**Institution:** University of Liverpool

Unit of Assessment: UOA4 Psychology, Psychiatry and Neuroscience

1. Unit context and structure, research, and impact strategy

1.1 Structure and Contributing Departments

UoA4 comprises **60.0FTE** staff from four institutes and seven academic departments within the Faculty of Health and Life Sciences (FHLS). FHLS is the largest of the three faculties at the University of Liverpool (UoL). Four cross cutting directorates coordinate academic strategy, investment, education, clinical interface, regulatory compliance, and PGR (**Figure 1.1; Section 3.3**).
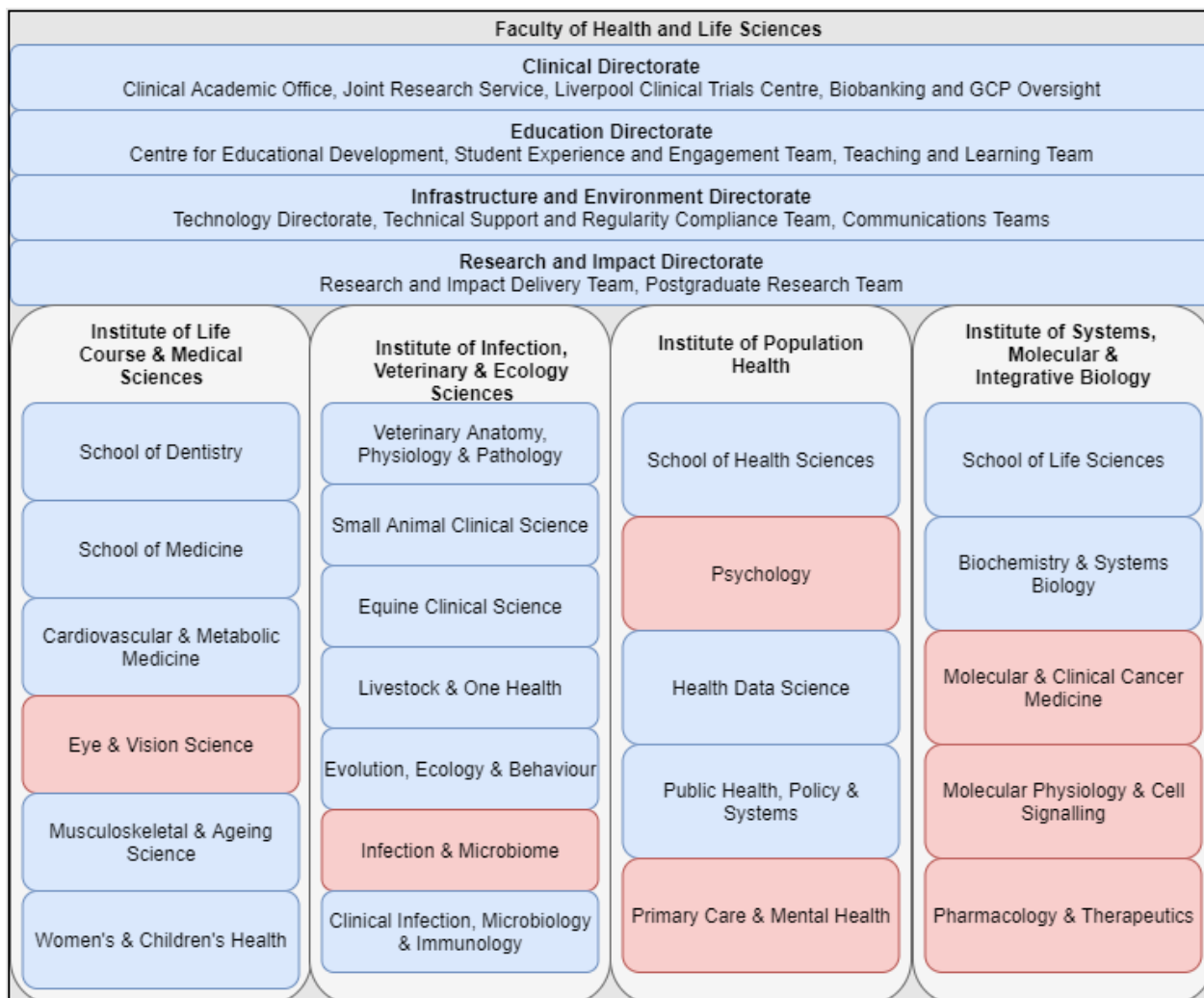
Figure 1.1 UoA4 Structure: Faculty and contributing departments (highlighted in red)

1.2 Research Groups

UoA4 research activity is organised into five interdisciplinary research groups (RG) defined around core areas of specialisation (**Table 1.1**).

REF2021

Table 1.1 UoA4 Research Groups and Core Areas of Specialisation

	Research Group		**Core Areas of Specialisation**
Psychology	Appetite, Obesity & Addiction	**RG1**	• Psychobiological and environmental determinants of eating and addictive behaviours. • Development and evaluation of interventions to tackle obesity and addiction.
	Perception, Cognition & Language	**RG2**	• Neuropsychological bases of human sensory, perceptual, and cognitive systems. • Cognitive impairment and treatment interventions in neurological populations. • Language acquisition and development in typical and atypical populations.
	Forensic, Investigative & Conflict	**RG3**	• Decision making in high risk/high uncertainty environments/critical and major incidents. • Interventions to prevent violence and sexual reoffending.
Psychiatry	Mental Health	**RG4**	• Genomic/environmental determinants of mental health: Perinatal, child and adolescent mental health. • Global mental health interventions in low- and middle-income countries and humanitarian contexts.
Neuroscience	Basic and Clinical Neuroscience	**RG5**	• Molecular, cellular, and genomic bases of central nervous system (CNS) function. • Neurodegeneration, neuropharmacology/epilepsy, neuropathy/pain, neuroinflammation/brain infection, genomics/psychiatric disorders.

1.3 Research Objectives and Achievements

1.3.1 Vitality and Sustainability: Review of Achievements against REF2014 Objectives

The 2014-2020 REF period has been transformational for our UoA4 submission.

Our main objectives in REF2014 were to:

1. Implement new initiatives to increase research income, build a diverse and sustainable funding base, and drive-up output quality.
2. Concentrate infrastructure investment, and staff recruitment, to build capacity and expertise in our core areas of research excellence.
3. Maximise opportunities for large-scale collaboration in health and security.
4. Establish centres-of-excellence around our internationally leading work in language development and mental health.
5. Ensure sustainability through investment in PGRs, ECRs and support for career development.

Our success in achieving these objectives is evidenced below ([#] refers to REF2014 objectives above):

- **Research Funding** [#1]: New initiatives for pump-priming, peer review and mentoring have helped drive up grant awards and income. **373 grants** involving UoA4 staff have been awarded with a total of **£60.2M** (equivalent to £1M per returned FTE), including 17 major awards >£1M and 151 awards >£100k. Accrued income over the period has increased substantially by 147% to £37.3M (cf. REF2014 £15.1M). We have achieved 48% overall UKRI grant application success rate compared to 26% national sector average (**Section 3**).

- **Outputs** [#1]: UoA4 staff have published 1551 peer reviewed outputs (data source: Scopus) with a total of 21,224 accumulated citations, ~13.7 citations per output (cf. REF2014 600 outputs; 4000 citations across all eligible Cat A staff, ~ 6.7 citations per output).

- **Staff Recruitment** [#2,5]: **24** (42% female) appointments across our 5 research groups, including **11 ECRs** (64% female) since 2014 (total net staff increase of 17 vs leavers). Implementation of new initiatives to support ECR career development (**Section 2**).

- **Infrastructure Investment** [#2]: UoA4 has directly benefitted from ~**£11.4M** of investment in buildings, laboratory space and equipment (including installation of a new 3T Siemens Prisma MRI scanner; **Section 3**).

- **New large-scale projects in health and security** [#3]: including coordination of the €9M, 29 partner, EU H2020 SWEET project; industry-funded £3.2M SWITCH trial; and lead roles in the N8-Agrifood programme and Liverpool Centre of Excellence for Sustainable Food Systems (**Section 1.3.2**) - facilitated by new structures to support clinical-academic collaboration including establishment of the FHLS Clinical Directorate and Liverpool Health Partners (LHP) (**Section 4**).

- **Establishment of Leading Centres of Excellence** [#4]: (i) Centre for Language and Communicative Development (LuCiD; ESRC, £3.9M – language development); (ii) Applied Research Centre North West Coast (ARC NWC; NIHR, £9M – mental and physical health); (iii) Centre of Excellence in Infectious Diseases (CEIDR) – interlinking with UoA1, brain infection, neuroinflammation (**Section 3**).

- **PGR awards** [#5]: increasing ~150% from 1.6 to 3.9 per returned FTE driven by increased external and internally funded studentships, and new PGR support initiatives (**Section 2.3**).

1.3.2 Vitality and Sustainability: Research Group Activity and Key Achievements

RG1: Appetite, Obesity & Addiction – 11.0FTE, Awards £10.4M (£945k/FTE)
Vitality and sustainability: (i) Six ECR staff appointments expanding our base of methodological expertise, including behaviour change, psychiatric epidemiology, and psychopharmacology. (ii) Major awards to support ongoing multicentre trials of appetite control and weight management (e.g., EU H2020 SWEET project and industry-funded SWITCH trial; population level interventions on obesity ERC £1.7M). (iii) Lead role in the N8-Agrifood programme and Liverpool Centre of Excellence for Sustainable Food Systems - a multidisciplinary initiative using food system science to improve health and the environment. *Methods*: Qualitative and quantitative, RCTs, behaviour change, epidemiology, psychopharmacology, brain imaging. ***Key Achievements:*** (i) Development of novel digital behaviour change interventions for alcohol use (**Jones**, *J Consult Clinical Psychol,* **Goodwin**, *JMIR Health*). (ii) Leading evidence-based UK Government policy initiatives on foods and drink marketing (invited Select Committee appearances/WHO, UNICEF). (iii) High impact epidemiological studies evidencing the complex links between trauma, alcohol, and mental health (**Goodwin**, *Br J Psychiatry*), substance use (**Gage**, *Psychological Medicine*) and obesity (**Hardman**, *JAMA Psychiatry*).

RG2: Perception, Cognition and Language – 14.0FTE, Awards £12.5M (£893k/FTE)
Vitality and sustainability: (i) £12.5M in grant awards and >£4M of new infrastructure investment in brain imaging (MRI), high density (128 channel) EEG, VR, eye tracking and upgrades to lab spaces. (ii) Establishment of the LuCiD Centre of Excellence - a multi-partner project on child language acquisition, and the development and evaluation of interventions in early years education and healthcare (ESRC, £3.9M). (iii) €1.6M Cross-Linguistic Acquisition of Sentence Structure Programme (ERC Consolidator Grant). *Methods*: Psychophysics, EEG, eye tracking, brain imaging (e.g., fMRI, DTI, fNIRS), brain stimulation, auditory/acoustic analyses, VR, clinical neuropsychology; computational modelling. *Key Achievements:* (i) Novel multi-methods work combining high-density ERPs, fMRI, and eye movement patterns to elucidate high-level human vision (**Leek**; *JEP: HPP; QJEP*). (ii) Establishment of key components of core vision assessments for stroke patients (**Rowe**; *BMJ Open; Plos One*) and rehabilitation techniques based on brain plasticity demonstrated using structural and functional neuroimaging (**Meyer**, **Rowe**; *NeuroImage*) (iii) Novel insights using corpus analytic, elicitation and computational modelling techniques into morphological and grammatical development (**Ambridge**, **Pine**, *Cognitive Psychology*; **Pine**, *Cognition*). (iv) Discovery of key links between statistical learning, lexical processing efficiency and word learning in infants and toddlers (**Lany**, *Developmental Science*).

