

Institution: King's College London

Unit of Assessment: 4

1. Unit context and structure, research and impact strategy

The Institute of Psychiatry Psychology & Neuroscience (IoPPN) was founded 100 years ago as the “Maudsley Hospital Medical School” to pioneer research in mental disorders and neurological disease. In the 1990s (as the Institute of Psychiatry) it became a faculty of King's College London (KCL). In 2016, in recognition of the need for greater integration across neuroscience and mental health research, it became the **Institute of Psychiatry, Psychology & Neuroscience (IoPPN)** by bringing two basic neuroscience departments (the Wolfson Centre for Age-Related Disease and the Centre for Developmental Neurobiology) into the Faculty and expanding our Department of Psychology. IoPPN contains virtually all staff returned in UOA4 for KCL. Our close partnership with the **South London and Maudsley NHS Foundation Trust (SLaM)**, the largest mental health service provider in the UK, is critical to our mission, and we have deepened links with acute NHS trusts within **King's Health Partners Academic Health Science Centre** including with the Regional Neuroscience Centre at **King's College Hospital**. With 1362 members of staff and 585 postgraduate research (PGR) students, IoPPN is the largest centre for mental health research in Europe.

Our mission is to “advance our understanding of the nervous system, neurological disorders and mental illness and to improve care for those living with mental health and neurological problems both locally and globally through world-class research, education and training.”

To achieve this, we are organised as the following **research groupings** (see figure 1):

- **Four mechanism-focussed areas in neuroscience** led by fundamental and clinical neuroscientists: Neurodevelopment; Pain and Sensory systems; Injury and Repair; and Neurodegeneration.
- **Six clinically-focussed research areas** led by academics in clinical psychology, psychiatry and neurology, and closely integrated with the National Institute of Health Research Biomedical Research Centre at the Maudsley (BRC-Maudsley): Developmental Psychology and Psychiatry; Addictions; Mood Disorders; Psychosis; Psychological Medicine; and Neurological Disorders.
- **Three cross-disciplinary platforms** orientated around methodology and impact: Biostatistics, Genomics and Informatics; Neuroimaging, Experimental Medicine and Trials; and Public Mental and Neurological Health.

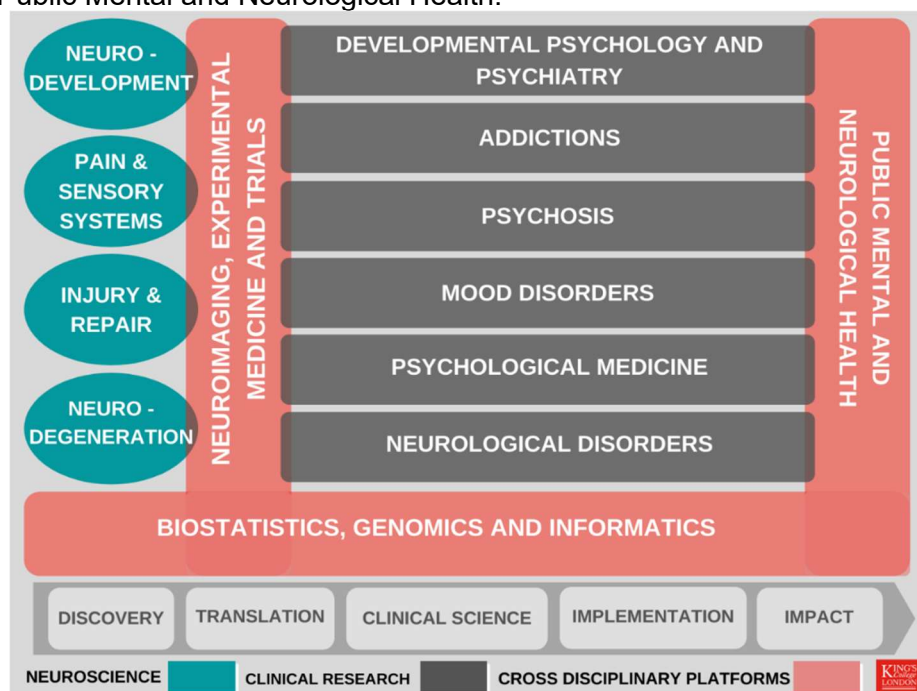


Figure 1: UoA4 Research groupings

Our clinical research areas link to their NHS partners forming integrated **Clinical Academic Groups** allowing rapid translation and implementation to boost impact. Our Public Mental Health grouping drives impact through engagement with policy makers, charities and professional bodies.

Interdisciplinarity is at the heart of our scientific strategy. Our reconfiguration as the IoPPN recognised the need for greater integration of psychiatry, psychology and neuroscience. We are home to statisticians, epidemiologists, health economists, computer scientists, imagers, geneticists, experts by experience, and social scientists. We enjoy rich collaborations outside the faculty, including KCL's Policy Institute, Faculty of Life Sciences and Medicine, Law school, and departments of Philosophy and War Studies to name a few. This interdisciplinary approach is exemplified by the **MRC Centre for Neurodevelopmental Disorders** (bringing together fundamental neuroscientists and clinical researchers) and the **ESRC Centre for Society and Mental Health** (bringing together social scientists, epidemiologists, clinical researchers, and experts by experience). We have established expertise in patient and public involvement including the **Service User Research Enterprise**, which supports service users to become researchers.

During this REF period we have made transformative investments into our **infrastructure** including the **Maurice Wohl Clinical Neuroscience Institute** (a 6500m² neuroscience research institute), high-end AI computing (DGX-2), the Nikon Imaging Centre, and advanced neuroimaging including a 7T MRI scanner and PET imaging centre. We have recruited 17 professors, 28 senior lecturers/readers and 39 lecturers. We have increased our commitment to an inclusive research culture where staff and students are individually supported, and diversity is celebrated. IoPPN is proud to have gained **Athena SWAN Silver Awards in 2014 and 2019** and to have contributed to our university-wide **Race Equality Charter Mark Bronze Award received in 2020**. Our strategy places diversity and inclusion at its centre with our **Vice Dean for Culture Diversity and Inclusion** (McNeil) contributing to decision-making at the highest level.

The breadth of our expertise and NHS partnerships allows us to serve as a **leading destination for the training** of the next generation of scientists in clinical psychology, psychiatric and neuroscience research. At any one time, we train over 30 Academic Clinical Fellows and Academic Clinical Lecturers (psychiatrists and neurologists) and 585 PGR students including over 70 clinical psychology trainees.

We act as a "hub" for a number of national and international consortia. In 2017, with 13 partner organisations, we established the **NIHR Translational Research Collaboration in Mental Health** which provides a national infrastructure for translational research in mental health. With London School of Hygiene and Tropical Medicine we run the **Centre for Global Mental Health**. We also lead several large-scale European H2020 and Innovative Medicine Initiative grants, including industrial collaborations aiming to identify new diagnostics and treatments for people with mental health and neurological disorders.

We expect our academics to take leadership roles in professional bodies and as government advisors to **enhance impact**. Examples include the Wessely review of the Mental Health Act [ICS – Mental Health Act]; Chief Medical Officers' reports on public mental health; MRC and DHSC's mental health research strategies; and the COVID pandemic response [ICS – Disasters and Crises]. International efforts include the EU's ROAMER project on mental health research prioritisation and our work as a WHO Collaboration Centre in Mental Health comprising leading contributions to the mental health gap (mhGAP) intervention guide (adopted in 90 countries) [ICS - Global mental health gap]. Our researchers have chaired and sat on steering committees and NICE Guideline groups [e.g. ICS Perinatal Mental Health].

Our impact case studies focus on several **marginalised groups** including people with addictions (ICS - Naloxone), victims of trafficking (ICS – Human Trafficking) and people receiving in-patient mental healthcare (ICS – Safewards). Much of our research seeks to fill evidence gaps in policy, for example our work with Military [ICS – Military Mental Health] and our work on e-cigarettes [ICS – E-cigarettes]. Through collaborations with industry we have developed new drugs [ICS – migraine] and more effective delivery methods [ICS – Naloxone]. Our research has underpinned

pioneering and agile approaches in a range of areas that bridge physical and mental health, for example in menopause [ICS - Menopause] and eating disorders [ICS – Eating Disorders].

KCL produces more highly cited outputs (top 1% citations) on mental health than any other centre internationally (SciVal) and we have risen from 16th (2014) to 4th (2019) in the world for highly cited neuroscience outputs on the same metric.

1.2 Our response to COVID-19

Our rapid, flexible and comprehensive response to the **COVID-19 pandemic** illustrates the vitality, breadth and depth of our science and collaborations, our leadership in mental health and neuroscience, and our commitment to impact. Rubin and Fear both serve on Scientific Advisory Group on Emergencies, SAGE and **Rubin is chair of the Scientific Pandemic Insights Group on Behaviour, SPI-B**, responsible for advising government on behavioural interventions (ICS - Disasters and Crises) for which he has received the OBE. **The NIHR Health Protection Research Unit in Emergency Preparedness and Response** (HPRU EPR, Wessely and Rubin) has conducted wide-ranging research on the pandemic, including the psychological impact of quarantine and public perceptions of health measures taken to reduce the spread of the virus. King's researchers from the HPRU EPR have also contributed to the King's Policy Institute's series of surveys with Ipsos MORI to assess public attitudes, beliefs and behaviour in the COVID-19 pandemic. Meanwhile Arseneault, Everall, Hotopf and Wessely were members of a working group on COVID and mental health research established by **MQ and Academy of Medical Sciences** (AMS) which wrote an influential prioritisation document published in The Lancet Psychiatry leading to a UKRI/NIHR highlighted call. Hatch, Hotopf, Rubin and Thornicroft have all briefed parliamentarians on behavioural responses to the pandemic and the impact of COVID on mental health and diverse ethnic groups.

In March 2020 King's established two **funding calls** under the "King's Together" scheme to pump-prime COVID-19 research projects, leading to eleven awards to IOPPN, several of which then went on to leverage external funding.

We have demonstrated the impact of the virus on the brain in one of the first neuropathology studies that showed evidence that microglia were activated, facilitated by the London Neurodegenerative Diseases Brain Bank (Al-Sarraj). Animal work has indicated a likely mechanism for anosmia (Grubb) and we are using microRNA approaches to knock down the essential RDRP protein (Shaw, DRI £100K).

Our clinical research studies have addressed the mental health and neurological impacts of COVID infection. Hotopf co-chairs the mental health, and Chalder the fatigue working groups of the national Post HOSPitalisation PHOSP-COVID study. Breen is co-PI of the Urgent Public Health COVID-CNS study (MRC £2.65M), investigating the epidemiology, risk factors and mechanisms underlying mental, cognitive and neurological health conditions associated with or exacerbated by COVID. Our informatics group (Dobson) has used health records to investigate the links between ethnicity, pre-existing health conditions and COVID-19 outcomes, and developed symptom trackers for use within hospitals to detect future case surges.

We are also studying the mental health impacts of the pandemic on the wider population. This has included work on mental health of care home residents (Aarsland), the NHS workforce (Urgent Public Health study, NHS -CHECK Study, Wessely MRC and Rosetrees £562k with work now cited in a Parliamentary Office of Science and Technology Note), those from minority ethnic backgrounds (Hatch, ESRC £638k), veterans (Fear, Cabinet Office, £148k), adolescents (Morgan MRC, £323k) and wider population impacts (for which Young won an MQ fellowship (£224k)). We have investigated experiences of people with mental disorders in relation to COVID (Wykes), the impact of COVID on NHS mental healthcare provision (Simpson - through the **NIHR Mental Health Policy Research Unit**), the excess mortality patterns in service users (Stewart) and the impact of COVID on ethnic minority groups with mental disorders (Das-Munshi, Health Foundation £170k). We have studied the impact of the pandemic on the mental and physical health of over 2000 of

our university work force in the KCL-CHECK study (Hotopf, Stevelink) using this to tailor interventions and messaging by the university. Our work includes public engagement – for example Sonuga-Barke led the production of the “Families Under Pressure” videos where celebrities present evidence-based parenting advice, now being evaluated in a trial (£500k ESRC).

Finally, King’s Academic Strategy for 2020-21 documents how we **support our research** activity and staff inevitably disrupted during the pandemic. King’s recognises the uncertainties the COVID-19 pandemic has raised for ECRs in career progression and has prioritised efforts to support them with funds to extend research projects and PhD studentships. King’s remains fully committed to supporting research staff in transitioning to the next stage of their careers.

1.3 Progress against REF2014 strategy

Our strategic plans in REF2014 are now realised. The establishment of **IoPPN** from its predecessor, the Institute of Psychiatry, represented a commitment to closer interdisciplinary work between discovery and clinical science and neuroscience and mental health research. Our neuroscience has benefited from the £50M (UKRI and foundations) **Maurice Wohl Clinical Neuroscience Institute** (opened 2016) which co-locates clinical and basic neuroscientists and houses the **Dementia Research Institute Centre** (£15M). The new configuration of IoPPN has resulted in a growth in research funding, including an **MRC Centre for Neurodevelopmental Disorders**.

We have **grown and diversified our Psychology Department** by recruiting 12 psychology research leaders to launch a new undergraduate psychology degree (already rated 11th in the World (Times Higher 2020) and 2nd in the UK (Guardian)). These leaders (including one professor, 2 readers, and 9 lecturers/senior lecturers) bring expertise in psychological models, information technologies and computational methods. Their collaborations across IoPPN have already borne fruit – e.g. Byrom established an UKRI student mental health network (SMaRteN, £911k), NIHR awarded Hoekstra £4.4M to study autism in low and middle income countries, and Fuhrman has gained £300K ESRC secondary data analysis funding. KCL is **2nd in the UK for highly cited publications in Psychology (SciVal)**.

We have consolidated and expanded infrastructure on clinical informatics and digital health by establishing the **Centre for Translational Informatics** (£10M in refurbished space in partnership with SLAM). The CTI brings together university data science with NHS informatics groups across King’s Health Partners and Health Data Research UK. The Centre hosts our clinical informatics tools (Clinical Record Interactive Search (CRIS) and CogStack) which provide the AI tools to interrogate electronic health records, now deployed across multiple sites; and mobile health platforms (RADAR-Base) providing an open source, “plug and play” platform for remote sensing using smartphones and wearables, now widely adopted outside KCL.

We have **progressed translational research** through our partnership with SLAM yielding an expanded **NIHR Biomedical Research Centre (BRC)** with the largest increase in peer-reviewed funding of any established BRC (£66M, 23% increase). Our BRC is one of only two that focus specifically on mental health. Developed in partnership with service-users and carers, its research strategy has four overarching goals: novel therapeutics, translational informatics, precision psychiatry and bridging the divide between mental and physical health.

Our **links with industry** have expanded – particularly in **pre-competitive partnerships and consortia with pharma**: we lead 25% of all neuroscience European Commission funded Innovative Medicine Initiative programmes (including AIMS-2-Trials, Murphy €115M). We have established the **Centre for Innovative Therapeutics** (C-FIT, director Mehta) which provides a central link between academics and industry.

Finally, we have progressed **applied health research and implementation science** through the **NIHR Collaboration for Leadership in Applied Health Research and Care (CLAHRC) South London** and its successor **Applied Research Collaboration (ARC) South London** (combined value £19.5M, 2013-2024). This brings together clinicians, researchers and citizens to improve

health and care services, and has influenced policy at local, national and international levels, including the NHS five-year plan. Our £7M **NIHR Global Health Research Unit** produces research to strengthen health systems in low and middle income countries.

1.4 Research strategy for the next five years

With the appointment of **Everall** as **Executive Dean** of IoPPN in 2017, we developed a new strategy for 2020-2025. A consultation with our staff, students and wider stakeholders (including patients and public), helped establish priorities. At the forefront of the strategy is our commitment to **supporting and developing our staff**, led by the Vice Dean for Culture Diversity and Inclusion (McNeill) and the Self-Assessment Team that she chairs. We have strived for culture change, matching our expectations for academic excellence with our expectations for support, guidance and fairness to ensure all staff can thrive (Section 2). The **Vice Dean for Research** (Hotopf) is also BRC Director and sits on the IoPPN Executive, King's Health Partners' Executive and KCL Research Committee, providing a line of sight across the university and into the NHS.

Our research strategy draws on national and international research prioritisation and policy, population health need, and funders' stated intentions, by identifying **four major opportunities and challenges** which we seek to address through our interdisciplinary, collaborative approach. It guides future investments and is rooted in producing impact.

Challenge 1: Discovery neuroscience for patient benefit: We will capitalise on the multidisciplinary configuration of IoPPN to harness the **neuroscience revolution** and build ever closer links between discovery and clinical sciences. This will deliver insights into aetiology and define mechanisms underlying mental health and neurological disorders, providing new avenues to diagnosis, treatment and prevention.

