Institution: Cardiff University

Unit of Assessment: 4

a. Overview

Overall Structure: In 2012 Cardiff University was re-structured into 3 colleges, each led by a Pro-Vice Chancellor. UoA4 is located in the College of Biomedical and Life Sciences. Two groups in the College conduct Cardiff University's UoA4 research. These groups have collaborated for over a decade and have increasingly co-ordinated activities in multi-level approaches to understanding behaviour and the causes of psychiatric and neurodegenerative disorders.

Research Groups and Substructure: One component of UoA4 (43.63 FTE) is the School of Psychology (http://psych.cf.ac.uk) where the aim is to understand the biological, psychological and social foundations of human and animal behaviour. Research in the School is organised within four major themes:

- Neuroscience
- Cognitive Science
- Social and Environmental Psychology
- Health and Developmental Psychology

In each theme research is conducted both with healthy individuals and with individuals with psychological disorders. This approach complements the focus on disorders in the other component of UoA4 (25.70 FTE) and is the MRC Centre for Psychiatric Genetics and Genomics (hereafter MRC Centre, see http://medicine.cardiff.ac.uk/cngg/), which started in 2009 on the foundations of 10 years of MRC Co-operative Group funding. The MRC Centre is in the School of Medicine. Its research is organised in three broad disease themes:

- Psychosis and Major Affective Disorders
- Neurodegenerative Disorders
- Developmental Disorders

In both components of UoA4 individual researchers can work within more than one theme. Collaborations between the School of Psychology and the MRC Centre are extensive, and have been facilitated by two Chair-level joint appointments in clinical neuroscience and behavioural genetics and over £9M of joint grants awarded between 2008 and 2013.

b. Research strategy

Strategic Aims for the Assessment Period

School of Psychology: The overriding aim has been to reinforce our position as one of the best UK departments for psychological research, with strengths spanning the whole discipline. In RAE2008 the objectives for the then coming period included:

- Improving research quality and capacity
- Enhancing the translational potential of our research
- Enhancing our clinical research portfolio
- Enhancing our international profile

These strategic aims have guided academic staff appointments at all levels, including a joint appointment with the MRC Centre to a Chair in Clinical Neuroscience and the UK's first Chair in Autism Research. Improvements in capacity, quality and sustainability have been underpinned by extensive support for PhD research via School funds and several externally funded programmes. The scale and significance of clinical and translational research have been enhanced by research activities conducted within the Cardiff University Brain Research Imaging Centre (CUBRIC), which is part of the School of Psychology, by the establishment of the Wales Autism Research Centre, and by strengthening links between environmental psychology research and other disciplinary approaches to address the globally important issues of sustainability and climate change. Hosting international collaborations and symposiums, alongside an active programme of research visitors and visiting speakers, has enhanced our international profile.

MRC Centre: The broad strategic aims for the last 5 years were to develop the capacity and sustainability of the MRC Centre to prosecute the primary aim of using genetics and genomics to inform understanding of major psychiatric and neurodegenerative disorders. The specific strategic

aims were to enhance the Centre's

- already considerable strengths in gene discovery
- capacity for exploiting genetic research to benefit patients through improved understanding of disease mechanisms and better diagnosis and classification.

As outlined in detail below, both aims have been achieved through the use of staff appointments, retention and promotion, investments in biostatistics, informatics, and infrastructure, key external collaborations with genome centres bringing substantial investments in kind, and research grant capture, including the MRC Centre itself and a major Wellcome Trust Strategic Award. This has been underpinned by a commitment to train clinical and non-clinical scientists capable of delivering this discovery and translation agenda.

Achievement of Strategic Aims: Research Environment

In 2011 Cardiff University established three new University Research Institutes (URIs) as a key element in its strategy to foster research of the highest international calibre. UoA4 researchers have the lead role in the first URI and a prominent role in the second.

- **Neurosciences and Mental Health URI** http://www.cardiff.ac.uk/research/neuroscience
  The institute's mission is to stimulate the development of new research aimed at translating basic research findings into a better understanding of psychiatric disease mechanisms, classification and diagnosis. It brings together researchers from the MRC Centre with those pursuing aligned research in the Schools of Psychology, Biosciences, and Optometry, all co-located on two floors of the £30M Hadyn Ellis Building (opened in 2013). This building also provides clinical areas to facilitate links between clinical and basic research. Internal investments of £4.1M promote collaboration and support a Chair in Stem Cell research, three Grade 7 Research Fellowships, a 4-year doctoral training scheme, as well as research assistants, laboratory managers and administrative staff. Fellows and doctoral students each collaborate with at least two members of the URI. Three additional cross-school professorial appointments support the work of the URI. Together, these institutional investments of approximately £34M achieve the shared objective of the MRC Centre and the School of Psychology of developing a long-term major translational infrastructure in neuroscience and mental health.
- **Sustainable Places URI** http://www.cardiff.ac.uk/research/sustainableplaces
  The goal of this institute is to provide a new basis for sustainability science. Sustainable living in sustainable places is examined by integrating established methodologies from the natural, physical and social sciences, enabling a new understanding of the interrelations between ecology, society and economy. By studying these interactions at local, national and international levels, the URI is positioned at the centre of global debates. It draws on Cardiff's expertise in the applied social and psychological sciences, biological and earth sciences, planning and architecture, business, and public health. The initial University investment was £2.1 million for 2010-2014, and Psychology is one of the nine Schools involved. Psychology is helping to drive two of the institute's current research themes: sustainable transport (in collaboration with colleagues in Engineering and the Business School); and sustainable communities (in collaboration with colleagues in Social Sciences).

These institutional commitments to promoting and sustaining our research in the long term have been complemented by the following major achievements.