RG3: Forensic, Investigative and Conflict Psychology – 4.0FTE (Psychology core staff), Awards £4.4M (£1.1M/FTE)
Vitality and sustainability: (i) An applied group within psychology including the National Unit for Critical Incident Decision Making and research arm of the HYDRA Foundation coordinating 85 critical incident immersive scenario training sites globally. RG3 links psychology with staff across engineering, computer science and the humanities through the UoL Institute for Risk and Uncertainty. (ii) £4.4M in grant awards and diverse portfolio of ongoing projects including: Wellcome Trust and ESRC (£315k, Interventions to prevent violence and sexual reoffending); EU, Home Office, College of Policing, National Crime Agency, and Europol (£650k, Development of risk management tools for law enforcement agencies); DSTL, US Army Research Laboratory, and FBI (£1.44M, Tools for decision making, communication and rapport-based interrogation). *Methods*: Qualitative and quantitative, working in partnership with agencies nationally and internationally and drawing on unique access to complex field data in extreme environments to identify what works in practice. *Key Achievements*: (i) Development of a risk management tool supporting the prioritisation of offenders accessing indecent images of children, now used in 24 countries (**Alison**; *Psychology, Public Policy and Law*). (ii) Development of rapport-based interviewing techniques to assist in securing vital intelligence to counter terrorism threats, and tools to improve multi-agency emergency responses (**Alison**, **Waring**, **Cole**; *Org Psy Rev)*. (iii) Project ARES providing resilience training to frontline NHS staff during the COVID-19 pandemic (**Alison**).

RG4: Mental Health – 14.0FTE, Awards £13.7M (£979k/FTE)
Vitality and sustainability: (i) £13.7M of grant awards including extension of the Wirral Child Health Programme (MRC GCRF 2019-2024; £2.59M), C-GULL longitudinal birth cohort project (£5.2M, Wellcome Trust 2020-2025 – see **Section 3**), new 5-year programme to develop and evaluate mental health interventions in Pakistan and South East Asia (NIH, $2.5M; ENHANCE, NIHR £3M), RE-DEFINE and COSTAR programmes to develop and implement interventions for mental health in refugees and asylum seekers (ERC H2020 €2.9M; ESRC/GCRF £1.1M). (ii) Launch of the new Department of Primary Care and Mental Health to heighten visibility and provide a platform for future investment to support our strategic priorities in mental health (**Figure 1.2**). (iii) Collaborative interface with NHS enhanced by the launch of ARC NWC (NIHR, £9M), and newly established North West Coast Mental Health Research Network (**Sections 3-4**). *Methods*: RCTs, qualitative and quantitative. *Key Achievements:* (i) Discovery of key sex differentiated pathways to specific mental health outcomes in childhood (e.g., **Sharp**, *Dev & Psychopath*). (ii) Major RCT showing that self-help strategies in antenatal provision without professional support are insufficient and should not be routinely introduced (**Slade**, *BJOG*). (iii) Novel intervention RCTs for depression and anxiety in women in post-conflict settings, and lay health worker intervention in India (**Rahman**, *Lancet, JAMA*). (iv) Novel intervention RCT to reduce distress in South Sudanese refugees in Northern Uganda (White, *Lancet Global Health*).

RG5: Basic and Clinical Neuroscience – 17.0FTE, Awards £19.1M (£1.1M/FTE) *Vitality and sustainability*: (i) £19.1M in grant income including Core support for UK based Cochrane Collaborative Review Groups: Epilepsy (£1.18M, **Marson**); Protein Homeostasis and the Ubiquitination pathway in Parkinson's disease (£830k, **Clague**); Covid-Clinical Neuroscience Study (£2.3M, **Michael**, **Solomon**, **Leek**). (ii) Core expertise across sub-groups in neurodegeneration, neuropharmacology/epilepsy (Liverpool Epilepsy Research Group), neuroinflammation and neurological consequences of viral brain infection (Liverpool Brain Infections Group/CEIDR), pain/neuropathy (Walton Pain Research Institute) and Genomic x Environmental determinants of psychiatric illness. **Methods:** 'Omics' approaches, animal models (e.g., mice, Drosophila, C. elegans), cell signaling, neuropharmacology, neuroimaging, RCTs. *Key Achievements*: (i) Identification of gene targets and pathways mediating neurodegeneration in PD and MND (**Quinn**, *Nature Genetics, Lancet Neurology*), and characterisation of the MIR137 gene in schizophrenia (**Quinn**, *Schizophr Bull*). (ii) High impact work across UoA1/UoA4 on neurological sequalae of viral brain infection; *Liverpool/KCL lead on* COVID-CNS consortia; COVID-Neuro Global Programme (NIHR £800k); UoL coordination of the NIHR Global Health Research Group on Brain Infections. (iii) Discovery of novel forms of therapeutic intervention for neurodegenerative illness including preclinical models of TMEM106B in mice (**Stagi**, *Neuron*), ethosuximide in C. elegans (**Morgan**, *Mol Neurodegen*), mitophagy and Tau in Drosophila (**Clague**, *JCB*), mechanism of ebselen action on the MND target SOD1 (**Hasnain**, *Nature Comm*). (iv) Breakthrough studies elucidating the causes of sensory hypersensitivity in fibromyalgia (**Goebel**, *Nature*). (v) RCTs in antiepileptic drug prescribing, examining the clinical, quality of life and cost-effectiveness of current and new antiepileptic drugs (**Marson**, *Epilepsia*).

1.4 Future Plans: Objectives and Strategic Priorities

Our **objectives** over the **next REF period** are to:

1. Support the University of Liverpool research and impact strategy (**REF5a**), and maximise our contribution to regional, national, and global priorities.
2. Ensure that staff recruitment and infrastructure investment is strategically driven and underpinned by clearly defined research and impact priorities.
3. Promote interdisciplinary working on cross-cutting grand challenges that link research groups, staff across UoAs, and facilitate unit cohesion around shared objectives.
4. Foster a fair, inclusive, and supportive academic environment for all staff at *every career stage,* and to ensure that equality, diversity, and inclusivity remain at the heart of our culture.

Achievement of these objectives is underpinned by our five-year **research and impact strategy** which has been developed by UoA4 staff around **six** cross-cutting strategic priorities (**Figure 1.2**) to (i) align with our core areas of expertise; (ii) address regional, national, and global priorities; (iii) maximise opportunities to bring about step changes in knowledge and impact from collaborative working across research groups and UoAs. Our strategy aligns with UoL interdisciplinary themes in: **Starting Well, Living Well and Ageing Well** - addressing grand challenges in health and security through our work in obesity, addiction, mental health, child development, public safety/critical incident management and clinical neuroscience; and **Digital** - maximising opportunities to deliver societal, health and economic benefits through technological innovation and impact (**REF5a**).
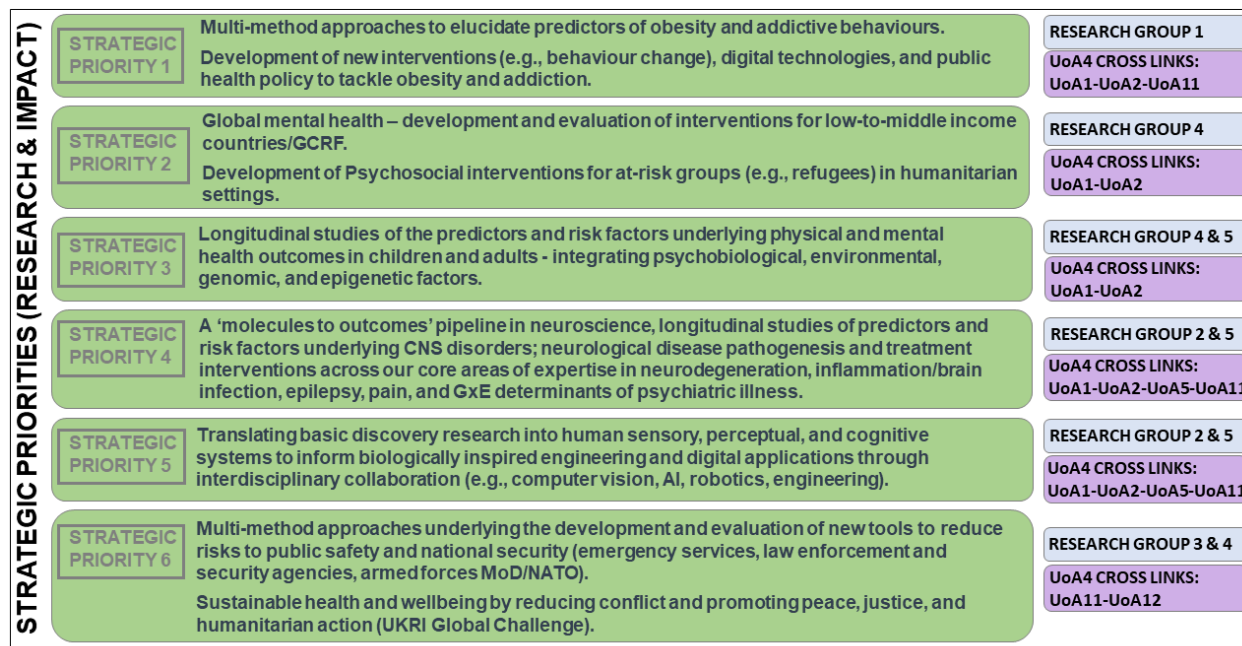
Figure 1.2 Summary of UoA4 forward strategic priorities, research groups and UoA4 interdisciplinary cross-links.

1.5 Impact Strategy

Impact is embedded in our research priorities (**Section 1.4**) and lies at the heart of the Faculty and University mission (**REF5a**). Our strategy is based around provision of a fully supported impact pipeline from concept formation to development and delivery (**Figure 1.3**). This pipeline is coordinated by the Faculty Research and Impact Directorate at each stage through a range of initiatives and support services, that provide guidance on partnerships, PPI, funding, IP, legal governance, outreach, and public engagement. UoA4 directly benefits from a range of initiatives including:

- Provision of internally funded awards to support impact development: (i) Knowledge Exchange and Impact Vouchers (FHLS funded; UoA4 £45k). (ii) Enterprise Investment Fund (FHLS funded; UoA4 £15k). (iii) Translational Research Access Programme (TRAP) – promotes collaborative translational research across UoL and its associated healthcare community to address health inequality across the Liverpool City region (FHLS funded £600k pa; UoA4 £162k; jointly funded by the Wellcome Trust from 2021).
- Externally funded Impact Accelerator Awards (UKRI funded; UoA4 £45k) supporting impact delivery to external organisations and the wider economy including charities, industry, and regional development agencies.
- Raising awareness and offering case development feedback and guidance through the FHLS monthly 'Impact Matters' seminar series and UoL 'Making an Impact' workshops.
- Appointment of academic impact leads to coordinate, and support, impact development at departmental level.
- Dedicated Faculty Impact Officers (4.0FTE) supporting impact development across the pipeline.
- Recognition of impact-related activity in our workload allocation model, annual personal development reviews (PDR), and promotion structures.
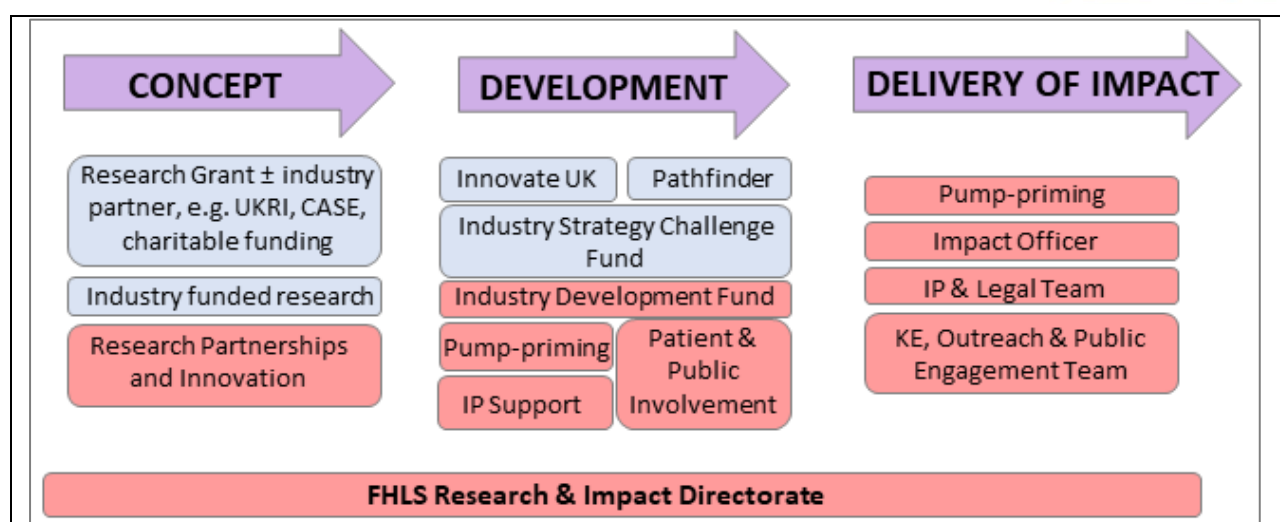
Figure 1.3 Impact pipeline from concept and development to delivery. UoL support schemes shown in red.