Challenge 2: Digital innovation: We will harness the **digital revolution** and use advances in data science and AI to drive a paradigm shift in clinical care. By using data to predict adverse outcomes we seek to prevent these occurring and, by developing digital therapeutics, we aim to close the mental health treatment gap.

Challenge 3: Improving mental health in young people: Recognising that 70% of mental disorders start in the first 25 years of life, we will improve the understanding of, and responses to, disorders that **emerge in childhood and adolescence**, with the aim of understanding risk factors and intervening earlier to gain better outcomes, leading ultimately to primary prevention.

Challenge 4: Addressing multimorbidity: In our aging population **multimorbidity is the norm** and as mental and neurodegenerative disorders make major contributions to multimorbidity, we will develop the knowledge base to inform strategies for prevention, treatment and policy.

The **IoPPN strategy identified numerous enabling activities** which are covered elsewhere in this document, including structures to recognise the importance of open and reproducible science, support for early career and established researchers, and the development of partnerships with industry.

1.5 Impact Strategy

Staff are encouraged and supported to develop research leading to patient and population benefits and impact is now built into our **staff development, appraisal and promotion process**. Successful impact is celebrated in our annual **Research Festival**, where staff and students hear about the breadth of our research and where findings have been implemented outside academia. We train and empower staff to achieve impact by running **masterclasses** with the King's Policy Institute, offering **mentorship** to junior staff from those who have attained impact and continuing our **short impact fellowships**. Our historic links with the NHS, exemplified by the large number (73) of academic staff returned holding honorary clinical roles with SLaM and other trusts within the AHSC, embed the consideration of impact into our research. We encourage staff to **build relationships** across sectors to accelerate impact opportunities, and to take up roles outside the university including secondments to the Parliamentary Office of Science and Technology and

government committees. Impact is driven by cross-sector collaborations illustrated in table 1 and expanded upon in sections 3 and 4.

Table 1: examples of impact supported by our collaborations across sectors

Sector	Example of mechanism for impact	Example of novel impact
NHS	NIHR Biomedical Research Centre at the Maudsley	Service models and new treatments for eating disorders (ICS Eating Disorders)
Patients	Service User Research Enterprise	New guidelines and policy on maternal mental health (ICS – Perinatal Mental Health)
Law-makers	Professional Leadership by senior academics	Review of the Mental Health Act by Wessely (ICS – Mental Health Act)
International Policy	King's Centre for Global Health	Strengthening of health systems to include mental health in Ethiopia and Nepal (ICS – Global Mental Health)
Industry	Licencing and Intellectual Property Office	Work on HCN2 ion channel as a target for analgesics leading to £250M out-licencing deal with Merck Inc & new preventives for migraine [ICS – Migraine]
Government	King's Centre for Military Health Research	Establishing policy for mental health in military (ICS– Military Mental Health)
Wider Society	Engagement Fellow, Science Gallery	Science-Art collaborations – e.g. “Hooked” an exhibition exploring addiction and ‘Modern Slavery’ an exhibition on human trafficking (ICS – Human Trafficking)

1.6 Open research environment, sharing of data and reproducibility

KCL is a signatory on the San Francisco Declaration on Research Assessment (DORA) and a member of the UK Reproducibility Network. IoPPN researchers have championed open science by establishing university-wide groups to raise awareness and influence practice and policy. **The RIOT Science Club** started by Westwood (an IoPPN ECR) provides examples of good practice and training in Reproducible, Open and Transparent Research. It is now franchised to four institutions and has partnered with the UK Reproducibility Network. In June 2020 we hosted the first **King's Open Research Conference**, with international leaders in the field speaking (e.g. Marcus Manufo, Amy Orben and Dorothy Bishop) attracting >1000 participants. **The King's Open Research Group Initiative (KORGI)**, is an action-oriented committee of senior academics, librarians and research staff, seeking to influence policies and procedures to promote transparent, accessible and reproducible research. We are enacting recommendations including the recognition of good open science practice in appraisal, promotions and hiring practice.

1.7 Supporting research integrity

The **King's Research Integrity team** provides training in this area via the **Centre for Research Staff Development** and the **Centre for Doctoral Studies**. Within the IoPPN the Vice Dean for Research acts as the **Research Integrity Champion**, with a network of **Research Integrity Advisors** at departmental level who provide support and advice on best practice and encourage early reporting of research misconduct. We have a joint **R&D Office for IoPPN and SLaM** which provides tutorials on research ethics and governance to students and to research teams, and one-to-one training for new research staff. Both the Joint R&D Office and the College Ethics Committee provide guidance on best research practice, assisting researchers to navigate the requirements and ensure that KCL researchers adhere to high standards. Our multiple **patient**

and public involvement groups, including the BRC Service User Advisory Group and Feasibility and Acceptability Support Team for Researchers, provide a means to ensure protocols and materials are understandable to patients and participants.

Researchers are required to follow regulations and policies related to research (e.g. GDPR, health & safety, COSHH), keep accurate records, take responsibility for the trustworthiness of their research, and be aware of the ethical obligation to weigh societal benefits against the risks inherent in their research. The university has updated procedures for investigating and resolving allegations of research misconduct to incorporate the requirement to notify funders at the stage of an informal investigation should it be deemed necessary.

1.8 Review of our research groups

Mechanisms in Neuroscience

IoPPN neuroscience research themes span mechanisms from genes, cells and systems, to clinical translational research, using diverse technologies such as neural stem cells and brain organoids, experimental manipulation of neural circuits, electrophysiology, structural and functional imaging, and mathematical and systems biology.

Clinical translation is at the heart of the IoPPN's research in this area, as expressed in our strategic goal *Discovery Neuroscience for Patient Benefit* (section 1.4), and including the back-translation from discoveries in human research to animal models. It is enabled by expertise and infrastructure that ensure a permeable interface between preclinical and clinical research. This cooperation between basic and clinical science is being applied in areas such as autism, epilepsy, schizophrenia, migraine, pain, amyotrophic lateral sclerosis (ALS) and dementias.

Translation is assisted by the **co-location** of basic scientists with translational researchers, within structures such as the Maurice Wohl Clinical Neurosciences Institute. This strategy has leveraged significant programmatic funding straddling the translational divide within each of the research groupings described below. It is further enhanced by strong links to **partner organisations** including **NHS trusts** – notably the regional neuroscience centre at King's College Hospital, which serves the largest population of any neuroscience centres in England – and the BRC-Maudsley and CRF translational research infrastructures (see section 3).

1.8.1 Neurodevelopment and its Disorders (led by Marín)

Aims: The group seeks to understand how the brain is built and how deviations from normal development impact behaviour and cause disease. Its approach is exemplified by the **MRC Centre for Neurodevelopmental Disorders** which brings together basic and translational science and involves the study of neurons derived from human patients with neurodevelopmental disorders such as autism, schizophrenia and epilepsy.

Current work and achievements: The group's diverse portfolio spans the **genetic and molecular mechanisms underlying neuronal diversity**. It uses animal models focussing on mechanisms underpinning brain regionalisation including critical periods for experience dependent remodelling of neuronal circuits (Mi *Science* 2018). Research is now explaining how **circuits come together** to orchestrate coherent responses to the outside world including the unravelling of the molecular code behind the wiring of populations of neurons (Favuzzi, *Science* 2019) and experience dependent modelling of neuronal circuits (Bergami, *Neuron* 2015). Work on **cell biology of neurons and glia** is uncovering novel post-transcriptional mechanisms of gene expression in neurons (Thomas-Jinu, *Neuron* 2017).

The group is home to an MRC Programme Grant (Marín), five Wellcome Investigator Awards (Berninger, Burrone, Marín, Houart and Rico), one ERC Consolidator (Grubb) and two ERC Advanced Grants (Marín, Rico).

Future plans:

- **Building the Human Brain:** Researchers will work to improve understanding of the molecular mechanisms patterning the human brain, how cellular diversity is defined in the human cortex and the cellular processes underlying cortical folding with the aim of investigating how these relate to developmental disorders.
- **Neural circuits in health and disease:** Focussing on cognitive functions such as working memory, decision-making and attentional switching, researchers will provide a structural and functional description of the emergence of neuronal circuits that control cognition, using the mouse as a model. This will help understanding of cognitive impairments in disorders including autism and schizophrenia.
- **3D brain culture:** With the **Francis Crick Institute**, the group are establishing human 3D brain culture to understand early stages of human forebrain development.
- **Computational methods:** The group are strengthening computational methods in collaboration with Crick researchers who are establishing a satellite group at King's.

1.8.2 Sensory systems, disorders and pain (led by Malcangio)

Aims: The group aims to understand mechanisms of chronic pain, sensory disorders and migraine and to translate mechanistic findings for patient benefit. This is aided by the cross-faculty **Wellcome Trust PhD Training Programme on Neuro-Immune Interactions in Health and Disease**, which links basic immunologists (Taams) with translational neuroscientists (McMahon, Denk) to understand the relationship between inflammation, pain and mental disorders.

Current work and achievements: The **translational headache research group** was established in 2014 after the appointment of Goadsby. This group identifies neural networks responsible for the genesis and maintenance of headache disorders in humans, back-translate these into animal studies using optogenetic and chemogenetic approaches (MRC NIRG, Holland) and then identify and test novel therapeutics (Akerman, *Brain* 2020).

Work on the **neurobiology and pharmacology of pain** has determined how cytokines, chemokines and ion channels contribute to a wide range of pain states (Clark, *J Neurosci*, 2015). A shining example of this research is the identification of a mechanism underlying chronic pain - **modulation of nociceptor excitability by the ion channel HCN2** (Tan, *Nature* 2016). A Wellcome Trust-funded project to develop blockers of HCN2 ion channels as analgesics has reached the Late Lead Optimisation stage and led to a **£250M out-licensing deal with Merck Inc.**

The group holds extensive Wellcome Trust funding (two investigator awards (McMahon, McNaughton) and two collaborative awards McMahon), and an MRC experimental medicine award (Williams). It is also home to a H2020 Innovative Training Network (Malcangio), and a new pain research theme of the BRC-Maudsley.

Future plans:

- **Neuroimmune interactions:** The group will study this area by leveraging the Wellcome Trust PhD Training Programme in Neuro-Immune Interactions, for example to investigate how extracellular vesicle release by neurons and immune cells regulate chronic pain mechanisms, and to explore communication between sensory neurons and infiltrating macrophages in neuropathic and inflammatory pain.
- **Ion channels:** The group plans to determine the role of the ion channel TRPM2 in neutrophil chemotaxis, how ion channels regulate and mediate pain and transduction, and how they can regulate the constitutive activity of G protein-coupled receptors (GPCRs). It will investigate further the role of the ion channel HCN2 in pathological pain states, such as migraine and tinnitus (Steel).
- **Unexplained pain syndromes:** To identify the pathophysiology of complex regional pain syndrome and fibromyalgia the group will elucidate mechanisms of auto-antibody mediated pain using molecular, cellular and behavioural methods to identify diagnostic biomarkers and candidate therapies (Denk, MRC NIRG).

1.8.3 The Brain and spinal cord injury, regeneration and repair theme (led by Bradbury)

Aims: The group aims to develop mechanistic understanding of injury, regeneration and repair through preclinical research and to translate this into treatments for spinal cord injury (SCI) and stroke in humans. Consistent with wider IoPPN strategy this is achieved through developing interdisciplinary collaborations. A central goal of the group is the clinical translation of regenerative therapies for disorders of the brain and spinal cord.

Current work and achievements: Research work on fundamental biology of **neural stem cell lineage and cell reprogramming** (Berninger) has made seminal contributions to the possibility of converting brain-resident cells into induced neurons (Karow, *Nature Neurosci* 2018). Research on **stem cell technology for building functional neural circuits** has shown uses of stem cell-derived tissue to regenerate neuromuscular circuits and restore motor function in mammalian animal models (Lieberman).

The group is researching **clinically relevant models of disease, injury and trauma** (Bradbury, Moon, Corcoran) focussing on rodent models of spinal cord injury (SCI) and functions which are a high priority for paralysed patients (e.g. hand use). A recent breakthrough demonstrated recovery of skilled hand function in rodents using novel gene therapy approaches (Burnside, *Brain*, 2018).

Members of the group are developing **pharmacological, cell and gene therapies** (Corcoran, Lieberam, Moon, Bradbury) and designing and testing novel compounds for first in man studies (Corcoran, MRC £2.5M). Researchers have recently demonstrated improved function in the impaired arm after severe stroke and belated infusion of neurotrophin-3 (Duricki, *Ann Neurol* 2019), a finding with the potential to radically improve motor function following stroke.

Future plans:

- **Gene therapies:** Leveraging KCL's £10M Advanced Therapies Accelerator and the new £7M MRC Gene Therapy Innovation Hub, researchers will progress gene therapy approaches for spinal cord and brain repair. Through partnering with experts from the **UK's Cell and Gene Therapy Catapult** and charitable foundations, the clinical translation plan will include risk assessment and gap analysis and regulatory meetings to discuss requirements for Phase 1 clinical trials.
- **Mechanisms of disease and injury:** The group will continue mechanistic research on the function of TRPA1 in the brain through mouse models which will determine the role of glial TRPA1 in regulating brain excitability and glial cell pathology in models of stroke (MCAO) and demyelination (LPS injection and cuprizone ingestion). The **Bradbury** lab is collaborating with the KCL Department of Vascular Risk & Surgery (**Modarai**) to develop an *in vivo* animal model to identify the mechanisms of ischaemic spinal cord injury, which is a complication for patients undergoing thoracic abdominal aortic aneurism repair leading to lifelong paralysis.
- **Cell reprogramming:** The group will develop *in vivo* models to study glia-to-neuron reprogramming in order to explore the translational potential of this emerging approach for brain and spinal cord repair.
- **Neural prosthesis:** With a consortium of physicists, engineers and biomaterial scientists (UCL, KCL, Cambridge, QMUL) the researchers plan to develop implantable devices for restoring function to paralysed muscles. These devices will combine engineering, stem cell biology and polymer optoelectronics to create an artificial body-machine interface between paralyzed skeletal muscle and an electronic pacemaker-like device.

1.8.4 Dementia and neurodegeneration research (led by Al-Chalabi)

Aims: The group aims to understand neurodegenerative diseases, their causes, and their relationship with healthy ageing. By translating basic and clinical science its ultimate goal is to prevent disease and improve patient outcomes, feeding directly into the IoPPN strategy on translating neuroscience for patient benefit.

Current work and achievements: The theme encompasses human gene discovery studies, mechanistic pre-clinical work at the level of genes, cellular signalling, novel animal models of disease, experimental medicine, first in man gene-therapy studies, repurposing trials and applied studies to define outcome measures of clinical relevance. The approach is **transdiagnostic** and works with ALS, frontotemporal dementia (FTD), Alzheimer's Disease (AD) and Parkinson's Disease (PD).

The group have made several novel mechanistic discoveries including a unifying mechanism across multiple neurodegenerative disorders (Miller), a mechanism that contributes to amyloid production, tau pathology and neuroinflammation in Alzheimer's disease (Giese) and identification of possible future therapeutic strategies involving RNA aptamers with high/medium-high affinity that can strongly ameliorate aggregation of TDP-43 (Shaw).

An example of the group's progress in translational neuroscience is the discovery of tens of genes causing and modifying ALS, FTD, AD and PD. Some of these are being translated into gene therapy trials in ALS. The first patient has been dosed in a trial of Antisense Oligonucleotide therapy targeting ALS patients carrying the *C9orf72* mutation (Shaw, Al-Chalabi) and a patent has been filed for an adeno-associated virus cassette design and vector delivery for gene therapy in ALS and FTD, with the aim of changing the course of these diseases.

Researchers from the group lead two EU consortia on cognitive ageing prevention (DCogPlast EU JPI) and progression to AD prevention (CoEN) through lifestyle factors (e.g. diet) and mechanisms (e.g. neurogenesis and gut-brain axis) (Thuret). A MRC-funded £1M project is studying the mechanisms of neurodegeneration in Down syndrome (Strydom).

Future plans

- **Gene discovery:** The group's discovery science will be focussed on gene discovery in neurodegenerative diseases, understanding mechanisms underpinning neurodegeneration such as RNA processing or endoplasmic reticulum-mitochondrial interactions, and autophagy dysfunction.
- **Role of digestion:** Researchers will be conducting studies to understand the role of gut microbiota and fat metabolism in brain health.
- **Repurposing treatments:** Development of repurposed molecules for treatments for ALS, FTD and PD, including for symptoms that are not a primary result of the disease, such as pain, sleep impairment and fatigue.
- **Role of glial cells:** The group will study the contribution of glial cells to AD and other neurodegenerative diseases.