- The award in 2009 of the MRC Centre for Psychiatric Genetics and Genomics.
- Research conducted within CUBRIC has expanded significantly. Since 2008 CUBRIC has been instrumental in securing £25M of research funding, including £4M of MRC funding for translational research, a major EUFP7 grant (co-ordinated by Cardiff UOA4, €5.9M) for taking imaging into the therapeutic domain, and a Wellcome Investigator Award (£1.7M over 7 yrs.).
- Wellcome Trust Strategic Award (2012, £5.2M) to translate the genetic findings of the MRC Centre in neurodevelopmental disorders, including schizophrenia and autism. UoA4 researchers lead this research, with co-PIs in the School of Biosciences.
- The £3.3M National Centre for Mental Health (NCMH) established in 2011. Led by the MRC Centre, the NCMH is Wales' only Biomedical Research Centre, and realises our strategic aim of enhanced access to the NHS and patient populations. With the aim of disseminating UoA4 research as widely as possible, we have developed a biobank and database of patients who

are interested in research beyond that conducted in the MRC Centre. This also promotes our objective of enhancing collaboration with industrial partners needing access to patients.
- The UoA established the Wales Autism Research Centre and the UK's first Chair in Autism Research in 2009, funded by a combination of charitable foundation, Welsh Government and University resources (£1M over 5 yrs).
- The UoA has been successful in winning additional resources through Cardiff University competitive schemes, resulting in 12 new senior positions (5 at Professorial Level) that are central to our strategic plans.
- Crucial to the MRC Centre's success in genetics has been vigorous engagement in external collaboration. By way of example, the Stanley Centre of the Broad Institute has invested $8.8M for sample recruitment and genesis of genome-wide data from MRC Centre samples.

Achievement of Strategic Aims: Research Performance

For the School of Psychology ~75% of the outputs submitted to RAE2008 were in 'first quartile' journals with respect to citation impact in their respective subfields. The corresponding figure for outputs submitted to REF2014 is ~100%. The School greatly increased its research income, with an average income of £4.5M p.a. in the REF assessment period (compared with £2.9M for the RAE2008 assessment period); increased industrial and 3rd-sector support for its research, relative to the RAE2008 assessment period (from £1.4M to £1.8M p.a.); attracted a regular stream of international research visitors (nearly 100 email accounts were opened for international visitors during the REF assessment period); and increased the number of doctoral degrees awarded from 12 p.a. in the RAE2008 assessment period to 16 p.a. in the REF assessment period.

MRC Centre productivity metrics were developed in consultation with the MRC Neurosciences and Mental Health Board. The Centre's External Advisory Board has monitored progress annually, noting the Centre is 'at the cutting edge of research', 'making significant internationally recognised discoveries' and that its scientific progress is 'excellent'. Since the start of 2008, Centre staff have published 283 papers in journals with impact factors above 7, and 162 in journals with an IF above 10, which compares favourably with the 5-year targets agreed with the MRC of 147 and 82. Although currently only 80% through the 5-year window, the Centre has already surpassed its targets for attaining grants in the new strategically important research areas linking its genetic research to cognitive neuroscience, animal and cellular models (14 grants compared to target of 5).

Research Strategy for the Coming 5 Years

The jointly agreed strategic aims of the School of Psychology and MRC Centre are aligned with the research strategy for the College for Biomedical and Life Sciences, driven primarily by the goals for the 'Mind, Brain and Neuroscience' College research theme, to which the School and the Centre are the main contributors. Key aims are:

- To establish a centrally located 6000m^2 imaging facility in a new, purpose-built building. Exploiting the success of CUBRIC (see above), this facility will support 20 cross-university imaging groups undertaking imaging science, cognitive neuroscience, and translational research. Cardiff University is supporting the build and equipment costs for this project (£44M). The building is due to open in 2015. Facilities will include
  - a 7T MRI scanner (only two currently in the UK, neither of them in Wales)
  - a new micro-structural scanner (the only other scanner of this kind is in the USA)
  - two 3T MRI scanners
  - MEG, TMS, EEG, NIRS (near infrared spectroscopy) and cognitive/clinical laboratories
  - enhanced imaging-linked computing cluster facilities (supported by a recent £644K Wellcome Trust grant)
  - purpose-built clinical suites and physiological monitoring designed to support clinical trials, encouraging better integration with the NHS and pharmaceutical companies.
- To establish a European centre of excellence in micro-structural imaging, leading to the new imaging centre becoming a multimodal node in the new EuroBioImaging consortium and supporting Europe-wide training and research in structural imaging methods.
- To provide superior facilities for imaging research on children and adolescents, boosted by the cross-School Wellcome Trust Strategic Award for Neurodevelopmental Research (£5.2M).

Developmental neuroscience is a strategic priority that draws on the complementary strengths of researchers in Psychology and the MRC Centre.

- To enhance capacity in areas in which the core MRC Centre group has been underdeveloped, including cognitive neuroscience, fundamental molecular and cell biology, and cellular models of disease, including stem cell models.
- To promote translational research by collaboration between MRC Centre neuroscientists and those in Psychology and in other Schools where there is expertise in cognitive neuroscience, fundamental molecular and cell biology, and cellular models of disease.
- To link more effectively with the NHS in Wales, in recognition of the translation imperative.
- To increase our funding from European sources, in particular Horizon 2020.