UoA4 impact development was directly supported by 15 months of Impact Officer time and £56k of pump-priming invested in our five cases (**Table 1.2**). The success of our impact strategy is evidenced by our broad portfolio of submitted impact case studies spanning four out of five research groups, the broad base of external partnerships, and by our strong and diverse portfolio of ongoing translational projects at different stages of development.

Table 1.2 Impact Cases and their associated internal support 2014-2020. PP: Pump-priming. IO: Impact Officer Time (months). RG = Research Group (**Table 1.1**)

Research Group	Impact Case	PP	IO	Examples of Partnership
RG1	Unhealthy food advertising to children (Boyland; UoL52Foodadvertising)	£9k	3	UK Government, Obesity Health Alliance, Cancer Research UK
RG2	Post stroke visual impairment (Rowe; UoL81StrokeVision)	£11.9k	4	NHS, NICE, Royal College of Physicians, British and Irish Orthoptic Society, Scottish Intercollegiate Guidelines Network
RG3	Prioritising Indecent Image Offenders to Prevent the Sexual Abuse of Children (Alison; UoL61Indecent images)	£7.7k	2	National Crime Agency, Home Office, College of Policing, Europol
RG3	Decision making and communication in critical and major incidents (Alison and Waring; UoL62Decisionmaking)	£14.8k	3	FBI, CIA, Department of Defence, Joint Forces Intelligence Group, Home Office, Public Health England, Metropolitan Police Service, National Fire Chiefs Council
RG4	Overcoming the treatment gap in perinatal depression in LMI (Rahman; UoL51DepressionLMIC)	£13k	3	WHO, Ministry of National Health Services (Pakistan)

1.6 Support for Interdisciplinary Research

UoA4 is strongly interdisciplinary:

(i) Interdisciplinarity is embedded in our strategic priorities (**Section 1.4**) and reflected in the wide diversity of interdisciplinary collaborations on outputs (**Section 4.1**).

(ii) Collaboration across groups is facilitated by a broad base of methodological expertise, access to state-of-the-art research facilities, technical support, and internal pump-priming schemes (**Section 3.4**; **Section 4.1.2**)

(iii) A strongly embedded regional environment for clinical-academic collaboration is facilitated both by the Faculty Directorates and Liverpool Health Partners (**Section 4.1.2**; and **Figure 4.5**).

(iv) Our interdisciplinary strategic priorities in digital technology (**Figure 1.2, Strategic Priorities 1, 5-6**) are supported by close links with the Liverpool Institute for Risk and Uncertainty (LIRU), Virtual Engineering Centre (VEC), Digital Innovation Facility (DIF), and the cross-Faculty Liverpool Centre of Excellence for Sustainable Food Systems (**Section 4.1.3**).

(v) Unit cohesion and vitality is supported by regular seminars and technical workshops publicised across departments, and broad staff involvement in local collaborative networks including the North West Coast Mental Health Research Network and the Liverpool Neuroscience Network (**Sections 3-4**).

1.7 Open Research Environment

We are committed to an Open Access (OA) environment. UoA4 delivers on the UoL OA Publication Policy (**REF5a, Section 2.5**) - author accepted manuscripts and gold OA papers are deposited to the UoL repository within 3 months of acceptance. OA costs are supported by a UKRI Block Grant (UoA4 £229k for 156 articles since 2014). Staff are encouraged to place pre-prints and underpinning data in appropriate repositories (eg., bioRxiv) and an Institutional Repository is provided to facilitate open access to articles, databases, and other outputs. UoA4 subscribes to the University Research Data Management policy, showing our commitment to maintaining the highest standards of rigour and integrity in research. All UoA4 Principal Investigators with UKRI grants complete data management plans (DMP) prior to the commencement of research projects.

1.8 Research Governance and Integrity

We maintain exceptional standards of rigour and integrity in research. UoL follows the Concordat to Research Integrity and is one of the first members of the UK Reproducibility Network (UKRN). All research is subject to the UoL Research Data Management Policy that requires that data storage meets GDPR, governance and ethical standards. FHLS has a robust system of ethics governance overseen by the Faculty Research and Impact Directorate. UoL provides online research ethics and integrity training by the Epigeum Consortium, and this is mandatory for all academics, research staff, and PGR students. All projects involving clinical populations are subject to NHS REC approval. Research involving human participants must confirm to the ethical guidelines of the British Psychological Society and Declaration of Helsinki.

2. People

2.1 Staffing Strategy and Staff Development

2.1.1 Staffing Strategy Overview

We recognise that people are our most important asset, which is reflected in our strategy *to foster a fair, inclusive, and supportive research environment for all staff and students at every career stage,* underpinned by core values of transparency, diversity, and equality (for UoA4 staff demographic profiles (**Section 2.4.1**).

2.1.2 Recruitment, Retention and Succession Planning

Our approach to recruitment is guided by our research and impact strategy (**Section 1**) which is used to target appointments to priority areas. Equality, Diversity, and Inclusivity are embedded at all stages in our planning, recruitment, and staff development structures (**Section 2.4**), and we are committed to supporting ECR appointment (**Section 2.1.3**), and staff career development across all academic grades (**Section 2.2**). To support vitality and sustainability we appointed 24 new academic staff over the REF period (42% female), including 11 ECRs and 2 strategic Professorial appointments (Leek - Cognitive Neuroscience, Poptani - Pre-Clinical Imaging). New appointees comprise 40% of the total Cat1A staff FTE, and represent a net staff increase of 17 new staff vs leavers since 2014. Retention is underpinned by state-of-the-art research facilities (**Section 3.4**), an inclusive and supportive working environment, staff development structures (**Section 2.2.1**), and transparent criterion-based processes for promotion (**Section 2.2.2**). Succession planning is achieved by ensuring that staff are provided with opportunities to acquire research, administrative and leadership skills, through a range of mechanisms including senior academic mentoring within research groups, the PDR process, and professional development training provided by the University of Liverpool Staff Development Academy (**Section 2.2.3; REF5a).**

2.1.3 Support for New Staff and Early Career Researchers (ECRs)

We recognise the importance of ECRs to the vitality and sustainability of the discipline. Our staffing policy is fully aligned with the **Concordat to Support the Career Development of Researchers (Section 2.2.3)**. Its success is evidenced by the upward career trajectory of our 13 returned ECRs who have gained external grant awards totalling £4.5M (~£350k/FTE), and generated ~300 outputs. We recognise fellowships as an important route of support for our most promising ECRs and have adopted the Tenure Track Fellowship (TTF) Scheme. TTFs are five-year appointments (3+2) with formal review in Year 3 to assess progress. A further two years of salary funding is available to provide further development opportunities towards tenure post Year 5. During the REF period UoA4 has appointed six ECRs under the TTF scheme, three of whom have already progressed to tenure. Two examples are presented below. Other strategies to retain and recruit promising ECRs include career development and mentoring schemes, preferential allocation of PGR students and travel funds, as well as pump-priming.

UoA4 ECR Case Study 1: Eric Robinson (PhD 2011)

Eric was appointed on a Wellcome Trust ISSF Tenure Track Research Fellowship. He quickly established a successful research programme investigating psychological influences on eating behaviour (>100 papers). He was awarded a prestigious ESRC Future Leaders Award (£260k), and MRC New Investigator Grant Award (£537k), and several accolades including the Outstanding New Faculty Award (World Obesity Federation). Eric secured tenure and was promoted to Senior Lecturer in 2016. In 2019, Eric was awarded an ERC Starter Grant (£1.7M) and promoted to Reader.

UoA4 ECR Case Study 2: Suzi Gage (PhD 2015)

Appointed in 2017, Suzi developed a successful research programme on drug use and addiction including >40 papers and a book ('Say Why to Drugs', 2020). Following major grant awards (e.g., Cancer Research UK, £174k) Suzi was awarded a Wellcome Trust Engagement Fellowship in 2019. She has an outstanding track record of wider engagement, including public events on drug use (e.g., Royal Institution, London; Bristol March for Science), and her own science blog 'Sifting the Evidence' (>3.6M views between 2014-2018). Suzi received the University Staff Award for 'Outstanding Contribution to Public Engagement' (2018), and the AAAS ECR Award for Public Engagement (2017). She was promoted to Senior Lecturer in 2019.

Other specific schemes to support ECRs (including PDRAs) include:
- ECR leadership network: a community forum offered by each department, where ECRs and senior academics come together.
- ECRs, PDRAs and new staff are embedded in a core research group coordinated by a senior member of staff to provide mentorship, support, advice on grant funding and publication strategies: 25% of research staff (in FHLS) are currently engaging with the UoL Mentoring Scheme of which 72% are ECRs; 615 outputs with PDRAs have been published over the REF period in UoA4, 24.5% with a PDRA first author.
- ECRs benefit from reduced teaching and administrative workloads in the 1st year of appointment.
- Internal funding support (£2k/pa x 3 years) for ECRs and new staff to facilitate lab set-up, travel, and networking (other internal pump-priming schemes are also available (**Section 3**).
- Development of a Professional Development Plan with their mentors.
- PDRA career development is supported by PROSPER, a unique UoL initiative (£4.4M UKRI RED Fund, see **REF5a**).
- One-day Annual Research Conference in FHLS (44% increase in attendance in 2019 compared to 2018).

2.2 Staff Development, Promotion and Recognition

2.2.1 Academic Staff Development

We recognise the importance of supporting staff development across all academic grades. All staff complete an annual Professional Development Review (PDR), which is undertaken with a senior colleague. All PDR reviewers undergo formal training, and work with mentees to develop an annual development plan, and to identify support requirements. Its success is evidenced by the high level of staff engagement: PDR completion rates for UoA4 staff are >90% across all staff groups. Support can take a variety of forms including ensuring an appropriate workload balance is maintained (which allows for a 70:30 split between research and teaching for T&R staff), allowing for temporary reductions in normal teaching and administrative loads to provide additional time for preparing grant applications or completing major projects, and access to internal funds to support training, development, and networking events. Staff development is also supported centrally through the Academy (**REF5a**) who provide a broad range of academic development training programmes to support career progression.