Clinical disorders

The overarching aim of the clinical focussed research groups is to improve the lives of people living with mental disorders, addictions and neurological disorder. This is done by increasing the knowledge base of the conditions, providing novel treatments and prediction tools, and embedding these treatments and tools within healthcare systems. Ultimately the goal is to prevent the disorders occurring and the group is working towards this by harnessing interdisciplinary research efforts, that range from **discovery science** (including neuroscience, genetics, cognitive neuroscience, developmental psychology, pharmacology, epidemiology and social science); **clinical science** (including clinical psychology and psychiatry, neuroimaging, and clinical trials); and **data and computer science**.

1.8.5 Developmental Psychology & Psychiatry (led by Simonoff and Sonuga-Barke)

Aims: As many adult mental disorders have their origins in early life, the research group incorporates studies from **foetal life through to adulthood**. Using population cohorts and clinical populations, the group aims to delineate how and when developmental pathways deviate from the expected, whether these differences are disorder-specific or general, and what causal mechanisms are at play.

Research provides vital insight into how mental health problems develop and into the early interventions to address them, helping IoPPN to address its strategic challenge around the mental health of children and young people. Through its work with digital interventions this developmental psychiatry group is also contributing to our 'digital innovation' strategy.

Current work and achievements: Researchers use study designs that allow them to parse the interplay between biological and environmental risk factors to interrogate their independent and joint effects. By studying **normal populations** using birth cohorts (Dunedin Cohort) and genetically-sensitive designs (The Twins Early Development Study (Plomin, Eley) MRC £12M, ERC/H2020 €3M and e-RISK) researchers have shown that the interplay between environmental risk factors (e.g. child maltreatment (Danese, *Am J Psych* 2017), bullying (Takizawa, *Am J Psych*, 2014), air pollution and genes leads to epigenetic and physiological changes in the immune system, with long-term impact on physical health (Baldwin, *Br Behav Immunity* 2018). Research on the **impact of early adversity on development and disorders**, including the English Romanian Adoptees Study (Sonuga-Barke, MRC £1.2M) has shown changes in brain volume specifically associated with neurodevelopmental outcomes (Mackes *Proc NAS*, 2020). Through links forged with the Centre for the Developing Brain (Edwards, UoA3), the group have completed the first population-based longitudinal study of infants at risk for a variety of neurodevelopmental and neuropsychiatric disorders (including autism, ADHD and intellectual disability (Nosarti, MRC £1M)).

Translational research includes the EU Autism Innovation Medicine Studies 2 Trials (AIMS-2-Trials) programme (two IMI awards, €145M, PI Murphy which represent the world's largest grants in neurodevelopment). Biomarker discoveries have led to a new drug testing policy being issued by the European Medicines Agency and findings were accepted by the FDA into their biomarker approval process. Translational work includes psychological treatments for anxiety in autism and cognitive-neuroscience derived targets for non-pharmacological treatments which researchers are now testing. These include real-time fMRI feedback and neuromodulation for ADHD (Rubia MRC, £1M).

Future plans

- **Children and young people's mental health:** Investing in research on children and young people's mental health is a key strategic goal and this is done in partnership with the NHS (SLaM). The **£65M Pears Maudsley Centre for Children's and Young People's Mental Health is currently under development** (opening 2023) and will co-locate researchers and clinicians, enabling them to interrogate the mechanisms underpinning mental disorders and to test novel treatments.
- **Identifying risk factors:** Building on research on individual risk factors, researchers will develop multi-variable **prediction modelling** including polygenic risk, neuroimaging, cognitive and social indicators. To understand developmental stability and change, the group will harness **normative modelling approaches** in its longitudinal cohort studies. The **international biomarkers discovery networks** will be extended, linking the EU (AIMS-2-TRIALS) to the USA (ABC-CT).
- **New interventions:** Researchers will be **developing new drug treatments** aimed at core autistic symptoms and building up trial methods by testing **a battery of objective measures** for symptoms e.g. using wearables (AIMS-2-TRIALS).
- **Digital approaches:** The group will harness **digital developments and use mobile technologies** to assist in diagnostic and outcome assessments. Researchers will be developing and testing **digital interventions** such as OPTIMA (NIHR Programme, Sonuga-Barke, £2M) which tests on-line parent training as an early intervention for children with ADHD.

1.8.6 Addictions (led by Strang and McNeill)

Aims: The group aims to reduce the health and societal impact of addictions, particularly to drugs, alcohol and nicotine. The research spans epidemiology, qualitative and service user-led research, early phase experimental medicine and major trials and implementation studies. The group's work

Investigates the onset, development and co-morbidity of addictions, contributing to the IoPPN's strategies around children and young people, and around multimorbidity.

Current work and Achievements: The research group influences policy and practice at local, national and international levels (see ICS naloxone and ICS E-cigarettes) and contributes to objective analyses to bring evidence to policy on these misunderstood disorders, including strategies for harm minimisation. Since the last REF the research has been **consolidated** into three broad types of addiction – alcohol (Drummond), nicotine (McNeill) and opiates (Strang), with smaller groupings working on cannabis and behavioural addictions.

The **disciplinary mix has broadened**, including qualitative methods to co-design outcome measures with service users (Neale, *Drug and Alcohol Dependence*, 2016), applied mixed-methods research on intimate partner violence (Gilchrist) and expertise in psychology and trials in hard-to-reach groups (Marsden). The group has been **integrated within local infrastructures**, with alcohol and smoking elements of the **NIHR Applied Research Centre**, and since 2016 there is a new theme on Lifestyle Substance Use and Harms in the **BRC-Maudsley**. The group is host to the **MRC Clinical Research Fellowship** programme in Addictions.

This rationalisation of strategy has led to more **programmatic research** grant income with several grants of substantial value (3 NIHR Programme grants) in contrast to the reliance on small grants before the last REF. This has enabled the **first large-scale randomised trials** in the UK in several substance abuse areas.

Future plans

- **Emerging addiction problems:** The group will build on success in existing substance-defined research to include the growing extent of **prescription drug use** and the risk of an epidemic of drug-related deaths similar to that seen in US. Expertise will be developed in **behavioural addictions**, including gambling, increasingly recognised as a serious public health issue, particularly affecting disadvantaged groups. Sharman has been recruited to develop this strategy.
- **Process of recovery research:** The process of recovery from addiction, and its maintenance, is under-studied. By securing philanthropic funding and appointing a new chair (Cunningham) in Addictions Treatment & Recovery we will conduct trials to explore and test treatments and how they interact with recovery processes.
- **Service user perspectives: Methodological work** will further integrate qualitative research and focus on deeper integration of service user and carer perspectives and engagement. The group plans to utilise **mathematical modelling** to identify periods of special relapse risk and to develop remotely activated protective interventions.

1.8.7 Psychosis (led by McGuire)

Aims: The Psychosis group seeks to understand the epidemiology, causes and mechanisms of psychotic disorders and phenomena, with a view to predicting their course and developing new psychological and biological treatments and preventive strategies.

Current work and achievements: Since 2014, the group has secured over £75M in new grant funding, which has led to the decision by the Wellcome Trust to select KCL as its **Strategic Partner for Psychosis**. In translational research, the group leads **international consortia** (EUGEI, OPTIMISE, PSYSCAN, and STRATA) and has established a network of consortia to standardise research methods and metrics in psychosis internationally.

Work on the **epidemiology of psychosis** has explored cultural and ethnic differences, including the INTREPID programme which investigates the incidence and impact of psychotic disorders in India, Nigeria and Trinidad (Morgan ERC and MRC programmes). Research on high-potency cannabis (skunk) and psychosis incidence (Di Forti, *Lancet Psychiatry*, 2015) has influenced cannabis policy (Di Forti, MRC Senior Clinical Fellowship). Work on the reduced life expectancy and multimorbidity of people with psychosis has identified targets for prevention (Gaughran, *BJPsych*, 2019).

Using multiple environmental and biological measures researchers have been working on ways to predict clinical outcomes. For example, work in high-risk psychosis groups has demonstrated inflammatory markers as potential biomarkers for treatment non-response (Nettis, *Psychoneuroimmunology*, 2019), whilst neuroimaging has shown that antipsychotic response is related to glutamate activity (Jauhar, *Lancet Psychiatry*, 2019).

Leveraging the IoPPN service user research expertise, the group have conducted research to develop **new treatments** – including cognitive remediation for cognitive impairments, avatar treatment for auditory hallucinations (Craig, *Lancet Psychiatry*, 2018) and the potential impact of cannabidiol as a treatment in schizophrenia (e.g. McGuire, *Am J Psychiatry*, 2018) (MRC/NIHR EME 1.8M Bhattacharyya) and for hallucinations in Parkinson's disease (£1.2M Parkinson's UK, Bhattacharyya).

Future plans

- **Integration with neuroscience research:** Leveraging collaborations with the MRC Centre for Developmental Neurobiology researchers will back-translate findings from human studies, for example by investigating hippocampal GABA dysfunction in rodents and endocannabinoid mouse work.
- **Precision Psychiatry:** The Stratification & Treatment in Early Psychosis (STEP) programme (Wellcome £15M), a global multi-centre study in high risk and first episode patients, will refine predictive biomarkers for clinical outcomes and treatment response. Alongside testing whether a given biomarker can accurately predict an outcome in an individual patient, it will assess the practicability of the biomarkers in a clinical setting, by developing digital tools that integrate multimodal data and generate an estimate of the outcome in question for the individual patient, ultimately to be fed back to clinician and patient.
- **New treatments and preventive approaches:** Our Wellcome STEP funding includes three large trials of CBD in high-risk groups, on first-episode patients, and in treatment resistant groups. Researchers will further test novel psychological treatments, for example the AVATAR2 trial will assess the utility of a computerised intervention for hallucinations (Wellcome £3.4M), the ECLIPSE NIHR Programme Grant will demonstrate the utility of cognitive remediation in NHS settings (Wykes, 2.2M), and a novel cognitive bias modification treatment will be tested for paranoia (MRC DPFS Yiend, £2.5M). This work will be further developed with Emsley's NIHR Research Professorship on clinical trials methods in psychosis.
- **Prevention:** The group has shown the reduction in life expectancy and high physical morbidity in people with psychosis and will now work to prevent these secondary harms. Evaluations of novel interventions designed to reduce the associated cardiometabolic risk will be completed, including health coaching (the 'Walk This Way' study, Stubbs) and vitamin D supplementation (the D-Fend study, Gaughran). Researchers will assess interventions to promote smoking cessation in people with psychosis.

1.8.8 Mood disorders (led by Young)

Aims: The group aims to understand the aetiology of mood and anxiety disorders and to translate findings from discovery science into novel approaches to treatment and prevention. With the recruitment of Young, Zahn and Stokes in 2014 the **Centre for Affective Disorders** (CfAD) was formed, which is developing a pipeline for translational research.

Current work and achievements: Neurobiology work is using animal and human-cell models to study insults that cause depression such as inflammation and stress and therapeutic interventions (antidepressants and omega-3) before translating into human experimental studies. In **genetics**, key researchers (Lewis, Breen, Eley) lead the International Psychiatric Genomics Consortium groups which have identified loci for major depressive disorder (Howard, *Nature Neuroscience*, 2019), bipolar disorder (Stahl, *Nature Genetics*, 2019), and anxiety.

Work on **early life risk factors** has demonstrated wide-ranging impacts of childhood trauma on psychopathology including affective disorders (Lewis, *Lancet Psychiatry*, 2019). It has also shown

that most of those affected received no care, leading to poorer outcomes and greater costs (Agnew-Blais, *Lancet Psychiatry*, 2016).

In **experimental medicine** the group is exploiting clinical immunopsychiatry methods in individuals at risk of depression (Wellcome Trust consortium £1.6M) and taking a precision-medicine approach to understand treatment response to lithium (R-LiNK Young, 8M). The **trials** portfolio has grown substantially, ranging from early to late phase drug trials. For example, Rucker (NIHR Clinician Scientist £1.1M) is establishing a programme on psilocybin; Cleare is investigating lithium and quetiapine in treatment resistant depression (NIHR HTA £700k) and Hirsch is leading work on psychological interventions for anxiety and depression using cognitive bias modification (MQ £400k).

In **global health** researchers have developed a technological platform to deliver psychoeducation for people with depression and co-morbid physical conditions and tested its cost-effectiveness in a multicentre RCT in Brazil and Peru (Chibanda, *JAMA*, 2016) and developed the *Friendship Bench* in which grandmothers provide peer support for those with depressive symptoms (Abas) initially in Zimbabwe and now translated to New York City (ICS – Friendship Bench).

Future plans

- **Population health:** To inform future prevention the group will explore heterogeneity in the manifestations, onset and persistence of affective disorders. They will use highly dimensional data (including clinical, neuroimaging, cognitive, remote sensing, genetic) collected on large clinical and population cohorts. These include a new wave of the Twins Early Development Study (TEDS, MRC, £3M, Eley); the Genetic Links to Anxiety and Depression study (Breen and Eley), a re-contactable cohort of 40,000 individuals with depression and anxiety, and the IDEA study (international study of mood and anxiety disorders across low, middle and high-income countries, Mondelli, MQ £1.3M).
- **Precision psychiatry:** In order to enable personalised treatment approaches, the group will seek to better understand genetic, immunological, psychological, and neurocognitive predictors of mood and anxiety disorders, response to treatment and prognosis. For example, Zahn recently secured £1M MRC funding to develop the prognostic markers of recurrence risk in depression.
- **Experimental medicine approaches into larger clinical trials:** This will use pharmacological, psychological, digital, neuromodulation, and neurocognitive approaches and will deepen and extend industry collaborations with pharmaceutical companies and the digital health sector.
- **Improving implementation:** The group will foster research on innovative service design and delivery with NHS partner organisations. This research will help services reach larger difficult-to-engage populations and patients using translational informatics (computer/web/app-based platforms for recruitment, assessment and interventions) and community cognitive behaviour therapy (CBT) workshops.

1.8.9 Psychological Medicine (led by Schmidt and Moss-Morris)

Aims: The group studies links between mental and physical health with the aim of integrating the two and achieving better outcomes for each. It explores how psychological processes such as adherence can impact physical health. This work leverages the IoPPN's partnerships between acute and mental health NHS Trusts within **King's Health Partners**. Researchers have successfully digitised some therapies and plan to expand this to other areas, addressing the IoPPN strategy around digital innovation.

The group's interdisciplinary approach aims to develop deeper understandings of processes and mechanisms, both biological and psychological, and to test novel treatments. Research covers eating disorders, persistent physical symptoms including pain, fatigue and functional motor symptoms, perinatal mental health and the mental health impacts of long-term conditions. The research includes **understanding the aetiology** of the underlying disorder.

Current work and achievements: Researchers have developed psychological models to understand maintenance of physical symptoms which is used to **develop complex interventions** – typically based on cognitive behavioural principles, including guided self-help for eating disorders (ICS Eating Disorders), workplace-based CBT approaches for menopause (ICS Menopause), motivational techniques to improve outcomes in people with high cardiometabolic risk, the largest trial of CBT in irritable bowel syndrome (IBS) (Everitt, *Lancet Gastroenterology*, 2019), and a trial on CBT for dissociative seizures (Goldstein, *Lancet Psychiatry*, 2020)). Based on Moss-Morris & Chalder's work on CBT for IBS (with Everitt, Southampton), an exclusive licence has been granted to Mahana Therapeutics to offer the prescription-only digital therapeutic in adults (previously called Regul8 and funded by NIHR, it is now known as Parallel with FDA marketing authorisation granted December 2020 to Mahana Therapeutics).

The group's pathway to impact includes **embedding such interventions within services**, including trials of education for GPs managing persistent physical symptoms; the development of COMPASS – theory-based digital CBT interventions for treating anxiety and depression across long-term conditions; and FREED (First Episode Rapid Early intervention for Eating Disorders), a multi-award-winning early intervention programme now nationally adopted by AHSNs (ICS Eating Disorders). The research has **influenced policy** for example, addressing evidence gaps in perinatal mental health (ICS Perinatal Mental Health), contributing to the English CMO's reports on public mental health and women's health and leading the influential Lancet Commission on physical health of people with mental disorders (Stubbs).

Future plans

- **Multimorbidity:** With the appointment of Stubbs (NIHR Clinician Scientist, Physiotherapist) and Dregan (Epidemiology) the group will seek to explore patterns, pathways and treatment approaches to multimorbidity involving mental disorders. Using birth cohorts, UK Biobank and electronic patient records researchers will explore bidirectional pathways between mental and physical health outcomes and identify targets for treatments (e.g. polypharmacy) to be tested within King's Health Partners.
- **Mechanisms:** Building on existing neurobiological explorations of disordered eating, researchers will continue to investigate this area with support of the BRC-Maudsley and an MRC grant, using data from cohorts of the developing adolescent brain (e.g. IMAGEN) to gain novel insights into shared and separate ED/obesity risk, which will then be tested in clinical populations. Using mediation analysis of clinical trial data, researchers will explore active ingredients of effective treatments for future refinement.
- **Digital therapies:** Building on the successful commercialisation of an IBS self-management platform, researchers will progress a pathway to develop other digital therapies. Such approaches are a sustainable way to embed the group's treatments devised within health systems. Researchers are now seeking to establish a framework for the development, testing, implementation and commercialisation of digital therapies, many of which will be "blended" with routine care.