Effective Mechanisms for the Development and Promotion of Research

In Psychology, strategy is developed in the Senior Management Team and the Research Committee; in the MRC Centre, strategy is developed by the MRC Centre Executive and by the theme groups. Members of staff are informed about research funding opportunities through local Research Offices and the University's Research, Innovation and Enterprise Services. Research policy in both components of the return is also discussed during annual Research 'Away Days'. All members of academic staff have dedicated laboratory space (wet and/or dry). Psychology has spent ~£100K p.a. in funding staff 'holding accounts' that can be used strategically to employ research assistance, purchase equipment, and fund conference travel. These are supplemented by returning a proportion of the recovered indirect costs on research grants to the PI. The MRC Centre devotes all recovered indirect costs to a central fund that is used, through internal peer review by the executive, to prime new research initiatives compatible with strategy. Research throughout UoA4 is monitored through annual staff appraisals, where progress is reviewed and targets are set for the coming year. All grant applications (>£25K) are internally peer reviewed by at least one senior academic to promote interdisciplinary research and high quality applications.

Involvement of Service Users and Effective Mechanisms for the Dissemination of Research

The involvement of service users and the dissemination of research is a significant element of our joint research strategy, as evidenced by funding for a dedicated Public Engagement Officer. Examples of innovation and success in this domain include sciSCREEN, a cross-disciplinary programme promoting engagement with science using film hosted at a local cinema; art installations and exhibitions open to the public from our artists in residence; grants from the Wellcome Trust to support artists and filmmakers; advisory roles in popular TV programmes (e.g., *Eastenders*); user education initiatives (awards totalling £800K); a Contemporary Science Debate/Science Show on ADHD (funded by European Science Foundation); 'Brain Games', a public event aimed at increasing awareness of brain-related research at Cardiff (part funded by the Wellcome Trust, see http://psych.cf.ac.uk/cubric/braingames/); participation in the Royal Society MP-Scientist Pairing Scheme; as well as websites and newsletters (e.g. http://ncmh.info/) and contributions to the Eisteddfod and the Hay Literary Festival. Service user 'research champions' provide input to our research. The Wales Autism Research Centre has initiated an 'Autism-Research-Policy-Practice Hub' (http://www.autismrpphub.org, co-funded by the ESRC and Welsh Government) with the explicit aim of ensuring that research knowledge has an impact on policy and practitioner communities. As well as adding to the vitality and public relevance of our research, measurable outcomes of our engagement strategy are significant awards made to researchers (noted below) and our ability to recruit for genetic studies from one of largest patient sample resources worldwide at any single site (e.g. 15,000 subjects with psychosis).

Capacity Building in Response to National Priorities and Research Student Recruitment

Both the School of Psychology and the MRC Centre have substantially increased their PhD student intakes (combined intake was 26 p.a. in RAE 2008, now 42 p.a.). We are also committed to building research capacity in response to national priorities. UoA4 has been highly successful in attracting external funding to support multidisciplinary studentships, for example the Wellcome Trust 4-year Integrated Neuroscience PhD programme (30 students, first cohort commencing 2008) and the ESRC Multidisciplinary Pilot Scheme, with 5 new 4-year studentships awarded in 2013 in addition to the 2.5 studentships provided annually through the all-Wales ESRC Doctoral Training Centre (established in 2011 and in which there is a dedicated Psychology pathway). UoA4 has also won external support for 8 studentships via a MRC doctoral training award for research employing magnetoencephalography (MEG). In response to the 2005 MRC Neurosciences and

Mental Health Board Mental Health Scoping Study, which identified a lack of academic capacity and research training in Mental Health, clinical and non-clinical research training is firmly embedded in the aims of UoA4 and of the Neuroscience and Mental Health URI. In addition to doctoral and post-doctoral training, UoA4 runs MSc courses in Neuroimaging Methods and Applications, in Psychiatry, and in Biostatistics and Bioinformatics. The last of these includes a MRC DTG Competition Training Grant for 4 MRC studentships per year for 3 years (commencing 2012), a funded Clinical Academic Mentorship scheme through which we provide mentorship, a training budget to enable clinical trainees to develop a competitive fellowship applications and, since 2009, a summer school in brain disorders research (100 attendees). Further evidence of successful delivery of the strategy with regard to our doctoral training programmes is provided below; here we also note that UoA4 provides the only Doctorate in Educational Psychology in Wales, with an annual intake of 10 students; and a successful Doctorate in Clinical Psychology, with an annual intake of 10 students (increasing to 12 in 2014). Training of Clinical Researchers at Doctoral level has had a particular boost via our success in attracting clinicians onto the Welsh Clinical Academic Training (WCAT) Fellowship scheme (n=8); indeed UoA4 has attracted 40% of all available WCAT-funded posts.

c. People, including:

i. Staffing strategy and staff development

Staffing strategy and staff development operate within Cardiff University's Investors in People Framework. The University's commitment to, and progress towards implementing, the European Charter and Code for Researchers and the Code of Conduct for the Recruitment of Researchers has been recognised by the European Commission with an 'HR Excellence in Research' accreditation. It is a requirement of both UoA4 components that all staff undertake formal Equality and Diversity training. Judgements about promotions in both groups are based upon excellence and made by the relevant School Promotions Panel and the University's Academic Promotions Committee in accordance with a formal Scheme of Assessment that applies equally to all staff taking into account their contractual arrangements and all relevant equality and diversity issues. The effectiveness of commitment to equality and diversity is evidenced by Athena Swan Bronze Awards to the University and separately to both Schools (Psychology and Medicine) represented in UoA4 in recognition of success in recruiting, retaining and promoting women in Science, Engineering and Technology, and by the university's appearance in Stonewall's Top 100 Employers (not merely University) Workplace Equality Index for lesbian, gay and bisexual people.

Staffing strategy in the School of Psychology is shaped by key requirements for: 1) excellence in research and research-led teaching; 2) expertise spread across the entire discipline of Psychology; 3) a healthy balance between senior staff and early career researchers. In the most recent groups of appointments (2011 and 2013) we took a decision to appoint only at the junior (Lecturer) level, and this policy will be continued in the foreseeable future, with an eye to the sustainability of our research performance. In keeping with the strategic aims identified above, our junior appointments have included three positions in autism and neurodevelopmental research.