2.2.2 Clinical-Academic Staff Development

The Clinical Directorate coordinates training and career development for clinical academic and research staff (UoA4 = 8FTE). Delivery is facilitated by the Liverpool Integrated Clinical Academic Training (ICAT) team overseen by the recently appointed Director: Paul May. ICAT is based on a joint strategy developed by the University and key stakeholders including NIHR, Health Education England Northwest and NHS Teaching Trusts and focuses on academic foundation training, academic clinical fellows (ACFs), clinical PhDs and academic clinical lecturers (ACLs, who must hold a PhD on appointment). Specific support and mentoring are provided for each stage and progress is reviewed annually via academic and subsequent formal Annual Review of Competency Progression (ARCP). The academic ARCP that we have developed is considered an exemplar by Health Education England and is now being trialled in other locations. Clinical lecturers receive specific support through protected academic time and association with a successful research group that is overseen by the ICAT programme. Having identified the retention of talented ACLs to senior clinical academic posts as a priority, we have established a new post-CCT clinical fellowship scheme where the University and NHS co-fund fixed term (three-year) senior clinical fellowships. These fellowships are competitively offered at Consultant level to ACLs who are nearing completion of clinical training, and aim to support the development of externally funded, intermediate-level clinical fellowships that are precursors to applying for tenure.

2.2.3 Technical Staff Development

UoL is a signatory to the Science Council's Technician Commitment that ensures greater visibility, recognition, career development and sustainability for technicians across all disciplines. The University has secured £25K for professional registration and training/development costs to support career development of UoL technicians and formal professional accreditation with the Science Council (Concordat Principles 3, 4, 5). This has been matched with a further £15K from FHLS. We are introducing a Research Scientist and Technologist Pathway to support the development of academic-related staff that manage our specialised research infrastructure and provide the data science capabilities that contribute to UoA4 activity, as well as providing a recognised pathway for career advancement. We have also developed a technical skills matrix that defines roles and drives training and development, upskilling our technical workforce and future proofing by identifying potential imminent skills gaps.

2.2.4 Promotion and Recognition

Promotion is criterion-based, accounting for contributions to research, teaching, and administration. To ensure fairness, consistency and transparency, applications are considered initially by an Institute senior academic management group comprising the Deans and Heads of Department. Supported applications up to Grade 9 are assessed internally at Faculty level. Grade 10 (Reader/Professor) applications are assessed at the University Promotion Panel chaired by the VC. External evaluations are obtained in all cases from three independent referees. 48% of successful promotions (21 out of 44 in total) during the REF period were awarded to female staff, with some staff receiving more than one promotion (39% of UoA4 staff overall are female). Recognition of staff contributions is also achieved by the Annual University Staff Awards which includes specific categories for 'Outstanding Contribution to Public Engagement', 'Research Impact of the Year', and 'Early Career Researcher of the Year'. Awards are presented by the VC at an annual all-staff formal dinner event funded by UoL. Staff contributions are also acknowledged in weekly departmental and institute-level newsletters and bulletins, and via departmental, and University news and social media platforms.

2.2.5 Implementation of the Concordat to Support the Career Development of Researchers

UoL was awarded an HR Excellence in Research Award (2020) which reflects our commitment to the Concordat for supporting researchers, improving working conditions and career development opportunities. Strong leadership is key to the success of our strategy, which we obtain through the validated University Leadership Framework Programme undertaken by all Department and Institute Heads, helping them to manage effective teaching and research, mentorship, and staff appraisal, and to ensure equality in workload allocation (Concordat Principles 2-4, 6). Additional mentoring is available to all staff via the University Mentoring Network, comprising 457 FHLS staff.

Targeted support for junior and fixed-term staff is provided via the Career Coaching Scheme which gives access to mentors with subject-specific experience (Concordat Principles 3-5).

2.2.6 Research Leaves and Sabbaticals

Staff applications for sabbaticals to support research activity are accommodated where possible, in line with University's Academic Research and Leave of Absence policy. As part of which staff benefit from flexible employment arrangements for research engagement activities.

2.2.7 Exchanges between academia and business, industry, or public sector bodies.

Exchanges with non-academic partners are supported by the Knowledge Exchange and Impact Voucher Scheme (KE&I), Impact Acceleration Funds (IAA), and Knowledge Transfer Projects (KTP) that fund a postgraduate academic research associate to work in a company for a short period. Two of our TTFs were co-funded by industry (**Section 4.2.2**.).

2.2.8 Recognition and Reward for Impact

Our strategy for impact development support is described in **Section 1.5**. In addition, the value of impact contributions is formally acknowledged and rewarded in a variety of ways including through explicit recognition of impact contribution in staff promotion criteria, workload allocation, and events such as the Impact Matters Series (Section 1.3.1) and Annual UoL Staff Awards (**Section 2.2.2**)

2.3 Research Students

2.3.1 Recruitment

Over the current REF period, UoA4 registered 169.8FTE PGR students (167.2FTE PhD, 0.25FTE MD, 2.35FTE MPhil), comprising 63% female, 6% identifying as having a disability, and 36 nationalities. 60% of our current PGR cohort are externally funded. Funders include: Wellcome Trust (11.25FTE), BBSRC (3.75 FTE), ESRC (18.45FTE), MRC (8.4FTE), EPSRC (2.3FTE), NHS (1.55FTE), charities (16.55FTE), Horizon 2020 Marie Slodowska-Curie Innovative Training Network (0.5FTE). 12.35FTE high-quality students have been recruited via the ESRC North West Doctoral Training Centre (NWDTC). Internally funded studentships are also awarded (e.g., via 0.5FTE demonstrator posts, 28FTE - **Section 2.2.5**). To sustain and grow our research groups IPH provides match-funding of studentships. In the REF Period, we have provided £707k in PGR fees (85 students), and £893k in stipends (35 students).

2.3.2 PGR Research Environment and Culture

PGR students are integrated into a vibrant and supportive research environment. We foster a strong and integrated PGR culture by embedding all students within a research group (**Table 1.1**). Students are given diverse opportunities to participate in academic life including: the annual PGR conference, Institute PGR research and poster days, presentations at journal clubs and research group lab meetings. Presentations at national and international conferences are encouraged and funded through bench fees and competitive bursaries. Over the current REF period 1027 outputs have been published with a PGR author (~3 per registered student; 32% as first author). PGRs are involved in outreach activities including "Meet the Scientist" and "The Green Man Festival" (**Section 4**). These events provide networking opportunities with other researchers and help students develop communication skills.

The Liverpool Doctoral College (LDC - see **REF5a; Section 3.5**) coordinates University doctoral training and development. Student progress is monitored through the PGR Development Programme, with all students attending at least one supervision meeting per month - overseen by the departmental PGR leads and Director of Postgraduate studies. Further progress monitoring and feedback is provided through the annual Independent Progress Assessment Panel (IPAP), comprising two senior academic staff. All supervisors have been trained through the Academy. We also offer a Buddy Scheme, which matches new students with those in the second year of their research degree, providing additional support and guidance from the student perspective. PGR students are also supported by a comprehensive training package of both generic and subject specific skills provided by the PGR development team, host department and the DTCs.

Our ESRC NWDTC pools expertise across three north west Universities in relevant disciplines, and students have access to a range of specialist modules and receive 'hands-on' methods training. Career guidance is delivered via the LDC, the host department EDI teams, and the student's research group.

2.3.3 Successful Completion

Within UoA4 the vitality of our environment and PGR support is evidenced by the PGR completion rate, which has increased ~150% from 1.6 (REF2014) to 3.9 per returned staff FTE. During the current REF period 243.6FTE (264 students) PhDs have been awarded, a substantial increase in numbers since 2014 (**Figure 1.4**) which partly reflects the unit's access to a wider range of doctoral training centres compared to 2014.This sustained growth also demonstrates the success of our PGR strategy, especially our increased success with UKRI doctoral training partnerships (DTPs) and reflects the strength of our recruitment strategy, our focus on PhD student development and wellbeing, and our progress monitoring process.
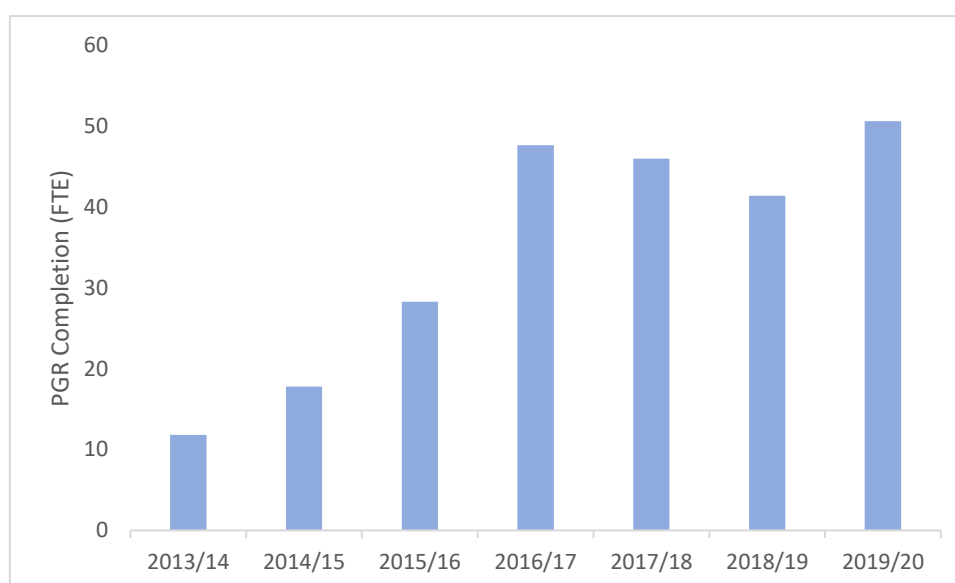
Figure 1.4 Sustained growth in PGR awards in UoA4 from 2013/14 to 2019/20

The 2017 Postgraduate Research Experience Survey showed 79% overall satisfaction for UoA4, comparable to the UoL average score of 78%. Across FHLS, 90% of PhD and MDs are employed, or in further study, after completion of their PGR programme.

2.4 Equality, Diversity, Inclusion (EDI)

2.4.1 Staff Profile

UoA4 has 60FTEs comprised of 18 Professors, 7 Readers, 19 Senior Lecturers, 16 Lecturers, 1 Research Fellow, including 13 ECRs. The unit is 39% female (33% REF2014), 8% BAME (no change), has 26% non-UK nationals (11% REF2014), and 8% part-time (3% REF2014). Table 2.1 shows the distribution of Cat1A staff by gender and academic grade. Notable is the increase in the proportion of female staff across all senior grades.

	Job Title Category									
	Research Fellow		Lecturer		Senior Lecturer		Reader		Professor	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
REF2014	<5	<5	13%	13%	11%	11%	<5	<5	36%	<5
REF2021	0%	2%	16%	10%	13%	18%	11%	2%	21%	8%

Table 2.1 E&D data comparing UoA4 REF2014 to REF2021 across academic grade.

2.4.2 EDI and Preparation of the REF Submission

The UoL REF Code of Practice has been incorporated into every stage of UoA4's submission. To ensure an inclusive process for output selection we ensure that EDI considerations transparently underpin our processes including diversity of the reading panel, involving all staff (including ECRs) in output rating; continuous monitoring for any bias in proposed returns; feedback to staff; and mandatory EDI and bias training (94% of UoA4 Cat1A staff have completed an 'Introduction to Diversity and Equality' training).

