consortium, the Stem Parkinson's Disease Consortium, the European BIOAX TBI Consortium Staff and the EU Horizon Prestige-AD Project, the EU FP7 EpiPGX and EPITARGET Consortia. Members of the Department were leads in Dementias Platform UK (DPUK, 2015-20) and remain active in DPUK2 (renewal, 2020-2025). Imperial was one of the founding partners in the pan-London 7T Network based at King's College, London (2018-present). Contributing to these efforts has been a strong, shared commitment across UoA4 to open science, data sharing and reproducible science, e.g., through making software available on Github, sharing data through consortia (e.g., the DPUK Data Portal) or championing world-leading data sharing efforts such as UK Biobank.

Internationally, Matthews and Reynolds have played important roles in developing the College's long-term strategic partnership with NTU, Singapore, for development of the joint NTU/Imperial medical school, LKC School of Medicine. They also have supported establishment of a Cognitive Neuroimaging Centre and the LKC/Imperial Brain Bank, as well as engaged in a range of collaborations and joint supervisions of students and post docs. Additional visiting

professorships or the equivalent have been held by returned staff with McGill University, NTU, the University of Siena, the University of Oxford and Edinburgh University. We are actively expanding our international partnerships to extend our capabilities in bioinformatics and genomic sciences, e.g., through the data science DEMON Network, the Harvard-Broad Institute led C-FoS collaboration for dementia and with Montreal Neurological Institute of McGill University in the Multi-omics AD Atlas Project.

Delivering Economic Impact

UoA4 researchers have developed longer-term involvement in several industry-academic partnerships, including MINDMAPs (Matthews with Invicro, Abbvie, Biogen, Takeda and Celgene, £0.6m), Dementia Platforms UK (Malhotra with GSK, Astra-Zeneca, Janssen, £0.5m), OPTIMISE, which is using remote reporting methods to comprehensively assess real world risks of disease modifying treatments in MS (Biogen, Celgene, Merck) (Matthews, £7m); the Nestle – Nutrition Research Centre (Frost [Uoa1], Matthews, £0.15m); Grunenthal for development of novel TRPV1 medicines for chronic pain (Anand, £0.73m); UCB for epilepsy target discovery (Johnson, ~£1.2m) and TEVA for the treatment of Huntington's disease (Piccini, £0.8m). UoA4 researchers have provided sustained consultancies for many major companies, e.g. Biogen, Ipsen, Novartis, Roche, Bristol Meyers Squibb and Merck, SMEs such as Nodthera, Canna Pharmaceuticals, and venture capital companies, e.g., SV Health Investors and the Dementia Discovery Fund. Four spin-out companies have been founded by UoA4 staff over the assessment period (TI Solutions AG and Elemind Technologies Inc. (2019, Boston, USA)).

Science and society

Imperial College works with a broad array of stakeholders and audiences to deliver science to benefit society. We involve patients and the public in our research strategy, e.g., in helping to select projects for inclusion in the Brain Sciences Theme renewal in the NIHR Imperial BRC competition. The College's Patient Experience Research Centre (PERC) runs public involvement training for UoA4 and other researchers. They are supporting the UoA in research strategy planning to help researchers remain aware of patient and carer priorities and in early review of research protocols for their acceptability for intended participants and feasibility. The Imperial NIHR/Wellcome Trust also maintains a patient and public review panel particularly to provide stakeholder perspectives on research importance and feasibility. More domain specialised advisory patient user groups within the Addiction and Substance Misuse Directorate at Central and North West London NHS Foundation Trust inform our mental health-related research, e.g., advising on how to approach and involve vulnerable populations safely.

Some examples of how we engage the public include: DoBS hosts an annual open day with tours of laboratories and posters that typically attracts over 100 visitors and manages monthly visits to the brain banks led by UoA4 staff that usually can accommodate about 10 people (potential donors, relatives, charity staff, nurses) to see our facilities and observe a brain cutting session. UoA4 staff and their teams are regular contributors to the annual Imperial College Great Exhibition Road Festival, with posters, "hands on" demonstrations (e.g., virtual reality cognitive testing). Returned staff frequently make public lectures or provide news briefings or participate in public debates regarding their science, e.g., at the Oxford Centre for the Creative Brain (Carhart-Harris, Matthews), on drugs policies (Carhart-Harris, Nutt) or through the regular series of AHSC seminars (Grossman, Matthews, Sharp). More than one-third of the returned staff have developed videos or podcasts or participated in traditional media briefings or broadcasts regularly to provide the public with updates on latest research or health issues, e.g., the [Being Patient](#) website for dementia (Nativio). During the COVID-19 pandemic, Hampshire joined with BBC Two Horizon to present "The Great British Intelligence Test", which rolled out the "Cognitron Challenge" for remote cognitive testing of more than 350,000 people in the UK, explaining by example how these assessments are done and what they mean. Nutt leads Drug Science, the leading independent scientific body on drugs in the UK working to provide clear, evidence-based information without political or commercial interference (<https://www.drugscience.org.uk/>).