1.8.10 Neurological disorders (led by Richardson)

Aims: Exploiting the close relationship with high-volume clinical services, this group aims to undertake experimental medicine, investigate comorbidities, develop innovative remote monitoring, and improve clinical services. These aims tie in with the IoPPN strategic challenges around multimorbidity, digital innovation and applying neuroscience for patient benefit.

Current work and achievements: In **migraine and primary headache disorders** preclinical work (see section 1.8.2) identifying calcitonin-gene-related-peptide led to multiple trials (e.g. Goadsby, *NEJM*, 2017) demonstrating efficacy of monoclonal antibodies for migraine prevention, leading to FDA and EMA approval (see ICS Migraine).

In **epilepsy**, there has been collaboration with industry in using combined TMS-EEG (transcranial magnetic stimulation EEG) to show drug target engagement in early-phase trials (Richardson). Researchers are exploring the genetic architecture of Rolandic epilepsy and Juvenile Myoclonic Epilepsy (Pal), and the heritability of abnormal brain network dynamics in a range of epilepsies

(Richardson). As a means to predict disease, members of the group are using digital biomarkers from wearable devices and the “internet of things”. Research is ongoing into the use of transdermal nicotine as therapy for sleep-related hypermotor seizures (Pal) and into behavioural interventions for sleep disturbance, frequent A&E attendance, and enhanced self-management (Noble, *PLoS One*, 2014).

For **Parkinson’s**, researchers are investigating nicotinic therapy for mild cognitive impairment and evaluating an intervention for palliative care (Chaudhuri). As a means to enhance mechanistic understanding, the group are developing a rich understanding of comorbidities and endophenotypes. Researchers have developed new patient reported outcomes of non-motor **Parkinson’s** symptoms (Chaudhuri, *Movement Disorders*, 2015) and are investigating the mechanism of comorbid anxiety, onset and key clinical events in **Alzheimer’s** (Aarsland, RADAR-AD, IMI £4M), **Parkinson’s** (Chaudhuri) and **epilepsy** (Richardson, RADAR-CNS).

Future plans:

- **Migraine and primary headache:** The translational research will continue to develop novel therapies and work with industry partners including Eli Lilly, Novartis and Teva to trial therapeutics further developing the work described in ICS Migraine.
- **Neurodegenerative disorders:** Gene therapy for **ALS** and **FTD**, faster multiarm-multistage drug trials, and drug discovery in large multinational ‘omics’ datasets will be progressed. Re-Neuron, a first-in-disease Phase 1B trial of stem cell transplantation is planned in **Alzheimer’s** (Aarsland). The group will develop a hub for RCTs of cannabinoids as a treatment for behavioural and psychological symptoms of neurodegenerative disorders, linking to a programme on cannabidiol (see 1.8.7). The group will continue to develop preventive strategies initially aimed at unaffected members of families with neurodegenerative diseases, based on results of clinical trials.
- **Brain and spinal cord injury:** To accelerate translation of the group’s exceptional preclinical science, a neurosurgery research team will be established to focus on translation.

Systems to drive innovation

The final grouping of research activities describes the platforms and methodologies we have developed to support impactful research. These have been created to ensure our specialisms can access the expertise, equipment and support needed to perform research and translate it into significant outcomes. By providing hubs of skills in research methods they enable the IoPPN’s interdisciplinary approach and bring methodological perspective to the problems their research seeks to address.

1.8.11 Biostatistics, genomics and informatics (led by Dobson and Lewis)

Aims: The digital and molecular revolutions have brought huge challenges and opportunities in the scale and complexity of data available for research. The group aims to innovate across disciplines with impactful, academic-led interdisciplinary methodological research, bringing together statistics, computer science, bioinformatics, genetics, epidemiology, psychometricians and service user researchers. As part of its remit, the group plays an important role in the IoPPN digital innovation strategy, harnessing the wealth of data produced across research groups.

Current work and achievements: In **genetics**, researchers have supported international groups identifying loci through the development of the *PRSice* software to compute polygenic risk scores for disease susceptibility and prognosis (Eusden, *Bioinformatics*, 2015), now widely deployed internationally.

Longitudinal cohort studies include TEDS, E-Risk, The Dunedin Cohort, and IMAGEN, and focus on human development, from cradle to grave – for example, researchers have demonstrated the harmful effects of lead-paint exposure in early life on adult health, including cognitive decline and poor mental health, work which is cited by CDC in its 2019 toxicological profile for lead (Reuben, *JAMA*, 2017).

The group has pioneered the use of **electronic health records for research**, including the CRIS and CogStack systems, which provide governance models, technological platforms and AI tools to interrogate health records in mental health and acute NHS trusts (Jackson, *BMJ Open*, 2017). Data are enriched through linkages (including health, environment, education, benefits and census data) and use of natural language processing to derive structure from narrative records. This work is now disseminated nationally via an MRC Pathfinder Award (£1.5M) and Health Data Research UK and forms a core component of the London AI Centre for Value Based Healthcare (£10M Innovate UK, £16M OLS).

The **m-Health programme**, including RADAR-CNS and RADAR-AD (IMI2 €30M), has led to the development of a flexible, open-source platform, radar-base.org, for tracking health using wearable devices and smartphone technology. This is now being used in multiple research programmes internationally. The group works extensively with **service users** to ensure these new technologies are acceptable and to help address potential ethical and regulatory barriers to implementation – there is a service-user led governance board for CRIS and extensive service-user input to our genomics and m-Health programmes.

Future plans

- **Multimodal phenotyping:** Researchers plan to generate knowledge from **population and clinical cohorts**, making data available for research use and providing a 360-degree view of an individual's biology, behaviour, health and environment. This data will be applied to predict changes in health states, accelerate new treatment testing and provide better care, including novel forms of delivery (e.g. digital therapies and mobile health).
- **Using infrastructure for patient benefit:** By leveraging links with HDR-UK and the London AI Centre, the group will disseminate methods and algorithms developed locally and move from **observational to interventional** research, including targeted trial recruitment, supplementary routine outcomes, and embedded emulated trials of complex care pathways.
- **Disseminating polygenic risk:** The group plans to make polygenic risk scores widely available for clinical research, for example in the prediction of outcomes in first episode psychosis, drug response, suicide risk and educational attainment.
- **Predicting outcomes:** A **prediction modelling group** has been established, which will expand capacity and develop new models for precision medicine. This will be applied across clinical disorders, for example to reduce the impact of multimorbidity by addressing physical health outcomes in people with severe mental illnesses.

1.8.12 Neuroimaging, experimental medicine and trials (led by Williams)

The translational research platforms for neuroimaging, experimental medicine and clinical trials aim to develop new biomarkers and novel treatments. The group includes physicists, modellers, engineers, pharmacologists, trialists and health economists.

Current work and achievements: The neuroimaging data combined with cognitive, biological and clinical data, provide the basis for **robust biomarkers of disease and prediction of response to treatment** (Loth, *Nat Rev Drug Discov*, 2016). The appointment of Moran and Leech has strengthened computational neuroscience, complementing our new £12M **Wellcome ESPRC Centre for Medical Engineering**. The group has developed neuroimaging as a powerful experimental medicine tool to **visualise drug effects on the brain** providing insight into drug penetration, target engagement, and potential indicators of clinical efficacy. This work is key to meeting the IoPPN strategic challenge of translating neuroscience for patient benefit.

New impactful technologies have been developed, including the first **head-only 3T MR system** (GE Healthcare and Tesla Engineering UK) and **silent MR imaging** procedures (GE Healthcare). These technologies will increase availability and acceptability of neuroimaging.

The high risk involved in developing drugs for novel targets in psychiatry has deterred pharma investment. To address these concerns, the group has developed **novel experimental medicine paradigms** to identify promising signals. These efforts are bearing fruit: since REF2014, **67**

clinical trials have been initiated in collaboration with industry on more than 30 distinct biological targets for a range of neurological and psychiatric indications. Researchers have developed methodology for innovative trials and established a corresponding portfolio of trials in mental health building on the opportunities provided by new m- and e-health systems. These include the development of novel psychological therapies based on empirically validated cognitive models.

Trials capacity has been enhanced with the recruitment of Emsley who was awarded a **NIHR Research Professorship** which aims to build national capacity for efficient evaluation of therapies using **adaptive designs**. Methodologies are being developed to enhance the understanding of mechanisms in **complex interventions** (Landau: MRC £423k), pooling data sources for evidence synthesis (e.g. conduct disorders - NIHR).

Future plans

- **Evaluation of therapies:** Leveraging **Emsley's NIHR Professorship** award, the group will progress the development of mental health therapeutics by establishing platforms for multi-arm multi-stage trials and Sequential Multiple Assignment Randomised Trials to be tested in psychosis and other diagnoses.
- **Cognitive Insights:** Recent funding from Boehringer Ingelheim (£2M) will enable **transdiagnostic cognitive task assessment** to determine common and distinct cognitive impairments in psychosis and mood disorders. These tasks will then be imaged to visualise the related brain circuits and inform future treatment strategies.
- **Appraisal of technology:** The recent, **patented innovations to predict treatment response in psychosis** and **silent, motion insensitive MRI** will be evaluated in applied clinical settings. The intention is to appraise such methods, across the lifespan, in challenging patient cohorts ranging from sleeping babies to hypersensitive autistic children and older subjects suffering from neurodegenerative conditions such as dementia and Huntington's Disease (£20M CHDI).
- **Access to MRI:** The group will also be leading a global effort to provide the **first low cost, portable brain MRI device across 20 countries including India, Pakistan and sub-Saharan Africa** (£1.5M Gates Foundation).

1.8.13 Public Mental and Neurological Health (led by Hotopf & Morgan)

Aims: IoPPN has always innovated in population mental health, bringing together expertise in epidemiology, public health, health service research, implementation science, public policy, law, social science, patient and public involvement and engagement. With a focus on **the public health challenges of a changing world**, the group studies local and global populations.

Current work and achievements: The group conducts much of its research in collaboration with other universities, the NHS, patient groups, NGOs and government bodies, e.g. WHO, Public Health England and Whitehall departments. It is pursued via an array of major awards and infrastructures including the ESRC Centre for Society and Mental Health (£6.2M), NIHR Applied Research Collaboration (£9M), NIHR Mental Health Policy Research Unit (joint with UCL, £5M), NIHR Health Protection Research Unit in Emergency Preparedness and Response (£4M), NIHR Global Health Research Unit (£7M) and King's Centre for Military Health Research.

The breadth and interdisciplinarity of the group's work is reflected in the number of impact case studies attributed to its research. Research spans the global increase in people living with dementia (Stephan, *Lancet Global Health*, 2020), the need for evidence for mental health policy for veterans (Stevenson, *BJPsych*, 2018), the communication of novel health risks, from Ebola to COVID-19 (Smith, *Public Health*, 2020), and the role of social media and internet use on self-harm. The research has impacted public policy, from informing changes to Mental Health legislation (ICS Mental Health Act); to demonstrating that screening for mental disorders does not improve outcomes for service personnel returning from war (ICS Military Mental Health); and informing public health responses to COVID-19 (ICS Disasters and Crises). Its research has systemically changed the treatment of mental health in-patients (ICS Safewards). In global mental health, researchers have identified the scale and nature of mental health needs in countries such as Ethiopia and Nepal and co-developed place evidence-based programmes with the communities (ICS Global Mental Health).

Future plans

- **Mental health and society:** The **ESRC Centre for Mental Health and Society** was established in January 2020 to improve our understanding of how social, economic and cultural transformations affect mental health. It will explore how policy changes which address the social determinants of health, affect the prevalence of mental disorders. The intention is to develop an evidence base for future public health interventions and changes in social practices and policies that will promote and sustain good mental health.
- **Public mental health:** Leveraging local and international collaborations a **Centre for Public Mental Health** will be established which will provide a coordinated approach to primary prevention of mental disorders and secondary prevention of their longer-term harms. The Centre will focus on key transition points across the life course including education, occupation and retirement. It will approach each transition from the perspective of (a) intersectional understandings of vulnerability and resilience (b) the use of health and linked data to monitor trends and digital approaches to provide interventions and (c) the contribution of mental disorders to multimorbidity.

In summary our research groups' aims coalesce into our core strategic goals, together illustrating our interdisciplinarity, our strong collaborations across the globe and our commitment to ensuring that our research is impactful particularly in advancing diagnosis, treatment and prevention of mental health and neurological disorders.

2. People

We work across the IoPPN to make it an inclusive, diverse and supportive environment where our staff and students are free to flourish. This is recognised as central to our strategy and a core duty of the leadership team. Whilst there is a need to ensure that "top-down" policies, processes and procedures are robust, fair and transparent, our philosophy is that culture change, which is widely recognised to be needed in HEIs, is most meaningful when there is strong staff engagement. We therefore support a series of "bottom-up" initiatives to encourage an inclusive and supportive culture.

Our **Diversity and Inclusion Self-Assessment Team (SAT)** is led by the Vice Dean for Diversity and Inclusion (McNeil) and co-chaired by a social scientist (Hatch). Using an intersectional approach, Hatch's work on the impact of discrimination on mental health (e.g. Wellcome funded Tackling Inequalities and Discrimination Experiences in Health Services (TIDES) programme) has influenced the development and implementation of our policies.

D&I representation is built into the main committees and processes, including appointments and promotion. At any one time over 100 staff members are directly involved in D&I activities (e.g. departmental champions, members of working groups) and these activities are recognised by promotion and appraisal practice. We test ourselves against external benchmarks and IoPPN is proud to have been awarded **Athena Swan Silver in 2019** following a previous Silver award in 2014. Our goal is to be a beacon of good practice and we aim to achieve Athena Swan Gold within the next three years. We have significantly expanded our work around race and race

equality, emphasising the imperative that senior leadership set role models, and have contributed extensively to the university's strategy on race equality and our successful Race Equality Charter Bronze award (2020). Our REF2021 preparations, in line with our institution's code of practice, recognises the effect that individual circumstances may have on a researcher's ability to contribute to research in our UoA.

The second main vehicle for staff support is the **Research and Innovation Committee (RIC)**, chaired by Eley (2014-2020) and now by Mehta. This group has representation from across departments, disciplines and career grades. It oversees a range of initiatives (described below) that provide a vibrant culture for researchers. The committee has a "by staff for staff" philosophy, taking ideas from its members and developing them into initiatives to support career development (e.g. THRIVE – described below). Our annual flagship event is the **IoPPN Research Festival**, which celebrates the breadth of our research and impact and provides our ECRs with the opportunity to increase their visibility alongside more senior staff. These are typically attended by 250 staff members with a similar number viewing the recording. Our processes relating to the **Concordat** are handled at University level and described in the Institutional Environment section. We aim to exceed the Concordat standards, and the **Centre for Research Staff Development**, launched in 2016, plays a major part in this.

A: Staffing Strategy and Staff Development Academic Performance Framework (APF)

In order to ensure that the organisation's expectations are transparent, and diverse contributions are recognised, we have developed an academic performance framework. This informs recruitment, probation and appraisal, covering education, research, citizenship, management and leadership, and dissemination and impact (see Table 2 below). For each academic rank, the framework describes the expected performance level in each domain. Whilst it is understood that different roles, disciplines and career stages might lead to variations from these ideals, the systematic approach ensures processes are fair and expectations are transparent.

Table 2: Academic Performance Framework Domains

Domains	Example activities
Education	Teaching hours, course leadership, feedback and quality assessments from students and peers.
Research	Grants, grant income (principal and co-investigator), research team leadership, PGR students, research outputs
Citizenship management and leadership	Staff development, equality diversity & inclusion activities, mentorship, widening participation activities, encouraging open science, peer review.
Knowledge, dissemination and impact	Public understanding of science, impacts of research beyond academia

Recruitment policy: We have established processes, including a recruitment tool-kit, to ensure recruitment is fair, under-represented groups are encouraged to apply, and appointment panels are diverse. Except where we identify a critical gap at senior levels, we prefer to recruit and retain "rising stars" rather than senior figures. During this REF period we have recruited 11 King's Prize Fellows from outside KCL (see section on supporting ECRs).

Probation: All new academics complete a three-year probation period with a probation mentor. The APF is used to ensure expectations are set and progress monitored. The probationer has guidance and support to meet the expectations of their role, and to allow them to raise issues if the environment does not support such progress.