2.5 Engagement and Delivery

2.5.1 Athena SWAN

UoL is a signatory to the Athena SWAN Charter, obtaining a Silver Award in 2016. UoA4 staff are drawn from 4 institutes with Athena SWAN Awards: 1 x GOLD, 2 x SILVER and 1 x BRONZE. Strategies and programmes have been put in place to support the recruitment and development of female research leaders, including gender neutrality in recruitment and staff development. Focussed support is provided by the Springboard Programme and the Aurora Women in Leadership Programme to facilitate the transition of fixed-term staff to more senior roles (Concordat Principles 3,4,5,6). The University supports several networks which promote and celebrate women in STEM subjects, including a female ECR Network and the Liverpool Women in Science and Engineering Society. FHLS has also financially supported national organisations such as the Women-in-Vision-UK network. We continually monitor equality in the context of staff promotion outcomes (**Table 2.1**).

2.5.2 Equality, Diversity, and Inclusivity (EDI) Initiatives

UoL has formalised its commitment to EDI through membership of the following charters: Athena SWAN Charter; Bambis Breastfeeding Mayoral Charter; Disability Confident; Stonewall Diversity Champion, Time to Change and moving to Level 2 Disability Confident. UoL also support various networks to address EDI issues: Black & Minority Ethnic Staff Network (8% of UoA4 staff have self-identified), the Disabled Staff network, the Female Early Career Researcher Network, Liverpool Women in Science and Engineering Society (LivWiSE) and the LGBT Network (**REF5a, Section 3.2**). During the current REF period, UoA4 has established EDI Teams (EDIT) at department level, comprising academic, professional services staff and students, including both permanent and fixed-term staff. The Departmental EDI leads also sit on Institute-level EDI Committees - which report directly to the Institute Leadership Teams. EDI leads are also embedded in academic recruitment panels and the EDI team also oversees the professional and personal development of staff and Wellbeing Initiatives (**Section 2.5.5**). Project RISE (Research in an Inclusive and Sustainable Environment) is another new UoL initiative to understand and mitigate the effects of the COVID pandemic, and other factors (Brexit, UK R&D policy) on equality, inclusivity, and diversity for research staff (**REF5a, Section 3.3.3**).

2.5.3 Accessibility

During the REF period, UoL has undertaken major programmes of investment in building accessibility. A disability access guide to campus is available on the UoL website, in addition to a list of accessible toilets, showers, parking bays and gender-neutral facilities. Departments appoint an academic disability lead to advise on accessibility and disability issues. The Computer Services Department provides a range of accessibility software and hardware for staff and students with disability issues.

2.5.4 Employment Flexibility and Support

To support return-to-work after long-term leave (e.g. maternity, sickness), UoL has introduced a range of family-friendly options including (see also **REF5a**): (i) A flexible working policy allowing individuals to vary or adjust their working pattern based on personal circumstances, including opportunities to work from home (5 UoA4 staff have temporarily or permanently adjusted their work patterns due to personal reasons); (ii) £5K of flexible funding is available on application to support research following return to work; (iii) Family Friendly Advisors (10 in FHLS) and support networks including the Carer's Network, Parent's Network and ECR Network provide information, guidance and mentoring for staff. The success of these initiatives is supported by our 100% return-to-work rate after maternity leave (N=7 UoA4 staff).

2.5.5 Wellbeing

The UoL annual Wellbeing Week provides an opportunity for staff and students to take part in a variety of activities aimed at boosting health and wellbeing. UoL offers a range of services to support wellbeing (e.g., the Mentoring Scheme, Wellbeing Advisors, and the Employee Assistance Programme) all of which are underpinned by a network of resources available on the Wellbeing Hub, including the Student Counselling Service, Mental Health Advisory Service, daily Wellbeing Drop-in sessions, Disability Advice and Guidance, and the Liverpool Guild of Students Advice Service. The Liverpool Doctoral College (LDC) supports all PGR, providing a dedicated team of supervisors, professional services staff, and student peers.

New initiatives developed from the OfS funded PGR Mental Health and Wellbeing Catalyst Project (2018-20), with support from the FHLS' PGR Hub and the LDC, have now been rolled out across the University. The project aimed to better understand the prevalence of poor PGR mental health and wellbeing and in response developed new interventions including a Peer Wellbeing Ambassador programme, of which there are now 19 ambassadors within FHLS and an online training module for supervisors on PGR mental health which is now compulsory for all supervisors.

3. Income, infrastructure, and facilities

3.1 Research funding

During the current REF period UoA4 staff have contributed towards 373 grants with a total award value of £60.2M (equivalent to £1M per returned FTE; average annual grant expenditure of £143k per eligible FTE). Income has increased 22% from the start of the REF period totalling ~£37.3M of accrued income (cf. £15M REF2014).

Source of Funds	Total
Research Councils	£11,975,598
Health research funding bodies	£5,293,855
UK govt/LAs/health	£4,574,753
UK charities (competitive)	£4,426,725
Non-EU other	£3,998,954
EU govt bodies	£2,481,092
UK industry	£1,819,576
UK charities (other)	£976,223
UK other	£708,759
EU industry	£508,231
Non-EU industry	£473,574
EU other	£124,101
	£37,361,441
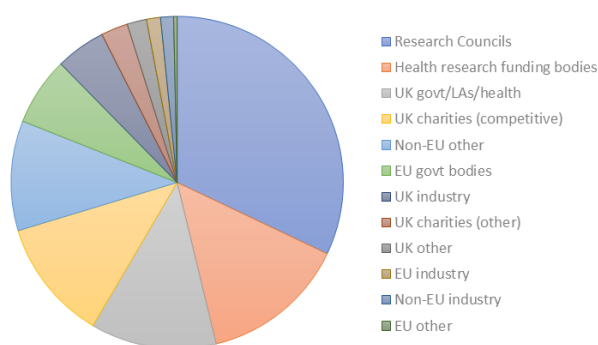
Figure 3.1 UoA4 distribution of accrued grant income by funder type

PI UKRI grant application success rate is 46%, exceeding the national average of 26%. The vitality and sustainability of our income base is evidenced by the diversity of the funding portfolio (**Figure 3.1**) with UoA4 grant awards from over 100 different funders. This includes 17 awards with a total award value exceeding £1M (**Figure 3.2**).
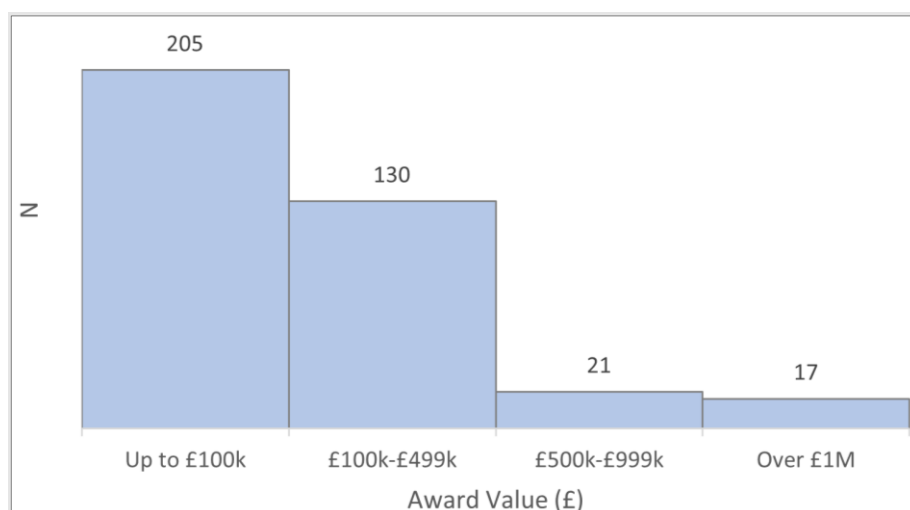
Figure 3.2 UoA4 distribution of grant awards by value

Table 3.1 Examples of large grant awards for UoA4

Project	Description	Funder	Award Value
Children Growing Up in Liverpool (C-GULL)	Birth cohort involving over 10,000 new-borns across the Liverpool region. C-GULL underpins our strategic programme of interdisciplinary longitudinal research investigating determinants of health and wellbeing in children and their families, and the development/evaluation of public health interventions.	Wellcome Trust	£5.2M
Applied Research Collaboration North West Coast	61 regional HEI, NHS, charity, government, and social care partner consortium supporting UoA4 work in physical and mental health.	NIHR	£9M
Centre for Language and Communicative Development (LuCiD)	A collaborative centre-of-excellence involving Liverpool, Manchester and Lancaster, LuCiD aims to understand child language acquisition and to design and evaluate effective interventions in education and healthcare.	ESRC	£3.9M
Sweeteners and sweetness enhancers: Impact on health, obesity, safety and sustainability' (SWEET/SWITCH)	SWEET - leading a consortium of 29 pan-European research, consumer, and industry partners. SWITCH - (renewed until 2023 with additional industry funding) to develop/evaluate benefits and risks of sweeteners and sweetness enhancers for public health and obesity.	EU/H2020 Industry	€9M £3.2M
The Refugee Emergency: DEFining and implementing novel evidence-based psychosocial interventions (RE-DEFINE) and COSTAR	RE-DEFINE (ERC) development/ evaluation of interventions for mental health in refugees and asylum seekers resettled in middle and high-income countries. COSTAR - community-based interventions for depression in Ugandan and Rwandan refugees.	EU/H2020 ESRC/GCRF	€2.9M £1.1M
ENHANCE: NIHR Research and Innovation for Global Health Transformation Programme	Development/evaluation of the WHO adopted CBT-based 'Thinking Healthy Programme'. Digital application for lay therapists in South Asia.	NIHR	£3M
COVID-CNS (Clinical Neuroscience Study)	National cohort study of the neurological, neuropsychiatric, and cognitive sequelae of SARS-COV-2 (COVID-19). Multi-site consortium jointly led by UoL and KCL.	MRC/UKRI-DHSC	£2.3M

3.2 Strategies for Generating Income

Our successful strategy for generating and sustaining income is based on:

(i) Strategically driven investment in high-calibre staff appointments into core areas of research strength (**Section 2**).

(ii) Thematic priorities defined by an interdisciplinary UoA4 Research and Impact Strategy that aligns with regional, national, and international funding priorities (**Section 1.4**).

(iii) Major investment in state-of-the-art research infrastructure (**Section 3.3.2**), and provision of internal pump-priming and technical support (e.g., Translational Research Access Programme (TRAP: UoA4 £162k), Shared Research Facility (SRF) access awards (TD Vouchers: UoA4 £49k; **Sections 3.3 & 3.4**); Wellcome Trust ISSF (Non-Clinical Fellow Support, Equality and Diversity Fund, Public Engagement Award: UoA4 ~£91k), MRC (Confidence in Concept Awards: UoA4 £77.5k; Proximity to Discovery Awards: UoA4 £1.3k).

(iv) Provision of internal support for grant development at departmental level by embedding staff within strong research groups to provide mentoring and peer review, and access to grant writing support and training through the Faculty Peer Review College/FHLS Research and Impact Directorate.

(v) Well-established regional research networks (e.g., N8, ARCNWC, NHSA, Liverpool Health Partners, North West Coast Mental Health Research Network, Liverpool Neuroscience Group) (**Section 4**) providing a platform for collaborative large multi-centre grant bids, engagement, and knowledge exchange.

(vi) Clinical-academic collaboration facilitated by Liverpool Health Partners and SPARK ('Single Point of Access to Research and Knowledge') (**Section 4.1.2**).

(vii) Ensuring support for grant development on return-to-work through our EDI Strategy (e.g., reduced teaching and administrative workload, mentoring and preferential access to pump-priming/PGR studentships) (**Section 2**).