Staffing strategy in the MRC Centre is determined by its Executive Group. Recruitment since 2008 has been linked to the research strategy described above. Sustainability and capacity in the strategic priority areas has been significantly enhanced through key appointments linking genomics to cell biology, cognitive neuroscience and brain imaging; in stem cells and cell therapies; and in bioinformatics and complex dataset analysis. Recognising that Psychiatry is short of research-engaged clinicians, a mission of the Centre is building capacity by training research clinicians. Our activities with respect to summer schools, mentorship schemes, and WCAT fellowships were documented above, but through NCMH we have also obtained research posts for 5 trainee psychiatrists and 6 trainee psychologists. We are also using the NCMH and a Biobank award to more actively engage clinicians across Wales in research; for example, we have helped 6 NHS consultants and other clinicians to develop successful applications to NISCHR, which allow them each to devote up to 16 hours of protected research time per week for 2-3 years to focus on clinical research.

Staff retention: Across UoA4, 62 of the 84 staff returned in RAE2008 are still employed in UoA4. Of those who left, 11 were ECRs who moved to positions in other HEIs, three left for positions in overseas HEIs, four were appointed to Chairs and one to Reader at other HEIs, one retired, one moved into private practice, and one moved to another Cardiff University School.

Staff Development

All UoA4 research staff have structured career development plans and a formal annual appraisal, consistent with the 'Concordat to Support the Career Development of Researchers' to which both Schools are signatories. Appraisals, which for academics are conducted by senior professorial staff explicitly include both a review of performance and identification of training and career development needs. Cardiff University offers a wide range of workshops and courses that can fulfil these needs. These are free to research staff and the Schools underwrite the costs for academic staff. Where training and development needs cannot be met within the institution, the contributing Schools meet the costs of external courses, subject to need. Regardless of status, all researchers are supported in their preparation of funding bids by internal independent peer tutoring and review throughout the process of grant preparation. Our commitment to the development of the careers of our researchers is demonstrated by the fact that of the 32 non-professorial staff at lecturer level or above in RAE2008 and who are also being returned to REF2014, 25 have since been promoted to SL (n=7), Reader (n=9), or Professor (n=9).

Early Career Researchers (ECRs)

UoA4 has been successful in attracting ECRs who have their own named fellowships and young investigator awards (Royal Society, Wellcome, MRC, Leverhulme, Marie Curie, WCAT, NIHSCR; 29 in the assessment period), and this strategy will continue. We set great store by the contribution made by Research Fellows to the vitality of the research culture, and ECRs are represented on all key decision making bodies (e.g., School of Psychology and MRC Centre Board and Research Committees). ECRs also have a senior mentor to help them reflect on progress, discuss difficulties, identify weaknesses, plan and advise on further development and identify training needs. Where needed (e.g., Leverhulme Trust fellowships), the School of Psychology matches funding for fellowships.

In the School of Psychology ECRs have been active in organising their own pages on the School website that provide incoming researchers with key information; they also organise weekly afternoon 'tea and biscuits' sessions for staff and PGRs to interact informally. ECRs, together with PGRs, organise weekly seminars on Friday afternoons; talks at these seminars are given mainly by ECRs and PGRs. In the MRC Centre all researchers (including RAs and students) are funded to attend at least one international meeting per year at which they are expected to make either a poster or platform presentation. The MRC Centre and the Neurosciences and Mental Health URI (which includes Psychology ECRs) run annual 'seedcorn' initiatives totalling approximately £180K where ECR researchers can bid for support to pump-prime research initiatives.

UoA4's commitment to ECRs is demonstrated by outcome: Of the 12 ECRs returned under RAE2008 who are also being returned to REF2014, two are now Senior Research Fellows, four have been promoted to Chairs, one to Reader, and four to Senior Lecturer. We also encourage Research Assistants of exceptional promise to undertake higher degrees; between 2008-2013, eight such individuals (excluding those progressing to formal studentships) obtained a PhD.

ii. Research students

Effective and sustainable doctoral research training

Awards of 4-year Wellcome Trust Integrated Neuroscience and MRC PhD schemes, and ESRC Doctoral Training Centre status (with an accredited Psychology pathway) provide external evidence of the effectiveness and sustainability of UoA4-related doctoral research training. The School of Psychology is also a member of the BBSRC South West Doctoral Training Partnership. Precise details of the arrangements for PGR students are not identical in the two Schools, but both provide three-tier tailored training programmes provided by the research group, the School, and the University through its University Graduate College. Research students in both Schools attend research seminars on a weekly basis, and give presentations with a deliberate 'layering' from informal (labgroup) through area (research group) to more formal (School/Centre/URI level). New students have their own office space and computer in recently refurbished, dedicated environments. They have access to state-of-the-art research facilities (see Infrastructure), and ample resources for their research. Students have extensive interaction with staff, post-doctoral researchers and other PhD students, academically and socially. Across UoA4, each student has at least a primary and secondary supervisor, and students are required to submit progress reports and research plans every 6 months. Progress is monitored by the supervisors and also by the Director of Postgraduate Research and the relevant Research Committee.

The School of Psychology has a large number of research students (currently 101, excluding a further 61 professional doctorate students), and the postgraduates form a strong research community. In the review period, approximately 20% of these PhD students were from outside the UK, 10% undertook joint projects with other Schools (Biosciences, Computer Science, Dentistry, Earth Sciences, Engineering, Mathematics, Medicine, Optometry, Pharmacy and Social Sciences), and 5% conducted research projects with industrial partners (e.g., Eli Lilly, GSK). Our 4-year completion rates are extremely high (>90%).