Retention: We recognise the challenges faced by early career researchers, particularly with the move to independence and transition from post-doctoral positions to lectureships, and other career destinations. We aim to meet these challenges with a multitude of offers (described below in section on support for researchers). We are addressing the uncertainty that comes from short-term contracts for research-only staff by putting in place policies to define the minimum length of contracts and ensuring staff with multiple renewals of short-term contracts are moved to permanent contracts.

Appraisal: All academic and research staff complete an annual appraisal with their line manager, which uses the APF as its benchmark. This is an opportunity to celebrate success and to reach consensus about agreed goals, leading to a joint document which identifies actions for the appraisee and the organisation to reach these goals. Expectations are tempered by consideration of personal circumstances which might impact performance. The performance and development review (PDR) includes a section on promotion, career development and flexible working/retirement and family commitments, to ensure the appraiser provides support and advice so the staff member can develop and meet their own goals. For clinical academics, a dual appraisal process with NHS and university appraisals operates. The university PDR takes account of proportion of time spent on clinical duties.

Mentoring: We have a mentoring offer available for all academic and research staff, via formal and informal mechanisms. Aside from probation, mentoring is optional. Uptake of mentoring is encouraged and acting as a mentor is recognised in appraisal. Mentors have access to training and advice, including "More than Mentoring", a resource for mentoring people with protected characteristics. Our mentoring offer is taken up by 50-60 mentee/mentor pairs each year and includes specific programmes for academics, research and technical staff, and schemes designed specifically for people with protected characteristics.

Promotion: The APF provides staff with an explicit framework about expectations for their grade. Line managers are required to discuss promotion at annual PDRs. IoPPN holds annual 'Understanding Promotion Workshops' to support staff who are considering their options for academic promotion. Although all academic staff can submit directly to the KCL Academic Staff Committee to review their promotions applications, the Faculty convenes a Promotions Recommendations Panel each year (prior to the university deadline). This allows applicants to submit their draft application which is reviewed by two assessors and discussed at a panel meeting where a collective decision is made as to whether or not to recommend that they proceed with a formal application to KCL. If the application is not supported, the panel advises on how to strengthen it. Data from the last three years show that nearly all applications recommended to proceed by the IoPPN Promotions Recommendations Panel have been approved by the KCL Academic Staff Committee. Our Panels are trained in D&I and consider formally declared circumstances (e.g. maternity/adoption/shared parental leave (SPL), illness, injury, disability, or caring responsibilities). An online Promotion Toolkit clarifies the role of the IoPPN Promotion Panel and ensures easy access to promotion materials/video and good practice on career development.

Support for academic and research staff

Our research environment is supported by the **Research Strategy & Development (RS&D) team**, with a dedicated Research Development Manager and Programme Manager for Industry Partnership overseen by the RS&D Director. The team provides advice and support at any point of the grant application process, including early-stage horizon-scanning and championing internal peer review schemes. They assist in developing large funding bids, strengthening relationships with funding bodies and seeking opportunities to accelerate transition from fundamental research to application and translation. They work on cross-institution initiatives identifying synergies, potential partnerships and facilitating new networks across the University and beyond.

Supporting early career researchers

King's Prize Fellowships provide a launchpad for outstanding postdoctoral researchers establishing their independence. It is used both to attract new talent from outside and as a part of our retention strategy. The fellowship provides salary and running costs for up to two years,

enabling appointees to compete for externally funded personal fellowships. Since 2014, 19 fellowships have been awarded for research in IoPPN: three are now lecturers, eight were awarded intermediate fellowships, one left academia, and seven have yet to complete. Support is further provided by the **BRC-Maudsley** and in 2017 we established **four BRC lectureships**. The BRC's **Early Career Bridging Awards** support retention of ECRs facing funding gaps, with four awarded per year, and the BRC also provides funding to support research **career re-entry**.

We have a portfolio of initiatives to **develop our early career researchers** which include:

- **The IoPPN Postdoc Network** provides a voice to the postdoc community, representing them on committees and equipping researchers with support for career development, grant writing and science communication. The Network actively communicates internally and externally via social media channels e.g. Twitter account of over 1000 followers. The Network is a founding member of a London-wide network aiming to improve career structure for postdocs. Its impact was recognised when it won the **2018 King's Award** for Most Outstanding Contribution to the Research Staff Experience.
- **THRIVE** provides a programme of workshops, group work and networking opportunities to support lecturers, senior lecturers and fellowship-holders (107 workshop attendees since 2015 including 35 in 2019-20). THRIVE covers career development, work-life balance, grant-writing and building collaborations.
- **Early career research awards** are awarded to junior researchers to develop a small project arising from an independent research idea (8 awards each year).
- **Mock grant reviews** where experts review grant and fellowship applications and discuss the merits and limitations to give a realistic sense of the process. Attendance exceeded 100 ECRs per workshop with at least one held every year.
- **Proposal writing workshops** which include monthly group sessions on grant writing over the course of a year. Delegates attend lectures and in groups of ~20 share a draft application and receive facilitated feedback from the wider group. Academics of all levels and disciplines can attend. Uptake is 60-100 per year with a total of 426 attendees since 2015.
- **Health Faculties Fellowship day:** This one-day annual event, aimed at postdocs considering their first independent fellowship, includes information from funders, fellowship holders and funding Committee members. Within this there are smaller meetings with funders and the King's Professional Services teams who support applications. The 2019 day was attended by 298 ECRs, 11 health research funders and 11 internal Professional Services groups.

Supporting senior academic staff

The **King's Leading Researchers Programme** is a flagship university-wide course to provide readers and newly appointed professors with tools to develop their skills as research leaders. The course covers topics such as project management and team leadership; generating and developing big ideas; taking risks and collaborating across disciplines; and gaining insights into funder requirements. The course includes group sessions, bringing together academics from across the university as part of a cohort of colleagues, and one-to-one coaching. Alumni include Morgan and Hatch who respectively lead and co-lead the ESRC Centre for Society and Mental Health and Emsley, who was subsequently awarded an NIHR Research Professorship.

Senior THRIVE is an IoPPN series of workshops for professors, readers and senior lecturers aimed at developing research strategy and skills needed for their senior role. It is biennial and, since 2016, has supported 93 academics with workshops on achieving balance between work roles, increasing visibility, maximising research impact, leading an international collaboration, or partnering with industry.

Recognition and rewards for research and impact: King's Recognition Pay Scheme recognises outstanding contributions by King's staff. IoPPN staff are nominated and then considered by the IoPPN Recognition Pay Panel. King's Awards recognise staff achievements across the university and the contribution this makes to achieving our Vision 2029. A specific award exists to celebrate contributions to D&I activity.

Succession planning: Our approach to succession planning is to ensure a vibrant culture within IoPPN which includes (a) training in leadership and mentoring (described above), (b) rotating leadership – since 2018 we have introduced fixed terms for key leadership roles including all heads of departments and divisions (c) the introduction of deputy heads of departments with role descriptions and specific responsibilities and the recognition of deputy roles elsewhere in the organisation to encourage and support mid-career academics to take on new challenges.

Outreach: The IoPPN is fortunate to be based in a diverse and vibrant inner-city environment. Consistent with the wider KCL commitment to Service we encourage staff to engage in multiple initiatives to foster better understanding of our research and the nature of mental and neurological disorders with our community. The **Maudsley Debates** provide a forum for controversies in mental health to be discussed and regularly attract over 300 attendees with over 7000 followers online. **Arts in Mind** is a week-long festival celebrating innovative collaborations between researchers at IoPPN and the creative and cultural sector, with 40 individual projects ranging from explorations of neural plasticity, addiction and psychotic experiences. Since 2013, the **IoPPN Youth Awards** have provided opportunities to young people from local schools providing a £50 book token, mentoring and experience in research. The Awards encourage students to work towards attending University and provide opportunities to develop skills beyond research. This programme has expanded from two recipients in one subject in 2013 to 30 in seven subjects in 2019. Meanwhile the **ESRC Centre for Society and Mental Health** offered virtual work placements to 100 local school students per year extending to 400 in 2020/21. The **Health Inequalities Network** (HERON) provides a forum for engagement and research collaboration between IoPPN academics and local third sector organisations.

Integration of clinical academics and NHS-employed active researchers: IoPPN is unusual in the richness of its clinical academic posts, largely due to the investment made by SLAM and KCH in supporting these positions over many years. This amounts to a recharge of £5.5M per year, supporting 72 academics. KCL provides associate status for NHS employed clinicians who can hold grants, supervise PhD students and be recognised with academic titles. The **clinical academic group** structures within the NHS Trusts support these NHS academics and help them to develop.

We have a mature **training programme for clinical academics**, which includes approximately 20 NIHR Academic Clinical Fellows in Neurology and Psychiatry at any one time. These individuals are further supported by BRC Preparatory Clinical Fellowships (three per year), which are then followed by 10 NIHR Academic Clinical Lectureships in Psychiatry or Neurology at any one time. These individuals are then supported to take up mid-career clinical fellowships. The BRC further has an Allied Health Professionals training scheme that encourages professionals under-represented in academia, including nurses, pharmacists and occupational therapists, to learn more about the research process.

At the census date the number of clinical academics (Clinical Psychology, Neurology and Psychiatry) within our Category A staff was 73 (21%).

B. Postgraduate Research Students: selection, support, training and supervision

PGR students occupy a key part of the IoPPN's mission. We have 585 postgraduate research students from over 70 different countries. As well as MPhil/PhD departmental research degree programmes IoPPN also offers a Doctorate in Clinical Psychology (including research) and an MD(Res) in Medical Humanities. Approximately 20% are self-funded, of whom two thirds are staff members who receive a substantial (75%) discount in registration to encourage career progression of research staff. A further 12% are funded by the NHS for DClinPsy; 18% UKRI, 8% NIHR and the remainder from charities, industry and government (UK and overseas). Each student's progress is carefully monitored through a network of departmental oversight groups which aim to identify barriers to successful progress.

Process of selection: Potential candidates typically choose projects from those submitted by academics to our diverse training schemes and are subsequently selected on the basis of their academic potential, including an interview by a minimum of two independent academics.

Training and supervision: All **supervisors** must be approved by the Deputy Dean for Postdoctoral Studies (Byford) and undertake mandatory training, repeated every five years. Students have at least two supervisors, with clear responsibilities set out at the onset of studies. All supervisors must go through the IoPPN 'Guidance for Supervision' with each new student in the first month after registration. This sets out responsibilities of supervisors and students, including meetings, communication, time planning, regulations, authorship, intellectual property and data storage. **Students and their supervisors** must consider a training plan which is regularly reviewed. Students' progress (including training) is monitored by departmental oversight groups every four months.

Training for PGR students is offered at University, Faculty, Departmental and Research Group levels. **At University level**, all students have access to the **King's Centre for Doctoral Studies** which offers face-to-face workshops, online courses and seminars, including Communication & Impact, IT Essentials, Data Management, and Writing and Publishing. Students are offered meetings with careers consultants or Royal Literary Fund writing fellows. More specialised training is offered via our **Doctoral Training Centres and Doctoral Training Partnerships**. For IoPPN students, the most relevant are the *Health Sciences Doctoral Training Centre*, available to all our PGR students, the *MRC Doctoral Training Programme* and the *ESRC London Interdisciplinary Social Sciences Doctoral Training Partnership*, available to all PGR students whose research has a social science focus. In 2019-20 we invested in a new **Centre for Doctoral Training in Data-Driven Health** to support students to develop skills across the breadth of data science include Big Health Data (machine learning, novel mathematics and statistics) and translating informatics into healthcare practice. **At Faculty level**, we provide PGR students with 'Bitesize Sessions', run termly and covering subjects such as Upgrading from MPhil to PhD, Progress Monitoring, and Research Integrity. We encourage research students to attend D&I related training and events. Our PGR students have access to a range of support around **career progression** with a dedicated IoPPN careers consultant for PGR. We ensure PGR student representation at key IoPPN committees such as Institute Management Board, the Research and Innovation Committee, and the D&I Self-Assessment Team.

Submission and completion data for PGR students

For full-time students our overall submission rate is 97.5% (98.8% completion rate) with a submission rate within 4 years of 97.1% (97.0% completion). Rates for part-time students are overall 77.8% (72.7% completion) and submission within 7 years 77.8% (72.7% completion within 8.5 years).

C. Equality Diversity and Inclusion (ED&I)

The IoPPN ED&I Self-Assessment Team (SAT) (described above) drives the implementation of relevant action plans (including Athena SWAN, Race Equality Charter, Stonewall) and monitors progress. Since 2014, our Self-Assessment Team (SAT) focus has expanded from Gender Equality to ED&I. This change was to ensure all barriers faced by all IoPPN underrepresented groups are addressed.

To embed ED&I across the IoPPN community we have introduced Champions representing groups of people with protected characteristics, Working Groups and Networks which are open to all staff, with over 100 staff and students actively involved. Career progression is supported widely through these groups, which also provide opportunities for leadership experience.

Our commitment to Race Equality was strengthened in 2016 when we established a Race Champion role to provide strategic leadership to all Race Equality work. Both the SAT's Race Equality Working Group and the IoPPN Race Equality Network support and raise awareness of this work. A Race Equality Action Plan was developed in 2018 following discussion groups with students in 2018 and staff in 2020. Since June 2020, we developed a #BlackLivesMatter resource

page, increased the delivery of Race Equality training, held staff and student open fora, introduced reading circles and reflective spaces, created peer-support spaces for Black students and updated our current Race Equality Action Plan.

We aim to integrate ED&I into decision making at every level. ED&I Core Team members sit on IoPPN committees and panels including the REF Working Group, King's Equality and Diversity Advisory Panel, promotion and senior interview panels, the recognition pay panel, as well as IoPPN Faculty committees such as the Institute Management Board (IMB) and Institute Executive. ED&I is a standing item every month at all management committees and departmental and core area meetings. Gender balance has improved in IoPPN committees: The Institute Management Board's proportion of female staff has increased from 32% in 2013 to 47% in 2020 and our REF oversight group is 46% female. We provide opportunities, via our 'Step into Leadership' programme for senior female staff and staff from diverse ethnic groups to gain committee membership experience. Our ED&I activity is influential within the wider university – for example, McNeill chaired the "It stops here" working group on bullying and harassment and Hatch co-chairs the Academic Reference Group for the NHS Race and Health Observatory.

Training in ED&I

We have invested in externally provided training in ED&I as a key component of our strategy for an inclusive environment. Training is mandatory for senior leaders who are involved in recruitment and who are applying for promotion. Training has included sessions on Implicit and Unconscious Bias, and Imposter Syndrome, with a current focus on Diversity Matters and Cultural Competency which are bespoke sessions centred around King's and IoPPN ED&I strategies. Focusing on Race Equality, we deliver regular sessions that cover Race Equality terminology, microaggressions, white privilege and inclusive language. The Race Equality Network organises events throughout the year including Black History Month. The Black and Minority Ethnicity in Psychiatry & Psychology (BiPP) Network was co-founded by IoPPN MSc students and hosts panel discussions, talks and workshops.

ED&I-specific events focus on intersectionality. Our Inspiring Women series including interviews, e.g. with Dame Fiona Caldicott and Harriet Harman QC MP. Events in collaboration with the Women and Mental Health Special Interest Group aim to engage health professionals and the public around challenges to women's mental health. The LGBTQ+ working group also deliver initiatives and events in collaboration such as within the IoPPN's LGBTQ+ Mental Health Research Group and SLaM to deliver an annual conference (attended by 116 people in 2020) and the film *Through the Rainbow Lens* on KCL's Youtube channel. We further recognise ED&I outside of protected characteristics, for example hosting the *Class Ceilings* an event exploring the experiences of academics from working class backgrounds.

Support for parents and carers

We have developed support systems for parents and carers including parent and carer champions. We have developed an online toolkit with links to policies, processes and case studies of individuals' experiences. After noticing a low uptake of paternity and shared parental leave, we identified barriers to uptake and improved access to information. During parental leave, staff have up to 10 paid 'Keeping in Touch' Days for work-related activities without impacting pay. We further provide funding to mitigate the impact of career breaks on academic work. Staff can apply for up to £10,000 from the King's Parent and Carers Fund, which provides small grants for staff with caring responsibilities to support their research, attend networking and career-development events outside working hours. In 2018, nine individuals from IoPPN received support from the Fund.

3. Income, infrastructure and facilities

Due to its strength in interdisciplinary working and forging partnerships, the IoPPN has built a sustainable pipeline of funding that draws from diverse sources and supports researchers at all stages in their career. By embedding impact in our organisational mindset, we have achieved support for research programmes that have benefitted patients, the NHS and the public.