We contribute to policy development, e.g., providing evidence to the NHS of the cost effectiveness of thrombectomy for acute stroke care (Lobotesis, see impact case study), evidence-based guidance to Governments for legal drugs and alcohol policies (Crawford, Nutt), advice to NHS on rationale of treatment for people with personality disorders (Crawford), guidelines for recognition and early treatment of neuroendocrine disorders after TBI (Sharp), secondary stroke prevention for people with atrial fibrillation (Veltkamp), management of movement disorders (Piccini) optimal use of amyloid PET scanning in the diagnosis of Alzheimer's disease (Malhotra) and the safety and efficacy of haematopoietic stem cell therapy for MS (Muraro).

Contributions to sustainability of the discipline

UoA4 staff hold senior advisory roles supporting >30 public bodies. Examples include Chair, UKRI MRC Neurosciences and Mental Health Board (Matthews), UK Biobank Steering Committee and Chair, Imaging Enhancement Working Group (Matthews); Wellcome Trust Neuroscience and Mental Health Expert Review Group (Lingford Hughes, Matthews, Sharp); Chair, Working Group on Personality Disorder, International Consortium for Health Outcomes Measurement, Director of Royal College of Psychiatry College Centre for Quality Improvement and NIHR Doctoral Fellowship Panel (Crawford); Chair, Academic Faculty of the Royal College of Psychiatry (Lingford-Hughes); BBSRC Genes, Development and STEM Board, Genomics England (Neurology) (Johnson); and multiple charities, including Medical Advisory Board of the MS Society of Canada (Matthews), Fondazione Cariplo (Sastre), the National MS Society (USA) Bioresources Panel (Reynolds), MS Society Grants Panel (Muraro), PD UK, the MJ Fox Foundation and Weston Brain Institute's grants panels (Piccini), the Rosetrees Trust Grants Board (di Giovanni); Chair, British Society of Neuro-Otology (Bronstein); Matthews was Chair of the Management Board of the charity Brain and Sharp now is Secretary and Treasurer for the Guarantors.

Returned staff have **senior editorial roles** for >20 international scientific journals, e.g., Handling editor, Brit J Psych and the journal Addiction (Lingford Hughes); Editor, J Psychopharmacol (Nutt); Executive Editor, Neuropath Appl Neurobiol (Gentleman); Publication Oversight Committee, Move Disord (Piccini); Science Matters, Neural Plasticity and Frontiers in Molecular and in Cellular Neuroscience and Cell Biochemistry (Editorial Boards, De Paola), Editor, Subst Abuse and Acta Psych Scand (*Erritzoe*); Editorial Board, Brain and Brain Commun (Sharp) Assoc Editor, Brain and Editorial Board, Nature Rev Neurol (Matthews); Associate Editor, Brit J Psych, Pers Mental Health and J Person Disord (Crawford); Assistant Editor, Addiction; Editorial Boards, Brain, Brain Commun, Epigen and Chromatin (Festenstein); Editorial Board, PLoS One (2011), Frontiers in Molecular Neuroscience (2015), Developmental Neurobiology (2010) (di Giovanni); Frontiers in Cellular Neuroscience (2014, Knopfel); Frontiers in Pharmacology (2019, Brancaccio)

Notable **invited talks** illustrating the breadth of engagement of submitted staff include those for the World Economic Forum, Davos 2020 (Carhart-Harris), Royal Society of Radiology Presidential Lecture 2018 (Matthews), Eli Lilly Symposium (Barnes 2018), World Congress of Neurology 2017 (Matthews, Piccini), 2015 British Neuroscience Association Christmas Lecture (Matthews), College de France (Festenstein), Royal College of Physicians (Alzheimer's Society Annual Research lecture, 2019, Malhotra), FENS Touchscreen Symposium (2016, Kopanitsa) and Cold Spring Harbour Laboratories (2014, Piccini). Mazarakis was the Hippocratic Orator of the Hellenic Medical Society (2016).

The international excellence of UoA4 returned staff additionally is indicated by their engagement as **senior advisors** by more than 15 companies, including Biogen, Bristol Meyers Squibb, Celgene, Evelo Biosciences, Novartis, AstraZeneca, Abbvie, UCB, NovoNordisk and Pfizer over the census period. Long-term collaborative translational scientific programmes involving research support ranging between £300k to £6m (individually) have been developed with six industry partners (Biogen, Celgene, Merck, Invicro Ltd., UCB, Roche). As well as **prizes**, NHSE Rehabilitation Innovation Prize (Bentley), AAAS Prize for Neuromodulation (Grossman)

Category C clinical contributors to UoA4 Wilson (OBE) and Shakir (CBE) were recognised in the **Queen's Birthday Honours** (Dec 2020) for contributions to the COVID-19 response and for services to world neurology, respectively.