3.3 Infrastructure and Facilities

3.3.1 Organisational Infrastructure Supporting Research and Impact

Support is coordinated at Faculty-level via four cross-cutting directorates (**Figure 1.1**). Three directorates directly support research and impact activity: (i) **Research and Impact Directorate**: Coordinates Faculty research and impact strategy, including PGR support, ethics, internal and external funding schemes, and the Research Support Office (pre- and post-award finance) and specialist professional support for peer review; demand management; contracts, and legal guidance; (ii) **Clinical Directorate**: Coordinates clinical-academic research activity and NHS partnerships (**Section 1.3.1**), including career development, progression and job planning for clinical-academic researchers; (iii) The **Infrastructure and Environment Directorate**, which oversees the Technology Directorate (TD) comprising state-of-the-art specialist bioscience Liverpool Shared Research Facilities (LIV-SRF) (**Section 3.4.1**). Access to TD facilities is facilitated by the TD Voucher Scheme which provides pump-prime funding for early-stage projects, and access to dedicated in-house technical support. Over the current REF period, UoA4 staff have benefitted from 13 TD Voucher awards (£49k). (iv) FHLS also coordinates provision of 10.5FTE of dedicated pre- and post-award support staff who are embedded in each Institute, and work to assist grant applicants and award holders. Pre-award activities include horizon scanning, peer review, supporting bid development and providing specialist funder knowledge. Post-award activities include project management support, and health checks on live awards. FHLS also has 4.0FTE Impact Officers providing specialist support to PIs to maximise research impact.

3.3.2 Infrastructure Investment

Over the current REF period, UoA4 has directly benefitted from **£11.4M** of investment in buildings, laboratory space and equipment. Highlights include:

- **£1M** investment in the Brain and Behaviour Laboratory in Psychology - including installation of a state-of-the-art high density (128-channel) open access EEG facility.

- Ongoing University funded **£1.6M** refurbishment of the main Psychology building and laboratory spaces.
- **£1.8M** upgrades and refurbishment to Liverpool Magnetic Resonance Imaging Centre (LiMRIC) including the acquisition of a new Siemens Prisma 3T MRI scanner.
- Refurbishment of the Sherrington Building **(£7M)** to provide a modern hub for laboratory-based biomedical research including our neuroinflammation/brain infection, neuropharmacology, and neurodegeneration research groups (Nuffield Wing).

Vitality and sustainability have also benefitted indirectly from ~**£1.2bn** in research and clinical-academic infrastructure investment across the University and city region, including:
- 'Institute in the Park' **(£260M)** at the new Alder Hey Children's Hospital to create a multidisciplinary environment for child health clinical researchers, child healthcare professionals and biotechnology companies (**RG4**, **RG5**).
- **£12.7M** for the new Digital Innovation Facility (DIF) which includes Robotics and Virtual Reality labs supporting collaborations between Engineering, Computer Science and Human/Life/Perception sciences and our strategic priorities in digital innovation.
- New **£335M** Royal Liverpool University Hospital (**RG4**), **£25M** Life Sciences Accelerator to support industry collaborations, and the **£600M** Liverpool City Council development of the Liverpool Knowledge Quarter – bringing together key stakeholders (HEIs, NHS, industry) across the region to foster new collaborative partnerships and innovation including themes in Health and Life Sciences, Digital Technology, Infection and Disease, and funding of the Liverpool Science Park, Bio-Innovation Hub and Paddington Village.

Together, this investment will result in co-location of clinically focused activity comprising academics, NHS partners and biotechnology companies to produce one of Europe's largest biomedical campuses.

3.4 Research Facilities

3.4.1 Research Labs and Infrastructure

UoA4 is also supported by a wide range of state-of-the-art facilities and research infrastructure (**see Tables 3.2-3.4**):

Table 3.2 UoA4 Psychology Labs

Facility	Description	Research Group
Brain and Behaviour Lab	Incorporates state-of-the-art facilities, flexible testing spaces and a fully shielded high-density 128-channel EEG system.	1,2,4,5
Eating and Drinking Lab	Purpose built facility incorporating onsite kitchen for food preparation and drinking laboratory with a mock bar/pub interior.	1
Child Development Lab	Specialist facilities for behavioural and language research with children including child-friendly labs and carer areas.	2,3,4
Clinical Testing Facility	On-site facilities for research with clinical populations (e.g., clinical neuropsychology, mental health, obesity, addiction).	1,2,4,5
Psychophysics Labs	Virtual reality (VR), desktop and portable eye tracking, acoustic analysis suite, HDR displays, motion tracking and haptic sensing.	2,3,4,5

Table 3.3 Shared Research Facilities (SRFs)

Facility	Description	Research Group
Imaging and Brain Stimulation – Liverpool Magnetic Resonance Imaging Centre (LiMRIC)	3T Siemens Prisma scanner and 2.0FTE of dedicated in-house radiography and technical support, near infra-red spectroscopy (NIRS), brain stimulation (TMS/tDCS -Walton Imaging Centre)	1,2,4,5
Centre for Genomics Research	Next-generation gene sequencing and informatics infrastructure including Illumina NovaSeq 6000, PacBio Sequel II, and 10X Genomics Chromium.	2,5
Centre for Pre-Clinical Imaging	Bruker 9.4T MRI scanner provides access to state-of-the-art MR imaging. Offers one of the most comprehensive and sensitive ranges of small animal imaging modalities available nationally (ultrasound, PET/SPECT/CT, opto-acoustic MSOT, and IVIS fluorescence and bioluminescence imaging).	5
Liverpool/Walton Biobanks	16 NHS REC approved Research Tissue Banks and ~400 biological collections of human samples totaling ~1 million stored samples. Walton Neurology Research Tissue Bank (~2,500 brain-derived samples).	5
Centre for Cell Imaging	State-of-the-art cell and tissue imaging and cytometry facilities. **Centre for Cell Imaging** provides a focal point for advice, training, and imaging provision with 7 confocal microscopes including Light-sheet, AFM, and Photothermal microscopes. **Cell Sorting Facility** offers up to 15 parameter fluorescence-activated cell sorting (FACS) and the first Helios Mass Cytometer to be installed in the UK.	5
Centre for Computational Biology	Offers specialized computing and statistical expertise to provide bespoke bioinformatics solutions and training for integrating and analyzing all types of data generated by our omics platforms.	5
Centre for Proteome Research	Operates 12 state-of-the-art mass spectrometry platforms that support identification and quantification of proteins and their modifications from a wide range of biological samples.	5

Table 3.4 UoA4 Clinical and Technology Research Facilities

Facility	Description	Research Group
Liverpool Clinical Trials Centre (LCTC)	A fully integrated trials unit that collaborates with local and national investigators in all aspects of RCT design. Links to the MRC-funded North West Hub for Trial Methodology Research (NWHTMR) and its successor, the MRC/NIHR Trials Methodology Research Partnership.	1,2,3,5
Single Point of Access to Research and Knowledge (SPARK)	Newly established to facilitate clinical-academic research, providing pre- and post-award support, clinical-academic contracts/collaboration, joint access to HEI/NHS Trust research infrastructure, research ethics and governance support.	1,2,3,5

| Facility	Description	Research Group
Virtual Engineering Centre (VEC)	Delivers solutions to industry, the public sector and healthcare partners by innovative digital designs. The VEC's multidisciplinary team has expertise across engineering, computer science, perception, data analytics, immersive visualisation, and manufacturing technology.	1, 2
Digital Innovation Facility (DIF)	A new £12.7M inter-disciplinary facility bringing together expertise in computer science, robotics, engineering, and immersive visualisation, to enable collaborative R&D and support businesses linked to digital technologies.	1,2

3.5 Library and Research Computing Infrastructure

UoL provides access to journals via the JISC Collections Journal Agreements. UoA4 is supported by subject-specific specialist access to a comprehensive range of academic journals, books, periodicals, and databases. Liverpool Elements software, the Library Research Data Management service, and its Research Support Officers, coordinate long-term research data management and support staff with OA and regulatory compliance. UoL has recently invested £10M in a new primary state-of-the-art campus data centre providing centrally managed space to house project-specific hardware and works closely with Net North West which manages our wide area network connections and our high-speed resilient links to JANET. Our researchers have free access to the High Throughput Computing service (HTC), and High-Performance Computing (HPC) capabilities via a central computing cluster. Our recently appointed, inaugural Head of Research Computing for FHLS (Gannon) is now building a Faculty-wide Research Computing strategy, investment plan and service delivery roadmap to enhance provision in the coming years and thus support our strategic objective of growing our data science capabilities.

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

4.1 Research Collaborations, Networks and Partnerships

UoA4 staff have extensive collaborative networks and partnerships. This is evidenced in several ways, including:

- High proportions of national (38.7%) and international (41.4%) collaborations on multi-author research outputs.
- Broad range of subject diversity of UoA4 interdisciplinary projects (**Figure 4.1**), and both international (**Table 4.1**; **Figure 4.2**) and national (**Figure 4.3**) collaborations on outputs.
- Diversity of PGR training partnerships including: 5 national doctoral training networks, EU Horizon training network, and 14 international networks including our partners in India (NIMHANS) and Japan (Riken) (**Section 2.3**).
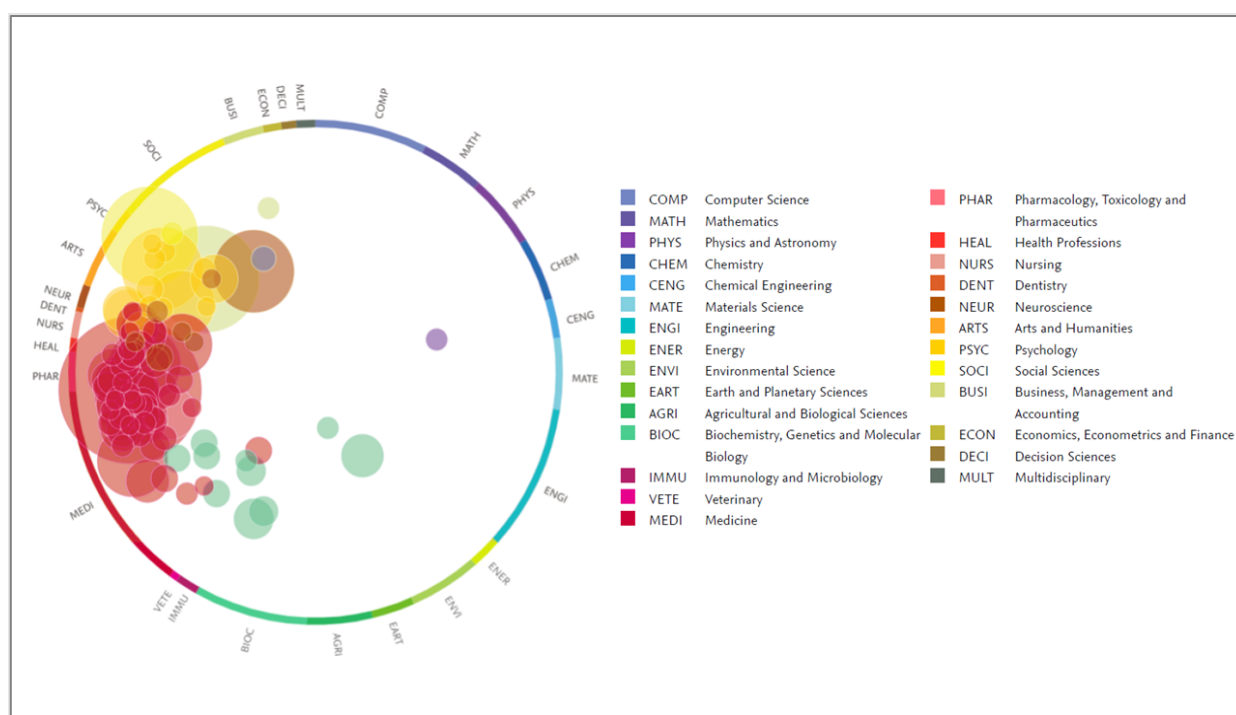
Figure 4.1 Topic analysis for all UoL UoA4 publications in the REF period (Source: SciVal). Each dot represents a distinct Scival topic in which we have published; dot size indicates our number of publications in that topic.