King's has a range of resources and facilities to enable collaboration and stimulate high-quality research. There are several internal university awards that provide pumping to strengthen our researchers' position in successfully competing for external funding. This includes support for interdisciplinary collaborations (King's Together), early career researchers (King's Prize Fellowships), early stage translational research (Challenge Fund, which yields a 10-fold return on investment), impact generation (Impact Acceleration Accounts), and commercialisation (KHP Accelerator). Our King's Together awards have supported the creation of several major grants, including the ESRC Centre for Society and Mental Health (see 1.8.13), our ESRC collaboration on student mental health (SMaRteN) and our Wellcome Trust PhD Training Programme in Neuro-Immune Interactions (see 1.8.2).

Our research capability has benefitted from significant recent investments in our IT infrastructure, research management systems and data repository offerings, to improve data access and analysis. We have enhanced our professional services support to research including Research Development, Library, Strategic Partnerships, Research Integrity and Research Platforms.

Review of our research income

The IoPPN has an average annual research income of £58.6M over this REF period. Total annual award values fluctuated between approximately £42M (2015/16) and £84M (2017/18) (Figure 2).

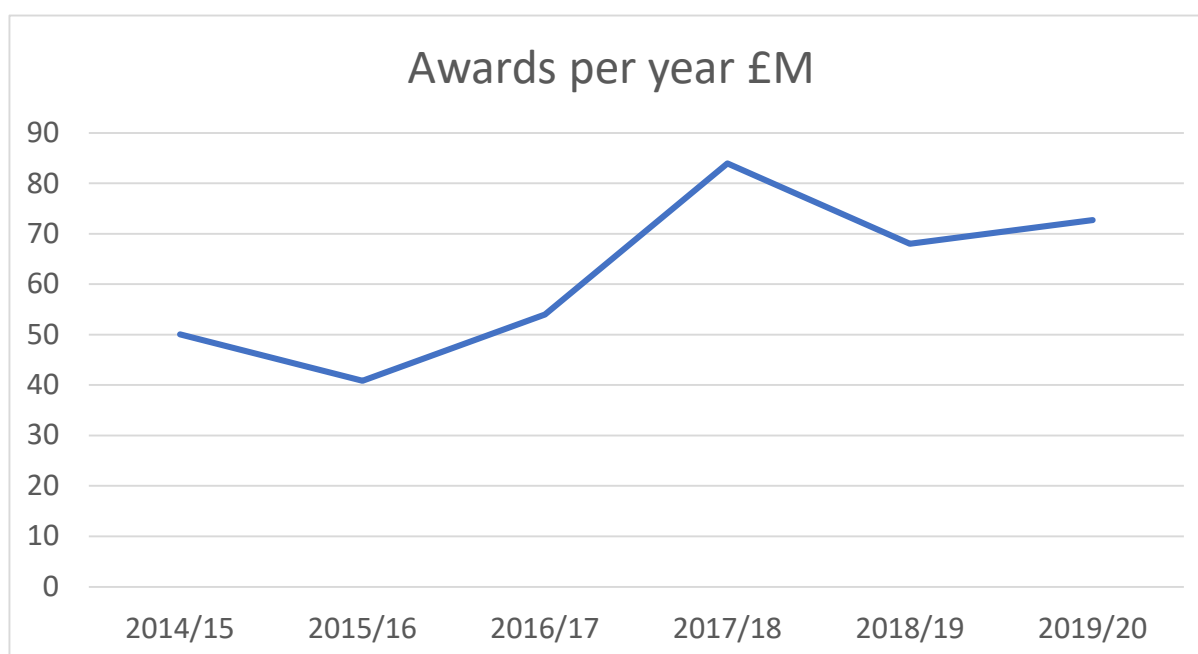


Figure 2 - new grant awards per year 2014-2020.

We have a diverse distribution of our funding sources (Figure 3). Approximately one third of our research income is from Government sources (including NIHR, but also including direct funding from DHSC, Department for International Development and Ministry of Defence). A further quarter of our funding comes from UKRI, principally MRC, and another quarter from research charities, principally Wellcome Trust. Another sizeable component (8%) comes from the EU. Our direct industry funding (7%) includes collaborations with 99 different industrial partners over this REF period ranging across pharma, biotech, digital and creative industries. To give an indication of the diversity and scale of our funding, we have over 650 active research awards, with some of the most significant described next.

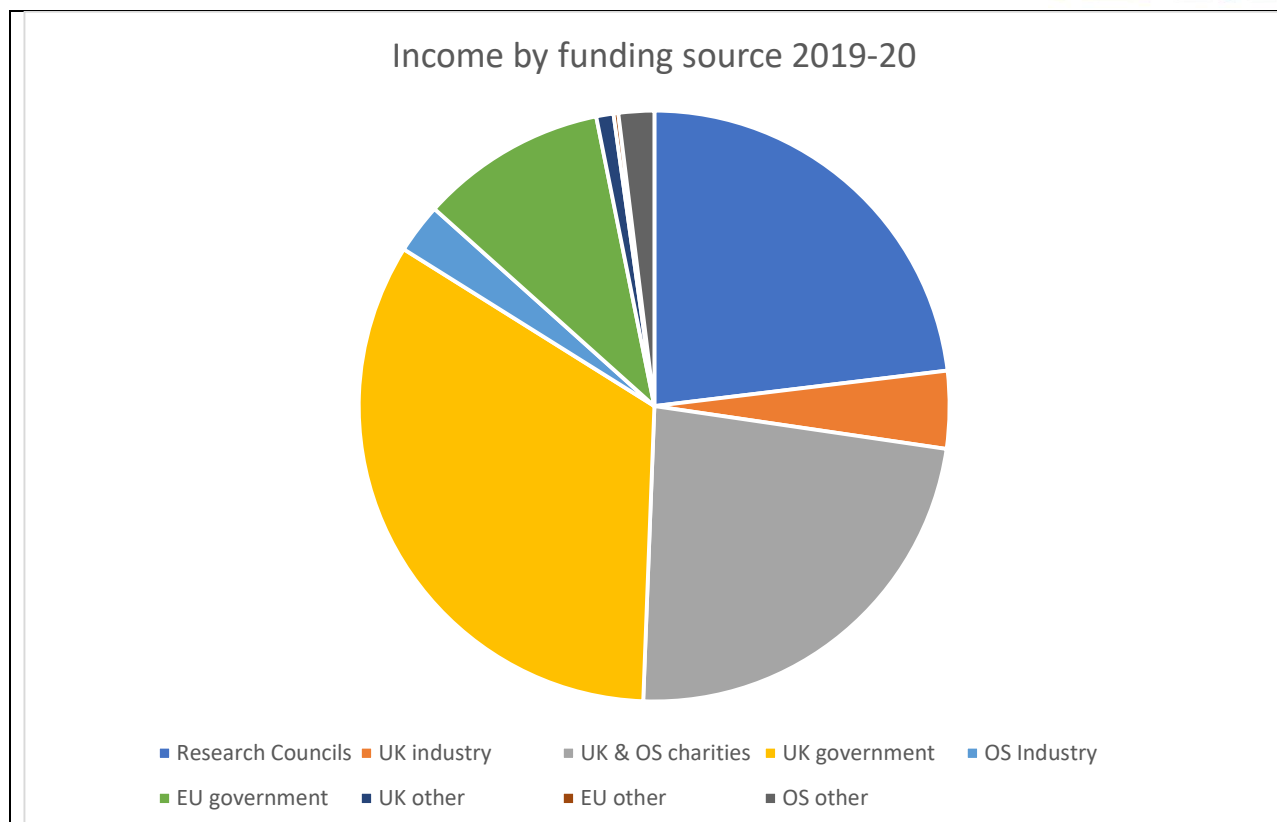


Figure 3 – income by funding source in 2019-20

Major Research Centres and Infrastructure Awards led by IoPPN:

Our research centres and infrastructure awards within this REF period demonstrate the diversity and breadth of our work, from fundamental and translational neuroscience (**MRC Centre for Neurodevelopmental Disorders (CNDD)** (Marín, £2.98M); **Dementia Research Institute Centre (DRI)** (Shaw, £15M)) through to structures enabling clinical research, including the **Maudsley-BRC** (Hotopf, £66M) and **Clinical Research Facility** (Goadsby, £4M). We also have established several Units focussed on implementation research, such as the **NIHR Applied Research Collaboration** (Thornicroft, £9M), the **NIHR Global Health Unit 'Health System Strengthening in Sub-Saharan Africa' (ASSET)** (Prince £7M) and our **NIHR Mental Health Policy Research Unit** (awarded jointly with UCL and KCL, KCL PI Simpson, £5M)). We are also substantially growing our public health research. Our new **NIHR Health Protection Research Unit (HPRU) in Emergency Preparedness and Response** (Wessely, Rubin, £4M) builds on the success of the prior unit expanding its remit to research novel technologies, preparedness and resilience in collaboration with Public Health England. The Unit and its members have been a vital research and knowledge hub during the recent pandemic (see section 1.2). Since its inception (January 2020) our **ESRC Centre for Society and Mental Health (CSMH)** (Morgan, Rose, £6.6M) has leveraged £1.4M in grant funding (£896k in COVID-focussed research).

Each major award is accompanied by significant capacity building, allowing us to develop the research leaders of the future. For example, the DRI has leveraged philanthropic funding (Van Geest Foundation) to create four van Geest intermediate career Fellowships, and ASSET funds seven PhD students and six postdoctoral fellows as well as training the health workforce in its African partner countries. We have successfully championed training at the neuroimmune interface, developing networks between immunologists, inflammation biologists, neuroscientists and mental health researchers with the successful award of the interdisciplinary '**Neuro-Immune Interactions in Health and Disease' Wellcome PhD Programme** (Taams, McMahon, Denk) which will support 30 students across five intakes (Wellcome £6.3M + £2M contribution from KCL, section 1.8.2).

Alongside our major Centres, we have seen success with large (+£1.5M) **personal funding awards**, (12 Wellcome Investigator Awards (IAs), 4 ERC Advanced, 2 ERC Consolidator, 2 NIHR

Research Professorships). These have both established the research programmes of the recipients and accelerated progress into larger programmatic work. Morgan's ERC Consolidator Award enabled him to establish the REACH cohort of 2500 secondary school children, which has since been a fundamental cornerstone of the CSMH, which he co-Directs. Equally Hatch's Wellcome (Humanities and Social Science) Investigator Award created the Tackling Inequalities and Discrimination Experiences in Health Services (TIDES) study, which delivers important studies on those most impacted by COVID-19 (see section 1.2). Marín and Rico's Investigator Awards and Advanced grants build into their Centre (CNDD) as well as their recent MRC Programme Grant. McMahon's Wellcome Investigator Award on Pain Mediators and Mechanisms drove a subsequent Wellcome Trust Strategic Award (£5M) MRC Programme grant (£2.7M), and his collaboration on European Commission grants (such as IMI-PainCare and 'Bone Pain' Training Network). Finally, two IoPPN academics (Howard and Emsley) were awarded NIHR Research Professorships. Howard has delivered significant impact through this Professorship including as Chair of panel for the NICE guidelines on antenatal and postnatal mental health (ICS Perinatal Mental Health). Emsley (section 1.8.12) is developing and implementing innovative clinical trial methodologies for mental health and, one year into his Professorship, he has developed a national Mental Health Methodology Group, and is a key Co-Investigator on the AVATAR grant, with Garety.

Since REF 2014 we have enhanced our portfolio of **externally funded fellowships** significantly, now with a portfolio of over 50 from multiple funders over this REF period. This has enabled early post-doctoral and mid/intermediate career fellows to drive their research questions and build research groups, and senior fellows to enhance their international research leadership. The awards complement our research portfolio and our Fellows range from fundamental biology (**Long**, neocortical development mechanisms, MRC, £1.4M), to underpinning risk factors for disease (**Modinos**, Stress in the pathogenesis of psychosis, Wellcome, £1.1M), through to more applied research (**Downs**, remote monitoring in ADHD, NIHR, £1.3M; **Salisbury**, improving mental health of pregnant teenagers in Africa, UKRI, £1.2M). Two new Senior Fellows (2020 awards, **Di Forti** and **McAdams**) build on their prior intermediate fellowships (one clinical and one non-clinical) and deliver research on the impact of cannabis use on mental health, and intergenerational transmission of mental health problems respectively.

Finally, we have driven a significant degree of success with collaborative programme grants. Examples include **AIMS-2-TRIALS** (Murphy, two IMI awards, €145M, sections 1.3, 1.8.5, 4). **RADAR-CNS** (Hotopf, EU IMI, €25M, section 1.8.13), the Wellcome Psychosis Flagship, **STEP** (McGuire, Wellcome, £15M, section 1.8.7), MRC Programme funding on treatment resistance and therapeutic advances (**STRATA**, MacCabe, MRC, £4M), **clinical trials employing cannabidiol** (Bhattacharyya, NIHR £1.85M, and Parkinson's UK £1.21M, section 1.8.7), **AVATAR2** (Garety, Wellcome, £3.4M, section 1.8.7) and MRC DPFS funding for a programme of work on cognitive bias interpretation modification in paranoia (Yiend, section 1.8.7). Continuing in this more applied theme, 2020 also sees the award of a £4.4M NIHR global health grant to Hoekstra for research with children with developmental disorders and their caregivers in Ethiopia and Kenya (**SPARK**). Wider explorations into arts and health (Pariante (KCL)/Fancourt (UCL), Wellcome, £2M) has created **SHAPER**, which builds on existing work between King's, UCL and arts partners (Breathe, English National Ballet) to examine the implementation of art interventions within the NHS.

Strategies for generating funding

To generate funding, we combine "top down" oversight for major calls led by the Vice Dean for Research with "bottom up" support for individual researchers to encourage academic independence and innovation. Our support mechanisms are described in section 2. Researchers have access to a database of previous successful applications.

For new major calls, we have established a system of task-and-finish oversight groups – in which research leaders across diverse methodologies are invited to maximise synergies, foster a culture of collaboration, and provide oversight and adjudication if institutional triage is required by funders. The Faculty Research Development Manager has the remit of supporting major grants and mid to senior fellowship applications and reports to the College's Director of Research Strategy and

Development who oversees the largest research applications, as well as maintaining relationships with major funders, including UKRI, NIHR and Wellcome.

Recognising the importance of industry funding, we established the **Centre for Innovative Therapeutics (C-FIT)**, directed by Mehta (see Section 4 below).

Scholarly infrastructure

Patient and public involvement (PPI) is central to our clinical research and we have invested in expertise and a network of specialised groups which support research with diverse clinical populations. Our strength in this area ensures our research is meaningful and impactful to patients and public and, at the heart of our PPI is a commitment to service user-led research. **The Service User Research Enterprise (SURE)** undertakes research that examines mental health services from the perspectives of those that use them, explores empirically and conceptually the impact of service user involvement in research (in terms of both process and outcomes), and critically interrogates how service users have changed knowledge production globally. **SURE is the largest unit within a university** to be predominantly composed of people who have both research skills and first-hand experience of mental health services and treatments. SURE develops service user researchers through graduate training and provides advice to researchers on good practice approaches to involving service users in research. We have a number of other service user and carer advisory groups including a Young People's Mental Health Advisory Group, an Addictions Service User group and FAST-R, a national service which provides rapid turn-around on patient facing materials and protocols.

We have exceptional **facilities in basic neuroscience**. In 2016 we established the **Genome Editing and Embryology Core (GEEC)** facility, to provide state-of-the art support for genome editing and transgenic projects. KCL's six **biological services units** provide expert in-vivo support for all translational animal research. We are at the forefront of **imaging research from single cells to brain networks** and have expanded our imaging facilities (Nikon centre: <https://nic.kcl.ac.uk>) to include a new centre for imaging excellence, complemented by our centre for **ultrastructural imaging** (<https://cui.kcl.ac.uk/#>) and **preclinical animal MRI facility** (<https://brain-imaging.org/>) that includes 9.4T MR and novel optogenetic fMRI technology funded by a Wellcome Equipment grant, enabling visualisation and manipulation of the nervous system from the macroscopic level, all the way through to functional neural networks. This breadth of research is complemented by access to the **Immune Monitoring Core** of the Guy's and St Thomas' NIHR BRC, providing expertise in flow cytometry, immunology and bioinformatics support.

The Maurice Wohl Clinical Neurosciences Institute (£50M) was opened by HRH The Princess Royal in June 2015 and won a RIBA London award the following year. The RIBA description stated: *'The building is an inspiring precedent for scientific research where fluidity and adaptability is needed to cater for the ever-changing requirements and technologies in the field... The building reflects and enables the most exciting and human aspects of science: care, knowledge-sharing, conviviality and the joy of discovery.'* The Wohl building consolidated our clinical neuroscience by bringing under one roof 250 researchers previously spread across three campuses. The Wohl accelerates our efforts to understand and develop treatments for patients affected by Alzheimer's disease, Parkinson's, ALS, depression, schizophrenia, epilepsy and stroke.