All students in the MRC Centre undertake the Diploma in Biomedical Methods, which provides general and specific training, and, depending on student needs, they can also access modules of the Masters courses run by the Centre (Bioinformatics, Biostatistics, Genetic Epidemiology, and Psychiatry). Four-year completion rates have been maintained at a high level (86%) during REF2014. The marked increase in PhD student intake since RAE2008, including clinical fellows, points to the sustainability of our graduate programme, which includes 3 funded 4-year doctoral training schemes (MRC, Wellcome Trust, and Neuroscience and Mental Health URI).

The University Graduate College (UGC) http://www.cardiff.ac.uk/ugc supplements the training provided by UoA4. It offers over 200 training packages and workshops, delivered in more than 400 sessions, covering both specific and transferable skills that enable research students to conduct their research and enhance their future employability. It also provides stand-alone supervisor training. The web-based booking system for these courses and workshops introduces research students to the Researcher Development Framework produced by Vitae, provides students with a self-assessment tool to identify which skill areas they need to develop, and indicates which course or workshop would meet that need. Students are strongly encouraged (and ESRC-supported students are required, through a credit accumulation system) to acquire a range of skills through participation in this programme. Cardiff University was short-listed by the *Times Higher* in 2010 for Outstanding Support for Early Career Researchers.

A strong and integrated research student culture

Research students play a central role in the research culture of UoA4. Indeed, some 40% of the UoA4 outputs submitted to REF2014 were co-authored with former or current research students. A vibrant culture of research presentation and debate is promoted in both the MRC Centre and the School of Psychology through weekly series of meetings at which all PhD students formally present their data, and research students in both groups attend and speak at an annual conference organised specifically for PhD students and run by the students themselves. Doctoral students are also funded to attend, and to present their data at, at least one national and one international meeting during the course of their PhD.

Cardiff University is among the few universities in the UK offering a dedicated facility for its postgraduate students. The **Graduate Centre** http://www.cardiff.ac.uk/gradc/ provides year-round centrally located social and study facilities to both taught and research postgraduate students, and associated activities such as conferences, lectures and seminars. It serves as a hub for postgraduates throughout the university, allowing students to meet and socialise within the broader postgraduate community, adding another dimension to life as a research student at Cardiff. It also hosts the South West and Wales Hub for 18 HEIs in the region, which additionally supports researchers through a region-wide annual conference, and topic-based events covering subjects such as Blended Learning, Evaluation, and Facilitation Skills.

d. Income, infrastructure and facilities

Research Income

Combined research spend for the School of Psychology and the MRC Centre is £8.3m per annum. The largest source of this research income is UK Research Councils; the next largest is UK charities, of which the Wellcome Trust is the most significant source. Thus ~£5m of the annual research income comes from highly selective, peer-reviewed competitions. In Wales there are no large sources of funding equivalent to NIHR support for clinical research, but UoA4 researchers nevertheless secured funding for Wales' only Biomedical Research Centre (£3.3m), the National Centre for Mental Health.

Examples of Significant Awards and Infrastructure Investments since 2008

- £58.3M new research awards, including
  - £25M from **Research Councils**, including £5M MRC Programme grant on

Schizophrenia (2011, renewal) and £2.7M MRC Programme funding in Alzheimer's Disease (2013, new); MRC award (£995K, 2013-16) to support cross-School research on behavioural and neurophysiological effects of schizophrenia risk genes; MRC Challenge award (£924K to Cardiff, 2013-16) to study cortical glutamate and GABA function in psychosis; MRC award (£1m, 2102-17, £425K to Cardiff) to support multi-site clinical research capacity in MEG, involving 8 UK sites;

- £15M in awards from **UK charities** (including Wellcome Trust Strategic Award (£5.2m, 2013-17) to model high penetrance schizophrenia mutations in cells and model organisms, Wellcome Trust New Investigator award £1.7m over 7 years (2012-19), and Wellcome Trust award (£668K, 2012-17) for dedicated computing infrastructure for CUBRIC;
- £9.3M from the **EU**, including leadership of two translational FP7 grants (BRAINTRAIN and REPAIR-HD, detailed below under International Collaborations), and other substantial FP7 grants, including EU-GEI (£3.1M to Cardiff, 2010-15) on gene-environment interactions in schizophrenia;
- £2.4M from **US** Government agencies and charities and an additional $5.7M from Stanley Centre of the Broad Institute at MIT in benefit in kind (processing MRC Centre samples) and $3.1M supporting sample recruitment;
- £3.3M from NISCHR/Welsh Government for Biomedical Research Centre;
- £950K SRIF/University investment in MRC Centre for genomics equipment.

Research Infrastructure and Facilities

Institutional commitment to easy access to research literature is reflected in Cardiff University's annual recurrent budget for electronic journals at £3.7m (2010/11), with subscriptions to more than 22,000 journal titles (above the Russell Group average).

A feature of research in UoA4 is the use of a wide range of methodological techniques to address novel research questions. Researchers have access to state-of-the-art facilities that provide unique opportunities for complementary studies across methodologies and for cross-group collaborations. The research facilities include:

- Over 1100m^2 of specially designed laboratory space for research on cognition, visual and auditory perception, social influences on cognition, emotion, and behaviour.
- Extensive animal laboratories in the School of Psychology (including the Henry Wellcome Laboratories for Behavioural, Transgenic, and Molecular Neuroscience), providing a purpose-built environment for studying learning and memory in animals, at the behavioural, molecular, cellular, neural and genetic level. These laboratories include a barriered area for the housing and production of genetically altered mice.
- Purpose-built laboratories for testing children and patients with neurological and psychiatric disorders.
- Cardiff University Brain Research Imaging Centre (CUBRIC) provides access to the latest scanning technologies including structural MRI, fMRI, EEG, MEG, TMS, TDCS, supporting research from basic neuroscience to clinical research and therapies.
- Dedicated administrative support for research, including ready access to participants for experiments (both undergraduate student and community-based participants) via in-house web-based volunteer panels, and Research Offices in the School of Psychology and the School of Medicine, providing specialist support for the preparation and submission of research grants.
- New research space of 3478m^2 in the Hadyn Ellis Building for the MRC Centre and for the Neurosciences and Mental Health URI provides a base for cross-school researchers who are conducting translational work. An additional £1.5M of CU support has been spent on basic equipment. The new space is close to other neuroscience facilities, including CUBRIC, Cardiff's Experimental MRI Centre (EMRIC) for animal imaging, and the School of Psychology Behavioural Neuroscience Laboratories.
- A dedicated NHS clinic space (270m^2) within the Hadyn Ellis Building to enhance UoA4 patient-centered research.
- MRC Centre Core Genomics Platform including sample tracking, automated sample preparation, platforms for both medium and high capacity Illumina genotyping, next

generation sequencing (Ion Torrent and Ion Proton platforms).
- The Biostatistics and Bioinformatics Unit (BBU). Initially primed with support from the Welsh Government and subsequently funded by the MRC Centre, the now University funded BBU has 3 Senior posts (one Chair), 3 CU-funded RAs, and over 150Tb of dedicated computing space to provide multiple analytic pipelines for UoA4 genome research.

Collaborative use of research infrastructure

As well as making use of the foregoing infrastructure in order to collaborate with other researchers within Cardiff University and beyond (e.g., Bristol University), UoA4 researchers benefit from a range of additional collaborative/core research infrastructural facilities. These include:

- **Advanced Research Computing @ Cardiff** (ARCCA): ARCCA http://www.cardiff.ac.uk/arcca/ is dedicated to supporting and enabling research through the co-ordination and development of high-performance computing (HPC) and e-research services for researchers. Hosting one of the 3 most powerful supercomputers in UK Higher Education, ARCCA provides an important resource for the large computing demands of the genomics studies of the MRC Centre.
- **Central Biotechnology Services (CBS)** http://medicine.cf.ac.uk/cbs/ provides a central ISO 9001 and 17025 accredited "core" facility to School of Medicine and other external (CU, cross-HEI, and Industrial) researchers for biomedical research. Representing an investment since 2008 of £2.3M in equipment and technical support, its genomics and proteomics platforms provide essential technological support to UoA4 researchers.
- **Wales GenePark** http://www.walesgenepark.cardiff.ac.uk**:** Funded by a Welsh Government grant to Cardiff University, the GenePark (jointly managed by UoA4 investigators) brings together genetics expertise in Wales and facilitates knowledge transfer to the NHS and commercial sectors. It provides UoA4 researchers with access to high capacity sequencing, and has facilitated the development of diagnostic testing based upon the work of the MRC Centre.
- **Wales Research & Diagnostic Positron Emission Tomography Imaging Centre (PETIC)** http://medicine.cf.ac.uk/petic/ was established with the aid of a £16.4M capital investment by the Welsh Government and is managed by Cardiff University in partnership with Cardiff and Vale University Health Board. This resource is an important component of the MRC Centre neurodegeneration translational strategy.
- The **Human Factors Technology Centre** http://psych.cf.ac.uk/hftc/ is a multi-disciplinary research centre founded by the Schools of Psychology, Computer Science and Engineering, with funding from a Science and Research Infrastructure grant (~£1M, HEFCW), the Data and Information Fusion (DIF) Defence Technology Centre (Ministry of Defence) and an industrial grant from General Dynamics UK. Its aim is to foster research in emerging areas that require collaboration between engineering and human sciences.
- The extensive **animal laboratories** in the School of Psychology (described above) have provision for shared access and use with other Schools, including the School of Biosciences.

e. Collaboration or contribution to the discipline or research base

Research Collaboration and Interdisciplinary Research

UoA4 research groups collaborate actively at national, international and university levels, and with industrial partners. The following summary is limited to major funded collaborations.

National and cross-HEI collaborations

- **Wales Institute of Cognitive Neuroscience** (WICN). This research institute was initiated in 2007 with a £5.2M grant from the Welsh Government to the Schools of Psychology in Cardiff, Bangor and Swansea to develop sustainable pan-Wales research capacity and international excellence in cognitive and clinical neuroscience. As a result, there is now pan-Wales critical mass in cognitive and clinical neuroscience in the form of 5 chairs (3 in Cardiff) and 16 research fellows. WICN provided support for more than 80 research projects involving at least two HEIs. WICN seed-corn funding and WICN-funded Chair appointments in Cardiff have resulted in grant funding exceeding £3M from RCUK for projects involving researchers in Bangor and Cardiff and has also generated significant external funding from other bodies (e.g., Wellcome Trust, Waterloo Foundation, Epilepsy

Research UK, Alzheimer's Research UK, BRACE).

- The **Climate Change Consortium of Wales (C3W)**. This is a cross-HEI collaboration with the universities of Aberystwyth, Bangor, and Swansea financed (£4M) by the Welsh Government through the Higher Education Funding Council for Wales (HEFCW). C3W has two overarching aims: to improve understanding of climate change and its consequences; and to develop in Wales an international centre for climate change research. Six partner schools at Cardiff are involved (Biosciences, Psychology, Earth and Ocean Sciences, City and Regional Planning, Engineering, and Social Sciences), testifying to the interdisciplinary nature of the research.
- **The Wellcome Trust Case-Control Consortium**: Craddock co-ordinated the Bipolar Disorder Group of this landmark cross-HEI collaboration, and chaired the chromosome copy-number-variant working group, the output from which was published in *Nature*.
- **The Wellcome Trust UK10K:** Owen is co-lead of the Neurodevelopmental Group of this £10M cross-HEI initiative to sequence 10,000 UK subjects.
- **GW4 group:** There are already extensive collaborations with researchers at Bristol (£2M in MRC funding alone) and there are plans for Cardiff researchers to collaborate more closely with colleagues in Bristol, Bath and Exeter, following the establishment of the GW4 group of universities http://www.cardiff.ac.uk/news/mediacentre/mediareleases/y2013/10114.html.
- **UK MEG consortium:** Singh is leading this MRC-funded (£1M) consortium that seeks to build multi-site clinical research capacity in magnetoencephalography.
- **STRATA Consortium:** O'Donovan is the lead Facilitator of the Genetic And Clinical Predictors Of Response work strand of this consortium led by KCL, funded (£4.9M) under the MRC's Stratified Medicine initiative.