Table 4.1 Global distribution of international research collaborations on UoA4 outputs by continent (% of co-authorship on all outputs 2014-2020).

Continent	% Co-authorship
Europe	48%
North America	19%
Asia	18%
Australia	9%
Africa	4%
South America	3%
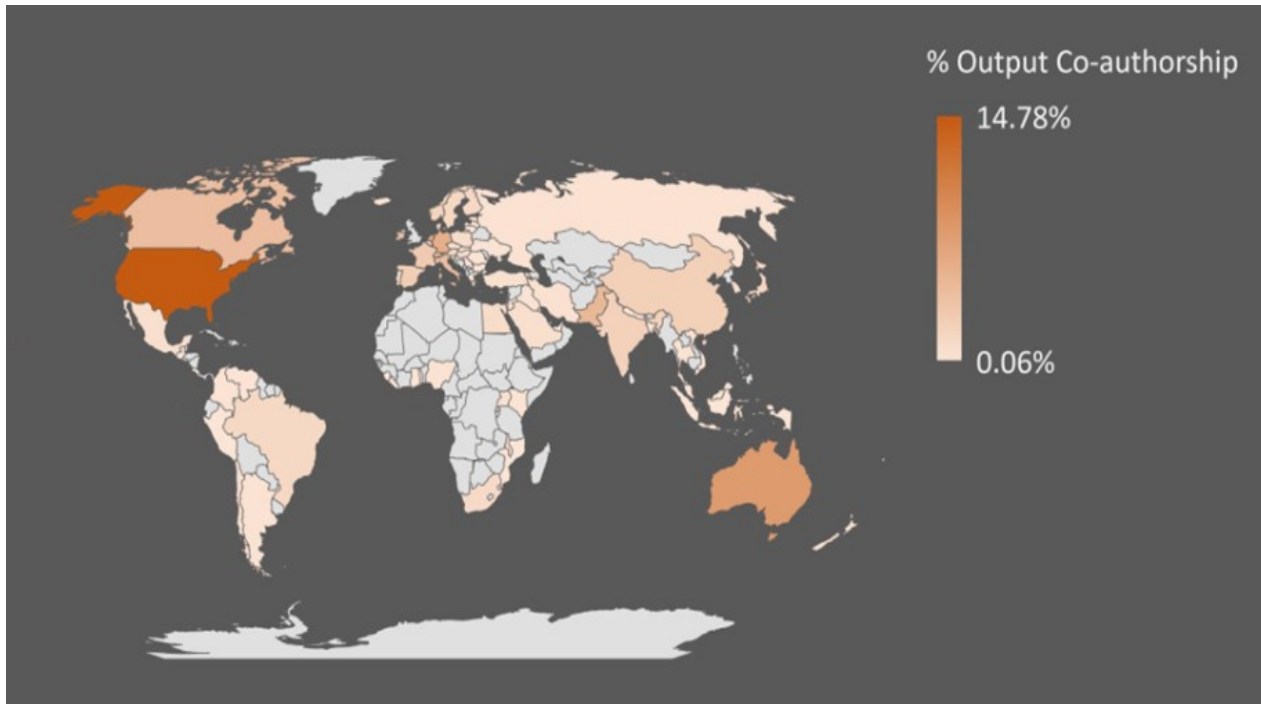
Figure 4.2 Global distribution of international research collaborations on UoA4 outputs (% of co-authorship on all outputs 2014-2020).

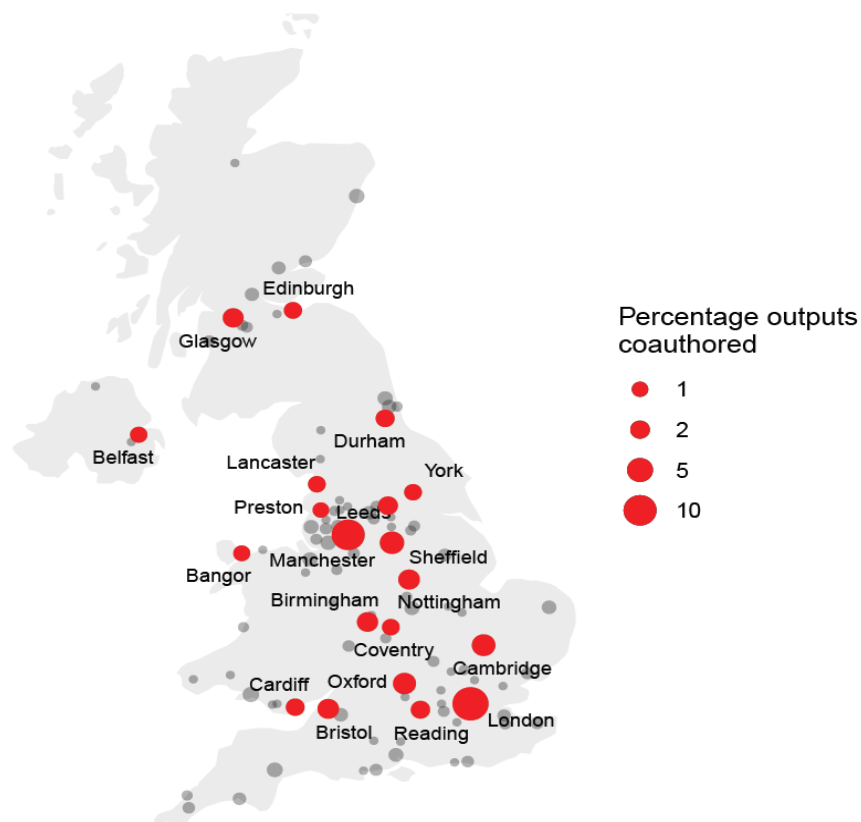**Figure 4.3.** National distribution of UK research collaborations on UoA4 outputs (% of co-authorship on all outputs 2014-2020). The size of spots reflects the percentage of papers affiliated with a town/city. Red spots are the top 20 collaborating locations (excluding Liverpool).

4.1.1 Enabling and facilitating collaborations

Strategies to promote collaboration with external HEIs, clinical and industrial partners are coordinated by the UoL Research, Partnerships, and Innovation Directorate (RPI). RPI provides expertise in knowledge exchange, governance, and Intellectual Property. Support covers project management for large bids, peer review, expertise on impact and knowledge exchange, scoping events, and pump-priming. Available collaborative pump-priming schemes include: Overseas Development Agency Seed Fund (ODA) providing up to £10K for research in low-to-middle income countries); the Enterprise Investment Fund, the Industrial Strategy Fund and Knowledge Exchange and Impact Vouchers (**Section 1.5**). UoL recently led a successful £3.5M grant from UKRI (worth £4.4m in total with partner institutions in Lancaster and Manchester) for a major strategic project, **PROSPER** to develop and enhance ECR career development, networks, and collaborative opportunities.

4.1.2 Facilitating clinical-academic collaborations

Clinical-academic collaborations are supported by a well-developed environment for engagement with NHS partners coordinated regionally by **Liverpool Health Partners** (a regional consortium with 9 local NHS Trusts and 4 regional HEIs (**Figure 4.5**).

Figure 4.5 Liverpool Health Partners. Collaborations with UoA4 research groups (RGs - see **Table 1.1)** are highlighted.

1.	The University of Liverpool
2.	Edge Hill University
3.	Liverpool John Moore's University
4.	Liverpool School of Tropical Medicine
5.	Liverpool University Hospitals NHS Foundation Trust — **RG1,4**
6.	Alder Hey Children's NHS Foundation Trust — **RG2,5**
7.	The Clatterbridge Cancer Centre NHS Foundation Trust
8.	Liverpool Heart and Chest Hospital NHS Foundation Trust
9.	Liverpool Women's NHS Foundation Trust
10.	Mersey Care NHS Foundation Trust — **RG4**
11.	NHS Liverpool Clinical Commissioning Group
12.	The Walton Centre NHS Foundation Trust — **RG2,5**
13.	NHS Knowsley Clinical Commissioning Group
14.	NHS South Sefton Clinical Commissioning Group
15.	NHS Wirral Clinical Commissioning Group
16.	Cheshire and Wirral Partnership NHS Foundation Trust — **RG4**
17.	Countess of Chester Hospital NHS Foundation Trust — **RG2**

Our region has the most specialist NHS trusts outside London. RGs in UoA4 work closely with trusts spanning specialist NHS services in mental health, eating disorders, child health and neurology (**Figure 4.5**): Mersey Care, Cheshire and Wirral Partnership, Liverpool University Hospitals NHS Foundation Trust (Aintree University Hospital, Broadgreen Hospital, Royal Liverpool University), Alder Hey and Walton (the largest specialist neurology service outside of London). In addition, clinical-academic collaboration in UoA4 benefits from direct involvement with:

- **Northern Health Science Alliance (NHSA)** - facilitating clinical-academic collaboration across the north of England involving 10 NHS Trusts, 10 HEIs and four Academic Health Science Networks (UoA4: Appetite, Obesity & Addiction, Mental Health, Neuroscience).
- **North West Coast Mental Health Research Network** bringing together academic and clinical expertise in mental health across regional HEIs and NHS trusts. This network facilitates new collaboration and serves as a platform for major regional bids for mental health research in our key priority areas (**Section 1.4**).
- **Applied Research Collaboration North West Coast** (ARCNW, NIHR, £9M, 2019-2024) - bringing together 61 health and social care partners (CCGs, borough councils, NHS Trusts, charities and third sector organisations) across the region to foster research collaboration and improve service delivery.
- **North West Coast Clinical Research Network** – NIHR funded network comprising 41 NHS partners (22 NHS Trust and 19 CCGs) facilitating NHS/academic collaboration on

treatments and care pathways in speciality therapy areas supporting UoA4 work in mental health, addiction, and neurological disorders.

- Cross-cutting expertise in UoA4 spanning seven academic departments (**Section 1.1**), and further collaborative expertise in Health Data Science and Biostatistics, Public Health Systems & Policy.
- **Liverpool Clinical Trials Centre -** a single, fully integrated CTU (**Section 3.4.1**).
- **Liverpool Centre for Alcohol Research (LCAR)** – supporting addiction research in RG1
- **Centre of Excellence in Infectious Disease Research** (CEIDR) – an interdisciplinary centre that coordinates work on infectious disease across UoL, Liverpool School of Tropical Medicine (LSTM), NHS Trusts and industry partners (UoA4 Neuroscience - brain infection and neuroinflammation).

4.1.3 Facilitating non-clinical research collaborations

Non-clinical collaborations underpin our interdisciplinary strategic priorities in translating discovery science to innovations in digital technology, engineering, security, and public safety (**Figure 1.2, Strategic Priorities (SP) 1, 5 & 6**). Key partner organisations include:

- **Liverpool Institute for Risk and Uncertainty** (LIRU) – located within the Faculty of Science and Engineering (FSE), the LIRU brings together interdisciplinary expertise to understand, and develop techniques to improve, psychological processes involved in responding to critical and major incidents (UoA4: **Alison, Waring**)
- **Virtual Engineering Centre (VEC)** – located at Sci-Tech Daresbury, the VEC collaborated with UoA4 (**Meyer**) on STRIVE – an innovative £3.3M government (BEIS) funded project to development new training processes for vehicle manufacturing, using multi-sensory virtual reality environments. This project resulted in a successful ESRC CASE studentship with Bentley/Jaguar and an Impact Case in Engineering (UoA12).
- **Digital Innovation Facility (DIF)** – located within the FSE, the DIF will play a vital role in supporting UoA4 strategic priorities around digital technology (**Figure 1.2, SPs 1 & 5**).