Our Molecular Genetics Laboratory has advanced with investments by the Maudsley Charity and the BRC-Maudsley. Our facilities provide access and research support from sample preparation to bioinformatics support. We offer DNA/RNA extraction from blood and saliva, automated blood fractionation, automated sample preparation and normalization. The laboratory is a Propel Certified Provider of Illumina's platforms and assays for genotyping, including epigenetic profiling. We support immunoassay projects via MSD assays for cytokines and chemokines, with robotics and LIMS tracking of samples. Our high-throughput genotyping platform is capable of generating GWAS data for ~2000 samples per week on a wide array of Illumina bead-chips. We support research groups studying numerous cohorts and phenotypes including

ALS, psychosis, responses to psychological therapy, antidepressant drug response, autism, ADHD and depression, and for the Human Hereditary and Health in Africa programme.

Human tissue and sample collections includes the **London Neurodegenerative Diseases Brain Bank** which provides clinically and neuropathologically well-characterised human brain and spinal cord tissue to the neuroscience community. The Brain Bank is part-funded by MRC and is shared between university and NHS (King's College Hospital). The Brain Bank includes samples from individuals with neurodegenerative and psychiatric disorders. The Brain Bank is also part of the **Brains for Dementia** initiative (funded jointly by Alzheimer's Society and Alzheimer's Research UK to support brain donation and provide brain tissue for researchers).

Our **translational research infrastructure** includes the **NIHR Wellcome King's Clinical Research Facility (CRF) (NIHR £4M)**. In 2019/20 the CRF hosted 58 experimental medicine studies in people with mental and neurological disorders, providing one of the few sites internationally where this type of research can be conducted in people with acute mental disorders and with a staffing complement including mental health nursing. Whilst awarded to SLAM it is embedded within King's College Hospital, demonstrating our close working across the AHSC.

Brain imaging is advanced through our array of MRI and PET imaging facilities. The **Centre for Neuroimaging Sciences** houses three of the latest generation MRI systems capable of performing contemporary functional, spectroscopic, anatomical and physiological mapping techniques. The **Clinical Research Facility (CRF)** contains two dedicated EEG suites and an identical 3T system for ease of methods translation to experimental medicine. In 2021, the CRF will house the **first head-only 3T MR system** designed specifically for brain imaging investigations. The Centre is leading the research and support for the **first low cost, point of care, portable MRI device** and will orchestrate the development and distribution across 20 sites in Africa, India and Pakistan. Our formal links to both Invicro and St Thomas' PET centres (2 PET-CT, a PET-MRI and a recently installed 7T MR) allows us to conduct a broad array of molecular imaging investigations.

The **King's Clinical Trials Unit (KCTU)** is registered by the UKCRC and receives funding from the NIHR. The KCTU supports academic-led trials across KHP and externally, providing expertise in statistics, health economics and provides operational support. Currently the KCTU supports 75 clinical trials in mental and neurological health.

The new SLAM-KCL **Centre for Translational Informatics (CTI)** brings together university research with NHS IT departments and industry partnerships with the goal of providing the components of a learning healthcare system. We secured funding from KCL and SLAM for £10M capital refurbishment programme and established Rosalind (£2M, local charities), a hybrid, on-premises cloud and high performance computing platform (7,500 compute cores, 60 terabytes of memory, and 5 petabytes of storage). The traditional HPC component of Rosalind enables high-throughput, large scale and big data analytics and simulation that would otherwise be computationally prohibitive, such as bioinformatics, genomic processing, physical sciences simulations, etc. The cloud platform offers a relatively new model for research computing that is particularly applicable to analytics and data platform services, e.g. for projects such as RADAR, and for development, prototyping and staging work for translational projects that interface with NHS data sources. In a collaboration between KCL's **London Medical Imaging and AI Centre for Value Based Healthcare and NVIDIA** our groups will have access to the UK's most powerful supercomputer, Cambridge-1.

The **IoPPN Library** is the largest psychiatric library in Europe. It has flexible study space, a silent study area and an assistive technology room. It provides high quality, essential support for researchers which includes over 700 electronic journals in Psychiatry, Psychology and Neurology, over 35,000 books/multimedia items, as well as rare and unique archives.

Operational infrastructure

The **Joint R&D Office for IoPPN and SLAM** supports staff of both the Institute and SLAM in delivering clinical research, ensuring that research meets all necessary ethical, contractual and regulatory standards before it can begin, working closely with partner NHS R&D Offices within KHP as well as the Research Governance, Ethics and Integrity team at KCL. The R&D Office is physically based within the IoPPN main building, allowing researchers to receive support from the staff in close proximity to other support functions. The R&D Office also manages the preparations for the REF submission to UoA4.

The Research Grants and Contracts Team provides dedicated professional service support for all King's staff with government, charity and industry research funding. The Pre-Award Team supports the submission of applications as well as formal acceptance of awards and negotiation of all funding. The Post-Award Team offers financial support, including day-to-day project management, claiming and reconciliation. The Pre- and Post-Award teams are located on each campus to facilitate interaction with academic and professional services, offer daily advice and run training sessions to share best practice. The International Research Funding Office provides both Pre- and Post-Award support for grants from the European Commission and International Funders like NIH. This specialist function is particularly important for the large multi-partner collaborative awards. The Contracts Team offer specialist expertise for direct industry funding, consultancy projects and they negotiate agreements which enable research at King's, but which do not provide income, such as material transfer agreements and non-disclosure agreements.

Since 2019, King's has deployed a new grants management system, which has improved research support and offered a more streamlined approach to grant management. Workshops and training sessions were provided during the change and a dedicated 'Help Desk' has been set up to support researchers and local departmental users as they use the new platform. Over the next year there will be further integration with core HR and finance systems, providing a better interface and enabling improved tracking of awards from inception to end.

The **King's Health Partners (KHP) Clinical Trials Office (CTO)** was established in 2007 as a joint initiative between KCL and KHP NHS trusts to formalise the pre-existing collaborations between the partners, to develop their clinical trials potential and to increase the quality and delivery of clinical trials including regulatory compliance. The KHP CTO provides a single interface for those wishing to conduct trials sponsored by the pharmaceutical industry.

Technical and support staff

Our technical and support staff community facilitates the operation of our research infrastructure. This skilled workforce, which makes up some 5% of our staff, underpins our essential laboratory and biological services, and our specialist expertise in areas as diverse as digital and advanced imaging technologies to stem cell and neuronal circuit methodologies. Our staff enable the development and maintenance of research infrastructure facilities and also include essential expertise in I.T., estates and facilities teams.

The King's Centre for Research Staff Development provides bespoke training, mentoring and career counselling for technical staff. As part of King's Professional Strengthening initiative, a number of networks have been established, which includes the Technical Services Network, bringing together our technical community to share best practice, facilitate professional development and provide peer support.

How infrastructure, facilities and expertise are used in relation to impact

Our infrastructures, facilities and expertise create a vibrant culture to deliver impact. Our **King's Strategic Vision 2029** commits to making the world a better place. We do this not only through research and education but also through recognising the importance of **international collaboration, service** to shape and transform, and by being a **civic university at the heart of London**.

Both the Maurice Wohl Institute and CRF have played important roles in work leading to the translation of basic research into the development of drugs for migraines (ICS Migraine) and HCN2 ion blockers as analgesics (see section 1.8.2). Whilst the CRF and KHP advanced therapies accelerator have facilitated research on advanced therapies for ALS, Alzheimer's and improvement of motor function following stroke (see section 1.8.3, 1.8.4 and 1.8.10). The London Neurodegenerative Diseases Brain Bank has been central in pioneering work to examine the impact of COVID-19 on the brain (see section 1.2).

By overseeing the inception and running of clinical trials, our Clinical Trials Office and Clinical Trials Unit help deliver on our translational goals and our links with industry enable final steps to be taken in the journey from bench to bedside.

Our wealth of expertise in links between physical and mental health, together with the infrastructure within KHP and the BRC-Maudsley have led to a broad range of impactful research exemplified by our impact case studies in menopause and eating disorders. The strength of our PPI initiatives, such as SURE, has helped ensure that research has real impact for real people, demonstrated by impact case studies such as Safewards and perinatal mental health.

Our Policy Institute connects researchers with policy makers and we have developed and strengthened these connections leading to impactful research such as that seen in many of our case studies, particularly in addiction (see ICS E-cigarettes and ICS Naloxone, Through the **King's Together** funding schemes we have developed collaborative programmes not only joining academics from different structures but also policy makers – for example Stevelink's programme on mental health and work links IoPPN, Policy Institute and Department of Work and Pension in developing a shared vision of research to address this important issue. Through workshops and policy labs, the **King's Policy Institute** has helped develop impact strategies for many researchers and this has built on their established expertise to produce impact in areas including our impact case studies on human trafficking, the Mental Health Act, and the Friendship Bench. Funding from the ESRC has supported the Policy Institute's **Impact Acceleration Account** which provides a route through which IoPPN researchers can access policy expertise in funded projects.

The **Centre for Global Mental Health** (joint between KCL and LSHTM) and the **King's Centre for Global Health**, alongside collaborations in international projects have yielded impact at an international policy level and King's researchers are co-developing mental health programmes with communities in Ethiopia and Nepal (ICS – Global Mental Health).

Our service strategy includes celebrating routes to impact such as collaborations with arts organisations. For example, in collaboration with the City of London Sinfonia we have created the Sound Young Minds programme which links with the Bethlem and Maudsley Hospital Schools, which educate children and young people with severe neurodevelopmental disorders (Marlow). Our work on trafficking has also involved public engagement through the art exhibition 'Modern Slavery' (ICS - Human Trafficking).

Our IoPPN **Research and Innovation Committee** (see section 2) has an Impact Subcommittee which runs events, including a conference on AI, which subsequently led to a successful King's Together award. Our annual research festival highlights impact, showcasing successful examples to colleagues and students. We enjoy close partnerships with **local charities** (the Maudsley Charity and Guys' and St Thomas' Charity) which in combination with NHS partners provide opportunities for rapid adoption of research by the local community. For example, *Cannabis and Mental Health* is a project funded by the Maudsley Charity which pilots support work by mentors with lived experience of psychosis and cannabis use for young adults suffering their first episode of psychosis and currently using cannabis.

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

Our strategy recognises that collaborations are vital to answer the many challenges in neuroscience and mental health research. We encourage the formation of interdisciplinary networks that can answer important neuroscience and mental health questions that they could not do in isolation. We enjoy wide-ranging partnerships with universities across the world. In 2014-2020 we published 5464 outputs in collaboration with other universities, representing 44% of our total outputs. Most of these collaborations occur organically, forged by individual investigators – an initiative that we have always encouraged.

Researchers in UoA4 played a major role in several high-profile strategic activities led by King's academics in UoA1:

- Neuroscience is a primary focus of the Wellcome-funded **London Collaborative Ultra-high field MR System** (7T MRI), embedded in St Thomas' Hospital; Williams (UoA4) is a co-applicant/co-director and neuroscience lead.
- IoPPN researchers are a critical part of the Innovate UK London AI Centre for Value-Based Healthcare (£10M + £16M to NHS partners), in collaboration with Siemens Healthineers, Nvidia, GSK, IBM and >10 SMEs. The Centre uses the IoPPN-led CogStack technology (Dobson, UoA4) as a core platform, and the “exemplar pathways” include neurological conditions such as headache.
- Neuroscience/neurology is one of four core themes of the Wellcome Medical Engineering Centre (£12.4M); this theme is led by Williams (UoA4).
- IoPPN academics lead the Actionable Analytics theme of the Health Data Research UK London Centre (£7M) and lead the National Text Analytics Resource Implementation Programme.

Academic Collaborations: National

KCL is a founding member of the **Francis Crick Institute** and our basic neuroscientists collaborate with Crick investigators and are establishing a reverse satellite to strengthen our computational methods (see section 1.8.1).

Commissioned by the Department of Health and Social Care through the NIHR's Policy Research Call, KCL and UCL lead the **NIHR Mental Health Policy Research Unit (£5M)**, which brings mental health researchers, clinicians, service users and carers closer together. The unit provided valuable research input to the Mental Health Act review (see ICS – Mental Health Act) and the mental health aspects of COVID-19 pandemic.

Following the 2016 NIHR BRC competition, we founded, with colleagues from across 14 centres in England, Wales and Scotland, the **Translational Research Collaboration in Mental Health (MH-TRC)**. This provides a mechanism for collaboration between NIHR and similar infrastructures in experimental medicine and early phase clinical trials in mental health and has been instrumental in providing a mental health research response to COVID-19 pandemic. The BRC-Maudsley provides 50% of the running costs. A similar **Mental Health Implementation Network** of NIHR Applied Research Centres has been created, co-led between KCL and Cambridge. KCL successfully led a collaborative grant (£1.9M, NIHR, PI: Drummond) to spearhead this work, which will identify, prioritise, implement, and evaluate mental health service improvement nationally within collaborating ARC regions.

We lead **two of the eight UKRI Mental Health Research Networks** including one on violence abuse and mental health (Howard and Oram) and another on student mental health (SMaRteN, Byron), which engages researchers with broad expertise in education, psychology, social sciences, arts and informatics to understand institutional and individual factors impacting student mental health. We participate in other such networks – e-NURTURE which explores digital technologies and children's mental health (Sonuga-Barke) and TRIUMPH, focussed on improving young people's mental health (Woodhead, project on LGBTQ+).

International Academic Collaborations

While we already have numerous, mature collaborations across Europe, the Americas and Africa, over the last 2-3 years we have made strategic investment in engaging colleagues in regions where collaborations have historically been harder to establish, in particular in Asia. To achieve this, we have invested in key senior managerial figures (including a Vice Dean for International Affairs, Dazzan, and a Director of International Business Development, Li) and prominent academics (including a Director for the **Global Mental Health Centre** – Araya). The outputs we have returned in UoA4 represent collaborations with co-authors from every continent and most countries of the world (Figure 4.)

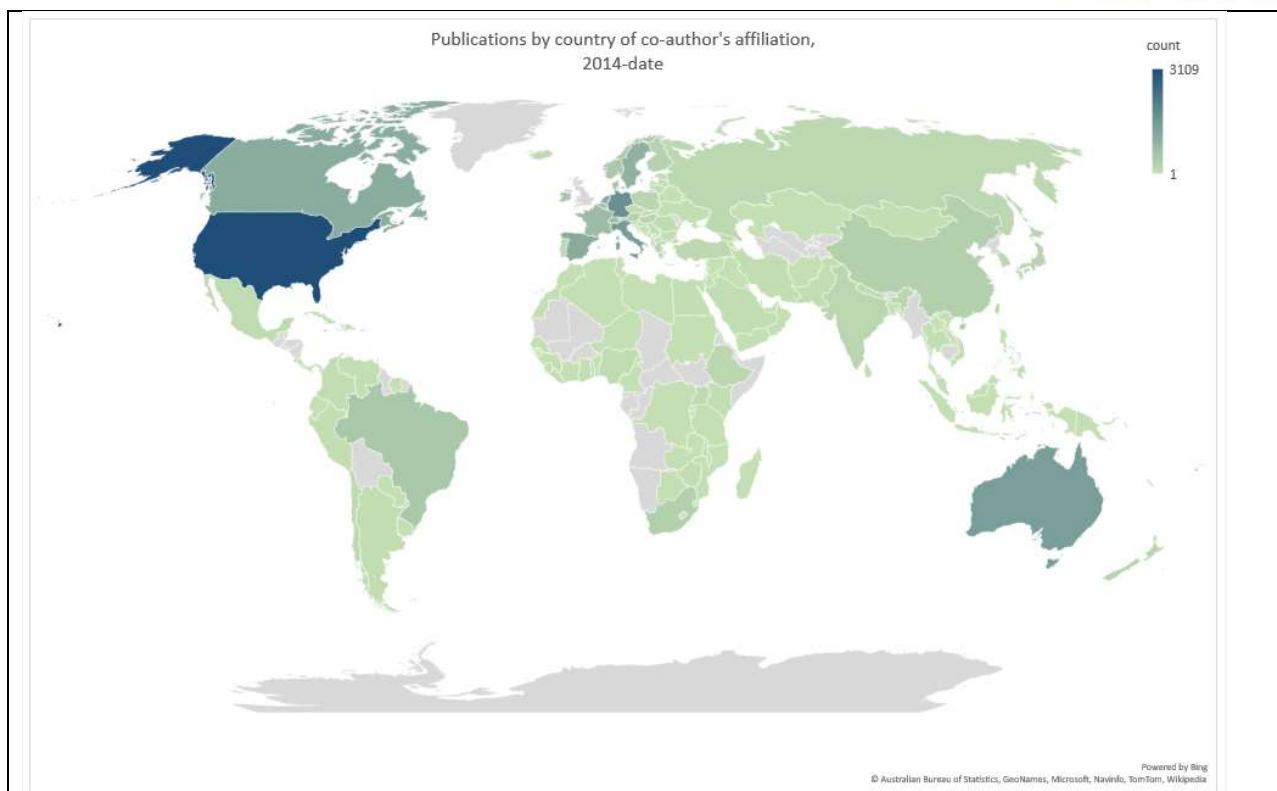


Figure 4: Publications returned within UoA4 by national affiliation of co-authors

These appointments have allowed us to join up existing, and instigate new, research, education and commercial opportunities with international partners. In **India** we have developed educational and research links involving the Institute for Stem Cell Biology and Regenerative Medicine (inStem) and the National Institute for Mental Health and Neurosciences (NIMHANS), to share expertise and build local capacity through a new research platform across clinical and basic research in neuroscience and mental health. In **Singapore**, we have developed a joint PhD programme with the National University of Singapore School of Medicine.