International collaborations

- A Smith is a partner in FLAGSHIP, a 53-month, part EU-funded project (€10M), focusing on improvement of safety, environmental friendliness and competitiveness of European maritime transport.
- Van Goozen is co-PI with a colleague at Leiden University of two large Dutch Science Foundation (NWO) grants (combined value €1.3M) on biomarkers of aggression in children and early interventions to prevent the development of aggression in infants.
- UoA4 researchers lead two EU-FP7 Programmes (BRAINTRAIN [Linden, €5.9M], a study exploring the therapeutic use of brain imaging; and REPAIR-HD [Rosser, €6M], a pre-clinical study to develop human stem cells for transplantation in Huntington's Disease); three EU-FP7 work packages, two in EUGEI (O'Donovan, Owen, Holmans, €3.7M), a study of genetic, clinical and environmental factors involved in schizophrenia, and CRESTAR (Walters, O'Donovan, €900K), a study of predictors of clozapine side-effects and response.
- J Williams leads PERADES, an international collaboration of more than 40 research groups in Alzheimer's disease, funded (€3.2M) in 2013 through the EU Joint Programme – Neurodegenerative Disease Research (JPND).
- UoA4 researchers (O'Donovan, Owen) led the genomics section of an NIMH Conte Centre ($1.5M to Cardiff) co-ordinated from Mount Sinai Medical School, which ended its 10-year life cycle in 2011, and co-lead (Pidgeon) the risk perception theme of the US NSF's Centre for Nanotechnology in Society co-ordinated by UC Santa Barbara from 2006-2015.
- UoA4 staff participated in two European Collaborative Research Programmes (combined value to Cardiff: £410K). Manstead and Spears linked with Amsterdam, Louvain-la-Neuve, and Groningen to study the role of emotions in intergroup relations, while Manstead and van der Schalk linked with Geneva and Berlin to study social aspects of emotion regulation.
- Other international collaborations in which UoA4 investigators play leading roles include the NIMH-funded Psychiatric Genomics Consortium of over 500 researchers (roles include O'Donovan, Chair of Schizophrenia Group & Overarching Management Group; Craddock, co-Chair of Cross disorder Group), Genetic and Environmental Risk in Alzheimer's Disease Consortium, which comprises 20 research groups from Europe and the US, led by J Williams), and International Genetics of Alzheimer's Project, co-founded by J Williams.

Intra-university collaborations

- Collaboration between research groups in UoA4 is embedded within the College research strategy. It is formalised by the Neurosciences and Mental Health URI, which is supported by Schools and by the College. The URI is an axis for strategic joint appointments among member schools and between them Psychology, Medicine and Biosciences contribute to 6 cross-School appointments (4 at professorial level, one senior lectureship and one lectureship). The fruits of this collaboration are demonstrable income (as spend) in grants shared between the two UoA4 groups of around £1M p.a., rising to £1.4M with inclusion of other members of the URI, and the recent Wellcome Trust Strategic Award of £5.2M, and the EU-FP7 BRAINTRAIN and REPAIR-HD awards described above.
- The School of Psychology is one of the core participants in the Sustainable Places URI supported at both the university and individual school level. Current collaborative income from grants is approximately £300k p.a., with a significant number of interdisciplinary postgraduate students (10 since 2008), jointly supervised with the partner URI Schools.
- Staff in the School of Psychology established the interdisciplinary Values in Action research centre http://psych.cf.ac.uk/via/, primarily a collaboration between philosophers and psychologists but also involving 3rd sector participants. The shared goal is to gain a better understanding of how personal values are translated into behaviour.

Collaborations with industrial research partners

- With Welsh neuromedical companies Magstim and Dymed, Chambers and colleagues in CUBRIC received funding of £194K from the Academic Expertise for Business (A4B) grant scheme to develop concurrent transcranial magnetic stimulation (TMS) and magnetic resonance imaging (MRI) at CUBRIC. This is also supported via a KESS PhD Studentship with Magstim (£55K).
- UoA4 has held 8 BBSRC industrial CASE awards during the assessment period.
- Research by Jones and Macken on auditory distraction and its impact on communication on military flightdecks, and on performance in the workplace generally is supported by industry-funded studentships in collaboration with QinetiQ, one of the world's leading defence technology and security companies (total value in assessment period: £200K)
- Robertson's work on multiple sclerosis and T-Cell function is supported by Sanofi (£250K)
- Funding initiative in experimental medicine in collaboration with P1vital Ltd (Oxford) comprising academic centres in Cardiff, Manchester and London (IoP) and industrial partners including Astra Zeneca, GlaxoSmithKline; http://www.p1vital.com/consortium.html. Translational research is being carried out in Cardiff with the aim of developing better treatments for psychiatric disorders (value £277K).
- UoA4 researchers are part of the Lilly Centre for Cognitive Neuroscience, a consortium of academic and industrial neuroscientists seeking to enhance the probability of clinical success for molecules targeted at conditions involving cognitive dysfunction. This includes a £300K award from Lilly for studying immunity and Alzheimer's Disease.
- The MRC Centre is a partner with Janssen in the Severnside Alliance for Translational Research (http://www.sartre.ac.uk) to develop novel drug target validation strategies.
- Since 2010, the MRC Centre has had highly productive collaboration with both Leyden-Delta and Novartis, enabling a collection of 12,000 new cases with schizophrenia that has been transformative internationally in psychiatric genetics.