4.2 Engagement and Impact

4.2.1 Strategic National and International Networks Supporting Impact

UoA4 staff are involved in several major national and international collaborative networks that support our **impact case studies**. These include:

- **National Institute for Mental Health and Neurosciences (NIMHANS)** - a major national institution located in Bangalore, India. We benefit from a joint UoL-NIHMANS PhD Programme. Our collaboration with NIMHANS has supported grant funding via GCRF and the Newton Fund, and our work on mental health interventions in low- and middle-income countries (impact case UoL51DepressionLMIC).
- **N8 Research Partnership** plays a key strategic role supporting our work in Appetite, Obesity & Addiction. Its mission is to integrate universities, industry, and society to maximise the impact of research, promote collaboration and deliver innovative research capabilities. It is funded by HEFCE (**£8M**) with a further **£1M** investment being provided by each partner (impact case UoL52Foodadvertising).
- **Better Policing Collaborative** (Liverpool, Nottingham, Birmingham, Derby, Manchester, Suffolk; Skills for Justice; 13 police forces) directly supports our research and impact work in preventing child sexual exploitation and improving critical incident decision making and communication. Jointly funded by HEFCE and College of Policing (**£1.1M**)**,** its mission is to build a sustainable system for understanding, critiquing, and using evidence to inform police practice and improve public safety (impact cases UoL61Indecent images and UoL62Decisionmaking).
- **NIHR North West Stroke Research Network** (Liverpool, Lancaster, Central Lancashire, Manchester), (impact case UoL81StrokeVision).

4.2.2 Engagement with Industry

The total UoA4 consultancy income for the REF period amounted to £399k. **58%** of UoA4 staff have undertaken industry engagement roles (e.g., advisory, consulting), and we have developed several major industrial partnerships generating £4.2M industry-related grant funding since 2014. Examples include: (i) a longstanding strategic partnership with Unilever supporting translational research in the field of sensory and cognitive neuroscience, including projects on the neural correlates of consumer behaviour and reward mechanisms. This partnership has generated inward investment from Unilever of ~£650K, including two TTFs (**Roberts** and **Fallon**, now appointed as lecturers in UoA4), an EPSRC case studentship and has contributed to the establishment of the new Brain and Behaviour Laboratory (**Section 3**); (ii) The **Virtual Engineering Centre (VEC –Section 3.4.1 and 4.1.3)** provides an interface between UoL (UoA4: **Meyer**) and industry (iii) the partnership with Genuity supports clinical genetics research in our neuroscience group in Parkinson's Disease (**Quinn**); (iv) understanding behavioural aspects of skin appearance, body image, and appetite & obesity for product development (Unilever, PZ Cussons, Californian Prune Board, Coca-Cola, Danone, Heinz, Sony, Tate & Lyle, Weight Watchers).

4.2.3 Research Consortia and Networks

UoA4 staff are actively involved in a wide range of national and international networks and consortia. Examples include: Rurban Revolution (**Hardman**); UK Centre for Tobacco and Alcohol Studies (AKTAS, **Rose**); CALIBRATE – network for alcohol research (**Cooke**); International Multisensory Research Forum (**Meyer**, **Bertamini**); Visual Image Interpretation in Humans and Machines (VIIHM), an EPSRC research network to foster interdisciplinary research between biological and machine vision researchers and industry (**Leek**, **Wuerger**); British and Irish Orthoptic Society Research Network, Council for Allied Health Professions Research, Norway Vision in Stroke Network (**Rowe**); N8 Policing Partnership, Better Policing Collaborative (**Alison**, **Waring**); UKRI-CLOSER Network for UK's longitudinal studies (**Sharp**); National Network for Developing Healthcare Technologies for Mental Health (**Brown**); Mental Health Innovations Network (**White**); North West Coast Mental Health Research Network. EPi25 (**Marson**) - epilepsy genetics; ENIGMA - Epilepsy Consortium (**Keller**, **Marson**); International Parkinson Disease Genomics Consortium (**Quinn**); Motor Neuron Disease Genomic consortia (ProjectMinE) (**Quinn**); Liverpool Neuroscience Group (**Quinn**, **Leek**, **Marson**, **Meyer**); International League Against Epilepsy Consortium on Complex Epilepsies (**Marson**, **Mirza**); Epi4k (**Marson**); EPiPGX (**Marson**); Cochrane Epilepsy Group (**Marson** Coordinating Editor); COVID-CNS (Clinical Neuroscience Science) Consortia (**Leek**).

4.2.4 Impact on Health, Society and Security

Our research has wide regional, national, and international impact on health, society, and security. Key highlights include: (i) development of evidence-based guidelines for TV food advertisement (Impact Case: **Boyland**); (ii) impact on *policy and practice* is achieved through National and International clinical advisory, training and guidance development roles and activities, e.g. contract with Health Education England to deliver specialist National Perinatal Continuing Professional Development program for qualified Clinical Psychologists (**Sharp** and **Slade**); (iii) Management of post-stroke visual impairment (Impact Case: **Rowe**); (iv) engagement with Alcohol Research UK and LCAR to improve the dissemination of alcohol-related research to the public (**Rose**); (v) VR exposure therapy for phobias (Alder Hey; TRAP; **Meyer**); (vi) work with national and international criminal justice systems (Impact Cases: **Alison, Waring**); (vi) mental health interventions in low- and middle-income countries (Impact Case: **Rahman**); and pharmacological interventions for epilepsy (**Marson**).

4.3 Wider Contributions to Society

FHLS coordinates and supports Public Engagement training events for staff and students including designing hands-on activities and communication workshops. The FHLS Public Engagement Grant Scheme (max £2k) is open to all staff and PGR students and each year FHLS awards between £10-14K. UoA4's prior grant success includes a two-day workshop open to the public: "How to create visual illusions" (**Bertamini**) and working with an artist to present parenting

challenges in storybook form (**Centifanti**). Gage was recipient of the University Award for Outstanding Contribution to Public Engagement in 2018 and the American Association for the Advancement of Science ECR Award for Public Engagement in 2017 – see ECR Case Study #2 (**Section 2.1.3**).

UoA4 staff are regular contributors to a range of public engagement events including:
- '***Meet the Scientists***' events at the World Museum, Liverpool; a Faculty-run programme with several weekend drop-in events each year where researchers run hands-on activities related to their work. Engages over 6,000 visitors annually and aims to share our research with the local community, to inspire the next generation of scientists and to give researchers an opportunity to gain experience of public engagement.
- **Liverpool Neuroscience Group WinterFest** – held annually in Liverpool to promote public engagement in neuroscience with keynote talks from leading scientists in the field.
- Festivals: **Bluedot Festival**; **Green Man Festival** and **York Festival of Ideas**; **Pint of Science** Liverpool
- Open house events, lab visits for schools, organisations, and members of the public, and guest classes by members of staff and students.
- **Sixth Form Summer Lab Placements Programme** (Nuffield Research Placements)

4.4 Contribution to the Discipline

4.4.1 Sustainability

UoA4 contributes to sustainability through **training future leaders** and its commitment to **impact**. Examples include: (i) PGRs are trained through our national and international training programmes and >90% of PhDs/MDs go on to employment or further study (**Section 2.3.3**). The NWSS DTP actively encourages research across disciplines and engagement with industry via CASE studentships. As future leaders, PDRAs and ECRs are supported by a range of initiatives (**Section 2.2**). (ii) We also place a strong focus on disseminating research impact to multiple beneficiaries, stakeholder groups, businesses, industry, and the public. Impact lies firmly at the heart of our strategy, and resources allocated to impact have grown year-on-year throughout the REF period. Several new initiatives - e.g., impact leads, local impact officers, Knowledge Exchange, and Impact Vouchers), Faculty led impact seminars and workshops, have been put in place over the last few years to support sustainability (**Section 1.5**).

4.4.2 Response to National and International Priorities and Initiatives

Our work over the current REF period, and forward strategic plan, reflects our response to national and international priorities in key areas spanning physical (e.g., obesity, addiction, neurological illness) and mental health in children and adults (UK, humanitarian contexts and in low-and-middle income countries), health inequality, public safety and critical incident management - underpinned by the development and evaluation of new interventions, and technologies, to enhance individual and population health outcomes (**Section 1.4**). Most recently, we have been at the forefront of the national response to the COVID-19 pandemic through our work in the clinical characterisation of neurological, neuropsychiatric, and cognitive complications of COVID-19 (**Michael**, **Solomon** – UoA1, **Leek** – UoA4) and Project ARES - providing resilience training to frontline NHS staff adapted from techniques developed at UoL from our ground-breaking work in critical incident response management (**Alison**) (**Section 1.3.2**).

4.5 Indicators of Wider Influence

UoA4 academics serve regularly as members and reviewers for research council committees and peer-reviewed journals and as advisors, as shown in **Table 4.1**.

Table 4.1. Number and percentage of UoA4 staff involved in advisory and engagement activities (responses from staff surveyed in 2020).

	N	%
Served on National or International Grant Committees (Research Council or similar)	16	36%
Served on Learned Societies	13	29%
Served on Scientific Advisory Boards	10	22%
Served on Professional Bodies	16	36%
Served on Journal Editorial Boards	22	49%
Industry Advisory Roles	19	42%
Government Advisory Board/Parliamentary Expert	7	16%

4.5.1 Major Research Prizes and Awards

UoA4 staff have been awarded **>15 major national and international excellence awards** Examples include: MBE (**Alison**) - For services to critical incident handling and the NHS during COVID-19); American Association for the Advancement of Science, Early Career Award for Public Engagement with Science, 2017 (**Gage**); UK Society for Behavioural Medicine Early Career Award, 2013 (**Robinson**); UKISCRS Silver achievement Award for Recognition of Outstanding Contribution to Society, 2013 (**Rowe**); Wellcome/AHRC Health Humanities Best International Research Award, 2018 (**White**); Geoffrey-Burton Award (AVA) for contributions to Vision Science, 2019 (**Wuerger**); Fred Yates Award (Society for the Study of Addiction, 2017), Cambridge Cognition Award (British Association for Psychopharmacology, 2014) (**Jones**); Channi Kumar Lecture Award (International Marce Society for Perinatal Mental Health, 2018 (**Rahman**).

4.5.2 Fellowships

Wellcome Trust Non-Clinical fellowships (**Gage**, 2018; **Robinson**, 2015; **Stagi**, 2013, 2019); Unilever Fellowship (**Stancak**, 2015, 2016, 2017).

4.5.3 Contributions to Major Advisory Boards

Examples include: Brain Tumor Charity (**Jenkinson**); Member of NICE Medical Technology Advisory Committee (**Knox**); MMU Centre for Bioscience External Advisory Board (**Quinn**); 1001 days parliamentary working group relating to perinatal mental health (**Slade**); Evidence Group for the Scottish Government's second New Scots refugee integration strategy, 2018 to present (**White**); Advisor, WHO, Maternal and Child Mental Health Policy for the EMRO Region and School Mental Health (**Rahman**); British Psychological Society: Perinatal Psychology (**Sharp**, Chair) Lancet Commission on Global Mental Health (2016-2018); (**Rahman**); Global Agenda Council on Mental Health, World Economic Forum 2015-16 (**Rahman**).

4.5.4 Government Advisory Boards

Examples include: Expert witness for House of Commons Health and Social Care Select Committee Inquiry into childhood obesity, 2015, 2018 (**Boyland**); Community Engagement Strategy Committee (Evidence submitted to House of Lords Select Committee, 2017 (**Corcoran**); Member of the Ministry of Justice Academic Expert Network, 2018 (**Gillespie**); Advisor to the Government of Pakistan, Ministry of National Health Services, Regulation and Coordination & Lead Expert for the President's National Plan to Promote Mental Health (**Rahman**).