King's established the **King's Global Health Institute** in 2018, directed by Prince (IoPPN). The institute is a hub for many international research efforts, including an NIHR Global Health Research Unit on Health System Strengthening in Sub-Saharan Africa (NIHR, £7M). Mental health is a strong theme of the Institute, which is linked with our **Global Mental Health Centre** (joint with LSHTM) and **WHO Coordinating Centre for Research and Training in Mental Health** (Co-directed by Salisbury (UKRI Future Leader Fellow) and Hanlon (KCL employee based in Addis Ababa)), and has developed impactful resources and research, including tools-kits by which LMIC can bridge the gap between population need and clinical provision (see ICS Global Mental Health).

We collaborate on many other international partnerships seeing them as a means to further the impact and influence of our research. Examples include:

- The **ROAMER project** was funded by EU Framework 7 as a Europe-wide collaboration of research funders, academics, clinicians, service users and carers. The project developed EU research priorities (Wykes et al 2015 Lancet Psychiatry) that influenced European (Horizon 2020) and UK research funding policy, with the priorities being adopted in the NHS Five Year Forward View for Mental Health (2016), the DH Framework for Mental Health Research (2017), MRC's Strategy for Lifelong Mental Health Research (2017) and MQ's Manifesto for Young People's Mental Health (2016) and Mental Health Research Goals (2020).
- IoPPN academics play leadership roles in the **Psychiatric Genomics Consortium**, an international collaboration of over 800 international scientists from 150 universities in 40 countries, leading three of the eleven disorder working groups (Breen (Eating Disorders),

Eley (Anxiety), Lewis (Major Depression)) and making substantial advances in identifying the genetic component to these disorders.

- We participate in disease focussed consortia, for example in Amyotrophic Lateral Sclerosis (ALS). With colleagues from 64 countries across Western Europe, Russia and the Middle East we contribute to the ENCALS consortium (<https://www.encals.eu/>) through membership of the Executive Board and chairing the Award Committee (Al-Chalabi). The consortium aims to find a cure for ALS and has developed harmonized data collections, outcome measures, and an annual international conference, with an aim to support early career researchers. Impacts include development of the King's ALS Clinical Staging System, now included in international consensus clinical trials guidelines and FDA guidance.
- The transCampus initiative is a partnership between KCL and Technische Universität Dresden. The transCampus aims are: stimulating, supporting and enabling collaborations in various fields of research and exchange; promoting the sharing of resources and promoting transnational projects and knowledge transfer. The mental health group of the transCampus (<https://transcampus.eu/mental-health>) is involved in joint European (H2020) and the recent application to establish a German Centre of Excellence in Mental Health Research.

Engagement with key research users, beneficiaries and audiences to develop impact and enrich environment

Communication with potential research participants

We encourage staff to engage with potential beneficiaries of research from the design stage, enabling the testing of the relevance of a research proposal. We have an established culture of **engaging service users and patients** in the design, leadership and conduct of research. We work with charities to enable further productive interactions service users and their carers e.g. Beat Eating Disorders, McPin, Parkinson's UK and Black Thrive. In military health, we work closely with the veterans groups and the Ministry of Defence to ensure research remains relevant.

By being embedded in our local **south London communities** we deliver impact under our commitment to service. The **REACH** programme (Morgan), launched in 2015, is implemented in 14 schools in south London (ERC funded). Participating schools use mental health awareness materials for teacher delivery in PSHE classes; gain additional in-school therapy support from students at the IoPPN; and campus visits with a taster lecture.

The Wellcome Trust and ESRC funded **HERON** (Health Inequalities Network, Hatch) provides a forum for health practitioners, community leaders and researchers to share experiences and information and to work collectively towards understanding and reducing health inequalities. HERON does this through integrated research and engagement activities; advising on and supporting evaluation activities; supporting projects to use various forms of media such as art, photography, performance and podcasting. HERON has generated several widely used toolkits and resources, including RISE (Research methods In School Education) developed with local secondary school students underrepresented in psychology and health related degree programmes.

Engagement with the wider public

The IoPPN has a dedicated **Press & Communications** team comprising seven staff with expertise in research dissemination, public engagement and knowledge transfer. It creates and curates content for digital and social media channels aimed at both internal and external audiences. Approximately 60 press releases are issued per year alongside individual pitches to select media. The team works closely with the Science Media Centre to provide expert comment on new research and evolving science stories and to set up briefings for those stories which may be controversial and/or generate extensive press coverage. The success of this was evidenced in the COVID-19 pandemic when our researchers provided comment on a range of issues from mental health impact on school children to long COVID and the impact of the pandemic on our

sleep and exercise patterns. The team run campaigns on specific mental health issues, often with our NHS and charity partners, for example the promotion of a series of animated tips giving evidence-based advice on parenting during the COVID-19 pandemic, *Families Under Pressure*, which were voiced by celebrities. The Maudsley Charity webpage that hosted the videos has received 17000 unique visits and the campaign posts on loPPN social media channels achieved over 20000 impressions. Off the back of the campaign researchers wrote articles for BBC Bitesize parents' toolkit. loPPN's presence on social media has seen exponential growth, with Twitter followers increasing from 6,800 in August 2015 to 33,400 in August 2020, LinkedIn followers almost doubling in six months from 31,900 in February 2020 to 55,152 in August 2020, and Instagram and Facebook growing at a steady rate. We provide **media training** for researchers, including advice on promoting research through the media, public engagement, and other formats including events and festivals.

Beyond our professional communication team, we encourage and support academics and researchers to participate in public engagement activities. The first exhibition of the **Science Gallery** at the Guy's Campus was "*Hooked*" – a series of installations and events informed by loPPN research on addiction and a further exhibition "*On-Edge*" explored anxiety disorders – with 33k and 40k visitors respectively. The BRC-Maudsley supports Marlow, a broadcaster and researcher, as a Public Engagement Fellow. During this REF period, Marlow has produced 14 radio documentaries for BBC Radio on subjects that include young people's mental health, eating disorders and self-harm.

Public engagement is a research activity in its own right. The **Time To Change campaign**, a global anti-stigma programme, has involved loPPN researchers both delivering the message, and monitoring its impact and thereby refining future communications. The campaign was voted as one of the greatest public health achievements in the 21st century by the Royal Society for Public Health.

Working with government

Our research **impacts government policy** and includes collaborations across several government departments. In relation to COVID-19 pandemic, Rubin and Fear are members of SAGE with Rubin chairing the Independent Scientific Pandemic Insights Group on Behaviours (SPI-B) (ICS Disasters and Crises). Wessely chaired the review of the **Mental Health Act** which was informed by research from our Wellcome Trust Mental Health and Justice collaboration (Owen) the NIHR Health Policy Research Unit in Mental Health (UCL/KCL) (ICS Mental Health Act). We have a 25 year collaboration with **Ministry of Defence** which funds the Academic Centre for Military Health, in which uniformed officers are seconded to work in KCL on the King's Centre for Military Health Research cohorts and related studies (Wessely, Fear). This collaboration has fostered over 500 publications and a recent knowledge-mapping exercise listed 6 KCL researchers in the top ten in this field. Research in this area has impacted military policy and mental health support for veterans (see ICS – Military mental health).

We have recently established ground-breaking record linkages between mental health records and research data with the **Department for Education** (National Pupil Database) and the **Department for Work and Pensions** (National Benefits Database), the first of their kind in England (Downs, Stevelink). These have allowed us to explore occupational outcomes of veterans and will allow mental health outcomes of Universal Credit to be studied. A linkage has been achieved with the **Department of Justice** with military records identifying the impact of service on future offending behaviour (McManus).

Through our expertise in addiction and harm reduction Public Health England have commissioned a series of reports on e-cigarettes which have subsequently influenced policy and training for stop smoking services in the UK and abroad (see ICS E-Cigarettes).

Collaborations with Industry

Our strategic review recognised the pivotal importance of industry collaborations in research and the need to engage across a range of sectors including pharma, biotech and digital. The wider

university strategy for industry engagement is described in REF5a. King's offers a complete system from idea through to (well-funded) spinout/commercial licensing. Initial translation is supported by "impact accelerator" funding, including our King's Health Partners Challenge Fund (£1M/year, biomedical focus, 23 awards to UoA4 since 2014), alongside resources and expertise from the Maudsley-BRC, King's Policy Institute and more. King's Research Development support researchers to obtain substantive translational funding from UKRI, Wellcome and similar sources. Our IP & Licensing team provide dedicated expertise and management of IP protection, licensing/spinout and associated commercial/venture fundraising. This team also undertakes a series of activities to ensure awareness of commercialisation opportunities. The KHP Clinical Trials Office is responsible for overseeing contract negotiations and regulatory scrutiny on clinical trials of investigational products.

Strategic partnerships with leading multinational companies, spanning UoA4 and UoA1/3/5/12, including Siemens Healthineers (MRI and AI), Nvidia (AI – King's is the European Strategic partner for AI & health research), Medtronic (surgical engineering for neurosurgery), UCB Pharma (cancer, neuroscience) and GSK (functional genomics, advanced therapies). The total committed investment across these partnerships is c.£40M.

Locally, the **Centre for Innovative Therapeutics (C-FIT)** is directly focussed on the challenge of accelerating novel treatments for mental health and neurological conditions by working with industrial partners. Led by Mehta, C-FIT was established with KCL funding and the BRC-Maudsley in recognition of the importance of industry collaboration. Since 2019 it has showcased our research and infrastructure to Janssen, Roche and Boehringer Ingelheim among others, leading to a £2M collaborative grant from the latter (see 1.8.12 for details).

Successes in industry-academia collaboration include:

- **IP/Licensing: HCN2 inhibitors:** Following discovery of the role of the HCN2 channel in chronic pain by McNaughton (see section 1.8.2), King's and Wellcome licensed the resulting IP to MSD. King's and Wellcome are eligible to receive up to £263 million in development and sales milestones, as well as royalties if a drug comes to market. MSD will also fund the McNaughton lab for further research on the biological mechanisms of pain.
- **Spinout: Neurogeneus:** Based on Shaw's work to identify genes linked to amyotrophic lateral sclerosis and frontotemporal dementia and focusing on reducing accumulation/enhancing clearance of TDP-43 protein, we have set up a spin out company to deliver AAV-mediated gene therapy, using a new patented expression vector.
- **Joint Venture: Beta Therapeutics & Diagnostics:** Collaboration between KCL and SEEK Pharmaceuticals applies their technology to enhance bioavailability and biodistribution of existing compounds for use across multiple indications.

Collaborative industry grant funding Another major source of industry engagement is through established grant funding mechanisms. We have led 25% of all Innovative Medicines Initiative consortia in neuroscience and mental health. These pre-competitive public private consortia include funding from major pharmaceutical companies. We currently lead RADAR-CNS (€25M), RADAR-AD (€5M), AIMS-2-TRIALS (€115M), and PAIN-CARE (£8.9M). Our work in EU-AIMS-2-TRIALS consortium was independently audited by the EU and judged to be the 'most impactful IMI initiative'. We are further involved in the Wellcome Trust Immunopsychiatry consortium, and the Innovate UK London Medical Imaging and AI Centre. Our new Doctoral Training Programme in Data Driven Health includes 13 industrial partners who are supporting CASE (collaborative award) PhD studentships.

Indicators of wider influence, contributions to and recognition by the research base

Editorship: We encourage staff to be involved in academic peer review and editorial duties and 100 of our academic staff declared editorial activity on journals. A number are editors-in-chief of major international journals including, Noble (Acta Neuropathologica Communications), Malcangio (Neurobiology of Pain), Sonuga-Barke (Journal of Child Psychology and Psychiatry), Pariente

(Brain Behavior and Immunity), Morgan (Social Psychiatry and Psychiatric Epidemiology) and Murray (Psychological Medicine).

Participation on grants committees: Many staff members sit on, or chair, grant funding committees. Within **Wellcome Trust**, for example, eighteen individuals have played a role including on the cognitive neuroscience and mental health panel (Eley, Shergill), the Clinical and Public Health Committee (Lund), Interview Panel (Lewis), BSIC (Williams), and as an advisor on the Mental Health Strategy area (Pariante). In **UKRI**, Wessely serves on council of ESRC, Marín and Simonoff sit on the MRC Neuroscience and Mental Health Committee, Hotopf on the Multimorbidity and MRC Centres and Units Review committee, Bevan on the BMC Major Awards Committee, Dazzan and Rubia on MRC Training and Career Development Panels, and Houart on BBSRC Panel C. With **NIHR**, Brown is the Chair of the NIHR/HEE Integrated Clinical Academic Doctoral Training Panel, Emsley sits on the Clinical Trials Committee, Howard on NIHR HS&DR Panel, and Landau sits on the Advanced Fellowship panel. Members of staff have wide ranging roles in **charities**, notably Eley co-chairs the MQ fellowship panel, Wessely Chairs the Forces in Mind Trust grant committee, Richardson sits on the Epilepsy Research UK Scientific Advisory Committee. On **international funding bodies**, Steel and Pastore have both contributed to ERC, with Steel chairing the ERC Consolidators Panel.

Fellowships: Among our current staff we have 19 Fellows of the **Academy of Medical Science** (Arseneault, Caspi, Happe, Hotopf, Howes, Marín, McGuire, McMahon, McNaughton, Moffit, Murray, Pickles, Shaw, Sonuga-Barke, Steel, Strang, Thornicroft, Wessely and Williams), two fellows of the **Royal Society** (Murray, Steel), five **Fellows of the British Academy** (Caspi, Happe, Plomin, Sonuga-Barke, Pickles) three academicians of the **Academy of Social Science** (Arseneault, Moss-Morris, Wykes) and two fellows of the **American Academy of Arts and Sciences** (Plomin, Steel). We have 13 **current NIHR Senior Investigators** (Drummond, Goadsby, Hotopf, Howard, McGuire, McNeill, Pariante, Pickles, Simonoff, Schmidt, Stewart, Strang, Young) and six **emeritus/emerita NIHR Senior Investigators** (Garety, Kuipers, Murray, Thornicroft, Wessely, Wykes). Thirty academics from IoPPN were named **Clarivate Highly Cited Researchers**, according to the Highly Cited Researchers 2020 list.

Prizes: Our staff are recipients of prestigious prizes for their research during this REF period. Senior staff have been honoured with **lifetime achievement awards** including Murray (Schizophrenia International Research Society Lifetime Achievement Award for 2020); Rutter (joint winner of Pardes Humanitarian Prize in Mental Health, 2020); Plomin (BPS Lifetime Achievement Award, 2020); Treasure (Academy of Eating Disorders, 2014); Eley (James Shields Lifetime Achievement Award from the International Society for Twin Studies 2017) and Garety (British Psychological Society Professional Practice Board Lifetime Achievement Award, 2018). **Other prestigious prizes for research** include McMahon (British Neuroscience Association's Outstanding Contribution to Neuroscience, 2019); Moss-Morris (British Psychological Society Outstanding Contribution to Research 2015); Marín (Prix Roger De Spoelberch, 2014); Al-Chalabi (Sheila Essey award for ALS research, 2016); Howard (Marcé Medal for research in the field of perinatal mental health, 2014) and Wykes (EPA Constance Pascal – Helen Boyle Prize for outstanding achievement by a woman working to improve mental health care in Europe, 2020).

Leadership roles: Many of our faculty take on **leadership of professional bodies**. Wessely, the first Regius Professor of Psychiatry, was President of the Royal College of Psychiatrists 2014-17, and the first psychiatrist President of the Royal Society of Medicine. Arseneault is the ESRC Mental Health Champion. Wykes and Dazzan were elected as President and Secretary respectively of the Schizophrenia International Research Society, 2018. Steel sits on the Council of the Royal Society and serves on their Science Policy Committee and is President of the Association for Research in Otolaryngology. Holland and Denk both received Emerging Leaders awards from the Medical Research Foundation in 2020

Honours: Finally, we are proud that a number of our academics have **received honours** including Wykes (DBE), Murray, Wessely, Strang and Thornicroft (KBE), Happé, Hotopf and Scott (CBE), Rubin and Treasure (OBE).