Participation in the Peer-Review Process

Here we limit ourselves to committee memberships of funding agencies and significant roles played in other major bodies during the assessment period:

Funding agencies

Alzheimer's Research UK: J. Williams (Chair). **Australian Research Council**: D. Dwyer (International Assessor); **BBSRC**: R. Honey (Board member); **European Commission**: D.K. Jones (member Expert Review Committee), **European Research Council**: M. Owen (Panel member), **MRC**: K. Graham, M. O'Donovan, J. Williams (Board members); **NISCHR**: D. Linden (Awards Panel member); **Norwegian Research Council**: S. van Goozen, S. Vann (International Referee Panels); **NSERC** (Canada): W. Macken (Peer Review Panel member); **NSF (US)**: N. Pidgeon (member Climate Decision Making Under Uncertainty Centres Panel); **NWO** (Dutch Science Foundation): G. Maio (member of Advisory Committee for Behavioural Sciences and

Education, TOP Grants); **Parkinson's UK**: A. Lawrence, (Advisory Panel member); **The Brain Tumour Charity**: R. Wise (Grant Review and Monitoring Committee member); **Wellcome Trust**: J. Aggleton, D.K. Jones, A. Thapar (Committee members); K. Singh, M. Owen (Panel members).

Positions of influence

Through their research prominence, many UoA4 researchers have been appointed or elected to positions of influence at local, national and international levels, the most notable example being J. Williams' appointment as **Chief Scientific Adviser for Wales**. Other examples are illustrated by the following list:

Academy of Medical Sciences: J. Aggleton (Council Member); **Alzheimer's Research UK**: J. Williams (Chief Scientific Adviser); **British Neuroscience Association**: J. Aggleton, M. Owen (Strategic Advisory Board); **DSM-V**: M. Owen (Psychosis Panel); **DEFRA and DECC**: N. Pidgeon (Vice-Chair of Social Sciences Expert Advisory Panel); **European Association of Social Psychology**: G. Haddock (Program Committee member); **European Society for Magnetic Resonance in Medicine and Biology (ESMRMB)**: D.K. Jones (Executive Board); **Experimental Psychology Society**: J. Pearce (President); **International Society for Magnetic Resonance in Medicine (ISMRM)**: D.K. Jones (Member, Board of Trustees, Executive Committee of British Chapter); **International Society for Psychiatric Genetics**: N. Craddock (Past President); **International Society for Research on Aggression**: S. van Goozen (Council Member); **National Centre for Mental Health**: N. Craddock (Director); **Research Excellence Framework**: M. Owen (Deputy Chair, Sub-panel 4), J. Hall (Panel Member), K. Graham (Output Assessor), A. Manstead (Expert Advisory Group); **RCUK**: J. Pearce (Member, Steering Group, International Benchmarking of UK Psychology); **Royal College of Psychiatrists**: N. Craddock (President of the Academic Faculty, Treasurer of Royal College); **Society for Personality and Social Psychology**: A. Manstead (Chair of Campbell Award Panel), G. Maio (Chair of Committee for Media Achievement & Media Prize Awards); **UK Biobank**: D.K. Jones (Advisory Panel Member).

Editorships and Associate Editorships

During the assessment period UoA4 members have had significant Editorial roles at major journals. Here we limit ourselves to the 2 Chief Editorships (CE) and 13 Associate Editorships (AE).

British Journal of Psychiatry: N. Craddock (AE); ***British Journal of Psychology***: G. Haddock (AE); ***Cortex*** (C. Chambers, Registered Reports Editor, equivalent to AE); ***European Journal of Neuroscience***: A. Isles (AE); ***Human Brain Mapping***: Richard Wise (AE); ***Human Reproduction Update***: J. Boivin (AE); ***Journal of the Acoustical Society of America***: J. Culling (AE); ***Magnetic Resonance in Medicine***: D.K. Jones (AE); ***Personality and Social Psychology Bulletin***: G. Haddock (AE); ***Psychological Science***: A. Manstead (AE); ***Schizophrenia Bulletin***: M. Owen (AE); ***Quarterly Journal of Experimental Psychology***: D. Dwyer (AE); ***Social Development***: D. Hay (CE), K. Shelton (AE); ***Wiley Interdisciplinary Reviews: Climate Change***: L. Whitmarsh (CE).

Distinguished Fellowships

During the assessment period the following were recognised by distinguished fellowships.

- Fellow of the **Royal Society**: J. Pearce and J. Aggleton
- Fellow of the **British Academy**: A. Manstead
- Fellow of the **Society of Biology**: D.K. Jones
- Honorary Fellow of the **British Science Association**: N. Pidgeon
- Fellow of the **International Society for Magnetic Resonance in Medicine**: D.K. Jones
- Fellow of the **Academy of Social Sciences**: D.M. Jones, A. Manstead
- Fellow of **Academy of Medical Sciences**: N. Craddock, A. Thapar

Major Prizes and Awards

- **Commander of the British Empire** (services to Alzheimer's Disease research): J. Williams
- **Erik Strömgren Medal** for Psychiatric Research: N. Craddock, M. Owen
- **Henri Tajfel Award** (from the European Association of Social Psychology): A. Manstead
- **Lieber Prize** for Schizophrenia Research: M. O'Donovan, M. Owen
- **Royal Society Wolfson Merit Award**: J. Aggleton
- **William K Warren Distinguished Investigator Award:** M. O'Donovan, M. Owen.